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Self-Referential Processing Accounts for Cultural Variation in Self-Enhancement Versus Criticism: An Electrocortical Investigation

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European Americans are self-enhancing, whereas East Asians are sometimes self-critical. However, the mechanisms underlying this cultural difference remain unclear. Here, we addressed this gap by testing 32 Taiwanese and 32 American young adults, who indicated whether their self-esteem would change in various episodes involving success or failure. We monitored their electroencephalogram (EEG) and assessed upper-alpha band power in response to the outcome information. An increase in upper-alpha power indicates internally directed attention; therefore, it is an index of self-referential processing when assessed during a judgment about the self. As predicted, Americans judged that their self-esteem (but not another's) would increase more after a success than it would decrease after a failure, thereby showing the previously observed self-enhancing pattern. Taiwanese tended to show the opposite pattern, self-criticism. Notably, Americans, but not Taiwanese, showed an increase in upper-alpha band power in response to the self's successes (vs. failures). This bias in the EEG index of self-referential processing predicted the cultural difference in self-enhancement (vs. criticism). The role of self-referential processing in self-enhancement is discussed.

Keywords: self-enhancement, culture, EEG, self-referential processing

Supplemental materials: https://doi.org/10.1037/xge0001154.supp

Self-enhancement (a tendency to overestimate the self's worth) is one of the most robust findings in social psychology. This effect has been repeatedly observed in European American samples (Kruger & Dunning, 1999; Taylor & Brown, 1988). However, it is less robust among East Asians (Heine et al., 1999). Sometimes, East Asians even show the opposite tendency of self-criticism (Karasawa, 2001; Kitayama et al., 1997). At present, it is not clear what mechanisms might account for this cultural variation in self-evaluation. Here, we propose that self-enhancement (vs. criticism) results from a bias in processing positive (vs. negative) self-relevant information. To measure this bias, we turned to electroencephalogram (EEG) and focused on upper-alpha band power. An increase in upper-alpha band power indicates internally directed attention (Benedek et al., 2014; Klimesch et al., 1999, 2007); therefore, it indicates self-referential processing when observed during a judgment about the self. We anticipated that European Americans, but not East Asians, would be more likely to engage in self-referential processing when they experience a success than a failure. This self-referential processing in response to one's success (vs. failure) should make them feel more strongly about their success (vs. failure), thereby leading to a self-enhancing judgment.

Culture and Self-Enhancement

Self-enhancement refers to an assortment of phenomena linked to the perceived positivity of the self. In Western cultural contexts, these phenomena are both widespread and robust. For example,

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All authors developed the study concept and design. Data collection was performed by Cristina E. Salvador, Aya Kamikubo, Brian Kraus, and Nai-Ching Hsiao. Data analysis and interpretation was performed by Cristina E. Salvador, Aya Kamikubo, and Brian Kraus. Cristina E. Salvador and Shinobu Kitayama drafted the article, and Aya Kamikubo, Brian Kraus, Nai-Ching Hsiao, Jon-Fan Hu, and Mayumi Karasawa provided critical revisions. All authors approved the final version of the article for submission.

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people seek social comparisons favorable to the self (Festinger, 1954). Further, they distort their memory to justify their inflated views of the self (Greenwald, 1980). It is also common that they overestimate their own but not others' competence, future success, and other positive traits. This effect is called the better-than-average effect (Alicke et al., 1995; Taylor & Brown, 1988). Based on this evidence, numerous scholars have posited that people have a motivation to see the self in a positive light (Festinger, 1954; Greenwald, 1980; Kruger & Dunning, 1999; Taylor & Brown, 1988).

Given the robustness of self-enhancing effects in the current literature, it may come as a surprise that self-enhancement is less robust or even absent in East Asian cultures (Heine et al., 1999). For example, the better-than-average effect is less robust (Heine & Lehman, 1995) or sometimes completely absent among East Asians (Markus & Kitayama, 1991a). Moreover, a variety of social psychological effects indicative of the motivation for self-positivity are also less robust among East Asians (Heine & Lehman, 1997; Kitayama et al., 2009). This cultural difference occurs even when responses are unlikely to be consciously monitored. For example, in one recent study, European American and East Asian participants performed a cognitive task to earn a prize either for themselves or their friends. During this task, an event-related potential signal called the error-related negativity (ERN) was measured. The ERN occurs when participants commit an error. Importantly, the magnitude of the ERN increases when participants are motivated to perform the task well (Gehring et al., 2012). As may be expected, European Americans' ERN was significantly greater when they sought points for the self than when they sought points for their friend, indicating a self-enhancing motivation. This same effect, however, was absent for East Asians (Kitayama & Park, 2014).

Cultural variation in self-enhancement has also been observed in an assortment of effects involving self-esteem (SE). The average level of SE, as assessed with standard self-report scales, is far higher for European Americans than for East Asians (Heine et al., 1999). Moreover, European Americans engage in various tactics to maintain or enhance SE, but East Asians typically do not (Heine et al., 2001). One example comes from a self-serving bias in causal attribution. European Americans typically attribute success to their ability or other internal traits and dismiss their failures by attributing them to external causes (e.g., bad luck; Miller & Ross, 1975). In contrast, this attribution pattern is less typical among East Asians (Heine et al., 1999; Kitayama et al., 2009).

Building on prior work comparing SE across cultures, Kitayama et al. (1997) had participants judge whether their SE would increase or decrease in numerous situations that involved either positive or negative outcomes (successes or failures). For European Americans, the tendency to exaggerate self-worth (or self-enhancement) may make them perceive the successes as genuine since they reflect their personal attributes (e.g., competence), while they may dismiss failure by blaming external reasons (Miller & Ross, 1975). Consistent with this analysis, European Americans reported that their SE would increase more when the outcome was positive (e.g., "succeeded") than it would decrease when the outcome was negative (e.g., "failed"). Of note, Kitayama et al. (1997) also found that Japanese reported that their SE would decrease more when the outcome was negative (e.g., "failed") than it would increase when the outcome was positive (e.g., "succeeded"). Japanese appear to have blamed themselves for negative outcomes more than they took credit for positive outcomes. The researchers interpreted this result as evidence for self-criticism among Japanese (Kitayama et al., 1997). However, we must treat this evidence for self-criticism as preliminary since most other studies do not find self-criticism among East Asians. Instead, East Asians typically do not show self-enhancement, at least as strongly as European Americans (Heine & Hamamura, 2007).

The possibility that self-enhancement is particularly strong among European Americans (Heine et al., 1999) is consistent with a broader idea that cultures vary in the view of the self that they value and sanction (Markus & Kitayama, 1991b). In particular, European American cultures value the independence of the self from others (Markus & Kitayama, 1991b). Independence requires confidence, optimism, and high SE (Heine et al., 1999). Such an emphasis on the self's positive attributes may make such attributes central to ones' self-concept. Through socialization, caretakers draw the child's attention to their strengths rather than weaknesses, and as a consequence, children may gradually internalize the habit of elaborating on their positive attributes (Kitayama & Salvador, 2017; Vygotsky, 1980). Eventually, those socialized in European American contexts may be prone to contemplate their positive self-attributes, confirm them, and express them in a culturally appropriate manner.

In contrast, East Asian cultures value the interdependence of the self with others (Markus & Kitayama, 1991b). These cultures do not place much value on the self's positive attributes. Instead, they place a greater emphasis on one's ability and willingness to adjust and conform to social norms (Heine et al., 2001). For example, in East Asia, parents may encourage their child to be attentive, be considerate, and abide by social expectations. They rarely try to boost their child's SE for the sake of doing so (Heine et al., 1999). Hence, those socialized in such cultures may not acquire a self-referential processing bias that favors the self. This analysis is consistent with the findings noted above that self-enhancement is often weaker or completely absent in East Asian cultural contexts.

In short, the current cross-cultural evidence shows that self-enhancement is more robust in European Americans than in East Asians. At present, however, it is not clear what specific cognitive and motivational mechanisms might be responsible for the self-enhancing effects European Americans exhibit. Nor is it clear how these mechanisms might explain the cultural difference in this phenomenon.

The Self-Referential Processing Hypothesis of Self-Enhancement

Given the robustness of self-enhancement, it is hard to question the possibility that people have a motivation for self-positivity—at least in Western cultural contexts. This motivation may help explain why, for example, European Americans responded more strongly to their mistakes in a cognitive task when performing the task to earn a prize for the self than to earn a prize for their friend (Kitayama & Park, 2014). It is noteworthy, however, that motivation may not always be involved in self-enhancement. Specifically, the mean SE score based on standard scales is surprisingly high among North Americans (Heine et al., 1999). Therefore, positive (rather than negative) self-relevant information may prove consistent with prior beliefs about themselves and expectations based on them. This cognitive mechanism may explain why people attend more to positive (rather than negative) self-relevant information (Gershman, 2019; Kim et al., 2020; Miller & Ross, 1975).

Researchers have sometimes treated the motivational and cognitive processes as mutually exclusive. However, this approach neglects the possibility that the preferential processing of positive self-relevant information may be motivated (Kunda, 1990). This more integrative view of self-enhancement suggests that the motivation for self-positivity exerts a bias in cognitive processing in positive (vs. negative) directions. Thus, the motivational effect may be realized through a bias in the cognitive processing of self-relevant information. In the case of self-enhancement, we hypothesize that people are motivated to attend to and elaborate on positive information relevant to the self over its negative counterpart. This bias in self-referential processing may then increase the impact of positive information on a subsequent judgment about the self. This formulation may be called the self-referential processing hypothesis.

Our analysis implies that European Americans preferentially process information favorable to the self. This preferential processing of information may lead to subsequent self-enhancing judgments about the self. However, East Asians do not show the preferential processing of positive (vs. negative) self-relevant information, which in turn may account for the absence of self-enhancement. To test this possibility, we must assess an in vivo measure of preferential cognitive processing—a measure assessed online while the effect is happening. Unfortunately, almost all previous studies in this area focus on outcome variables, such as self-enhancing judgments and information search. Rarely have measures of this processing been assessed simultaneously with the relevant outcome variables. In the current work, we sought to overcome this limitation by using an EEG measure of self-referential processing.

EEG Index of Self-Referential Processing

Prior evidence shows that the spectral power of the upper-alpha range (10.5–13 Hz) carries information about whether attention is directed either externally or internally (Klimesch, 2012; Klimesch, Doppelmayr, Pachinger, et al., 1997; Klimesch, Doppelmayr, Schwaiger, et al., 1997). Unlike the lower half of the alpha band (8–10.5 Hz), which is topographically diffuse and more general in its functions (Klimesch et al., 1999), the upper half of the alpha band (10.5–13 Hz) indexes internal versus external attention (Salvador, Kraus, et al., 2020). Specifically, when individuals attend vigilantly to an external object, their upper-alpha power is known to decrease—an effect called alpha suppression (Benedek et al., 2014; Klimesch, 2012; Ray & Cole, 1985). Alpha suppression is found across various tasks that require externally directed attention, including sentence processing (Bastiaansen et al., 2002; Bastiaansen & Hagoort, 2006) or more social tasks, such as attending to others' behaviors (Perry et al., 2011; Salvador, Kraus, et al., 2020). Conversely, upper alpha becomes stronger (or less "suppressed") when there is competing demand for internally directed attention. Attention may be internally directed, for example, when the eyes are closed to avoid external stimulation (Ray & Cole, 1985). Also, alpha band power is higher at rest when a person self-reports thinking about the self (Knyazev, 2013) or is high in independent self-construal (Kraus et al., 2021).

Altogether, this growing body of evidence shows that the relative increase of upper-alpha band power is a robust indicator of attentional resources allocated internally to memory representations (Klimesch et al., 1999). It is important to note that upper-alpha power in and of itself is not a measure of the specific content of internal memory representations instantiated by this internal attention. The specific memory representations that are activated are dependent on the context, such as the demands of the task. When the task involves a judgment about the self, it should call out certain representations of the self. These representations may include abstract trait-like representations of the self, episodic or autobiographical memories, and future plans (Northoff, 2016; Schacter et al., 2003). Under these conditions, upper-alpha power may reliably capture self-referential processing. Consistent with this idea, one line of research has found that alpha power—including the power of the upper-alpha range—is greater for people who retrospectively report that they were more engaged in thinking about the self (Knyazev et al., 2011, 2012).

Present Study

In the present study, following Kitayama et al. (1997), we asked people to imagine themselves and others in a series of social events. A description first set up a context (e.g., "You finished your school exams last week") and then depicted an outcome that occurred in the context by manipulating the last word (e.g., "soon after you found out that on the most important one you succeeded/failed"). The onset of the last word was when participants learned of the outcome for the first time. Participants then indicated whether the event would influence their SE and by how much.

We predicted, first, that in the self-judgment condition, European Americans would show a relative increase in power in the upper-alpha band (a hypothesized correlate of self-referential processing in this context) when the outcome was a success but not when it was a failure. Second, we also predicted that European Americans would show a greater self-enhancement bias: They would judge that their SE would increase more for the success outcomes than it would decrease for the failure outcomes. Third, the increase in upper-alpha power in response to positive (vs. negative) outcomes would predict this self-enhancement bias. That is, participants who show a greater upper-alpha band power increase in response to successes (vs. failures) would show stronger self-enhancement. Importantly, we predicted Taiwanese (who are similarly interdependent as Japanese) would not show this pattern. By assessing both self-enhancement and upper-alpha power, we tested whether the cultural difference in the upper-alpha power during the processing of successes (vs. failures) would explain the cultural difference in self-enhancement. To explore whether independent or interdependent self-construal might be related to self-enhancement or criticism, we tested whether these construals might be associated with self-enhancement and self-referential processing. Finally, we expected these effects would be specific to the self and would be absent in a control condition involving a judgment about another's SE.

Method

Participants

Thirty-eight European American young adults in the United States and 45 Taiwanese young adults in Taiwan participated in the study. All American participants were right-handed, reported being of European American descent, and were born and raised in the United States. They were compensated with course credit for their time. All Taiwanese participants were right-handed and reported being of

Taiwanese descent and raised in Taiwan. They were compensated with NT$420 (approximately US$14). Of the 38 American participants, six were excluded for not finishing data collection (one), reporting neurological issues (two), and excessive artifacts in their EEG recordings (three). This left 32 participants with usable data (20 female, M_{age} = 18.97, SD = 1.09). Of the 45 Taiwanese subjects, 13 were excluded for either having excessive artifacts in their EEG recordings (11) or for use of psychoactive medications (two). This left 32 subjects with usable data (15 female, M_{age} = 21.78, SD = 3.13). An earlier study successfully used upper-alpha suppression as a measure of external attention with $N = 30$ in each experimental condition (Salvador, Kraus, et al., 2020). We set the same target N as that prior study, which was 50% more participants than some prior studies on self-enhancement (e.g., Cai et al., 2016). Materials, scripts for data analysis, and de-identified behavioral and EEG data of the present study are available at https://osf.io/ahwe7/?view_only=07bd652a8da94d64a73ed2a55b170d81. This study was not preregistered.

Materials

It is crucial to use culturally familiar and thus experientially realistic stimuli to assure ecological validity in the assessment of self-enhancement (or the absence thereof). Stimuli for the SE judgment task were adopted from Kitayama et al. (1997). This study presented 400 situations involving success or failure to American and Japanese students, who reported whether and how much their SE would go up or down in each situation. These situations had been generated from the respective populations (i.e., American and Japanese college students) to ensure their relevance for these participants. We randomly selected 20 success and 20 failure situations from the 400 situations in the Kitayama et al. (1997) study and edited them so that each episode was broken down into two separate sentences. The first sentence established a context and was followed by the second sentence, which presented the outcome. The outcome was manipulated by varying the last word or phrase. A total of 160 stimuli were created out of the 40 situations by manipulating the target (self and other) and outcome (success or failure) of the situation. We manipulated the target (self or other) by asking participants to imagine either themselves or a stranger (e.g., Steve) in the situation. We varied outcome (success or failure) by changing only the last word of the sentence. Aside from changing the words by specifically manipulating the target or outcome, the sentences in all the conditions were kept identical. Back-translation was used to ensure the equivalence of the translation between the two languages. Further, two U.S.-Taiwanese bilinguals ensured that the stimuli were culturally valid and common in both the U.S. and Taiwanese contexts. The stimuli of the current study are listed in online Supplemental Table S1.

Procedure

Participants were told that they were recruited for a study on self-evaluation. Upon arrival at the lab, participants filled out a consent form and prescreening questions on medication use, history of seizure disorders, head injury, ethnicity, and handedness. Participants were then seated approximately 60 cm from a color computer display. After the EEG was set up, participants completed a resting state task reported elsewhere (Kraus et al., 2021). Participants subsequently performed an SE judgment task (see Figure 1), wherein they read a two-sentence story describing a situation that varied in the outcome (success vs. failure) and the target (self vs. other) of the situation. Then, they were asked to make a series of judgments about the target's SE. Participants completed four practice trials to learn the procedure and ask any questions they had. The stimuli were presented in a randomized order with a restriction that a variation of all 40 situations was shown in each of the four experiment blocks. All stimuli were presented in English for U.S. participants and in Traditional Chinese for Taiwanese participants.

As shown in Figure 1, on each trial of the SE judgment task, a fixation cross was presented for 1,000 ms, followed by the first of two sentences describing a situation. Participants imagined either the self or another person as the target in the situation (e.g., "You/Steve finished your school exams last week"). The first sentence was presented for 4,000 ms. After the first sentence, another fixation cross was presented for 1,000 ms. This was immediately followed by a second sentence, which described either a success or failure for the target ("Soon after you/he found out that on the most important one you/he failed/passed"). Unlike the introductory sentence, the second sentence was presented one word at a time, every 350 ms, with a 200-ms interstimulus interval. To minimize any motor artifacts in the EEG recording, participants waited 2,000 ms after the completion of the last phrase of the second sentence before being asked to judge how the situation would influence either their own or the other person's SE.

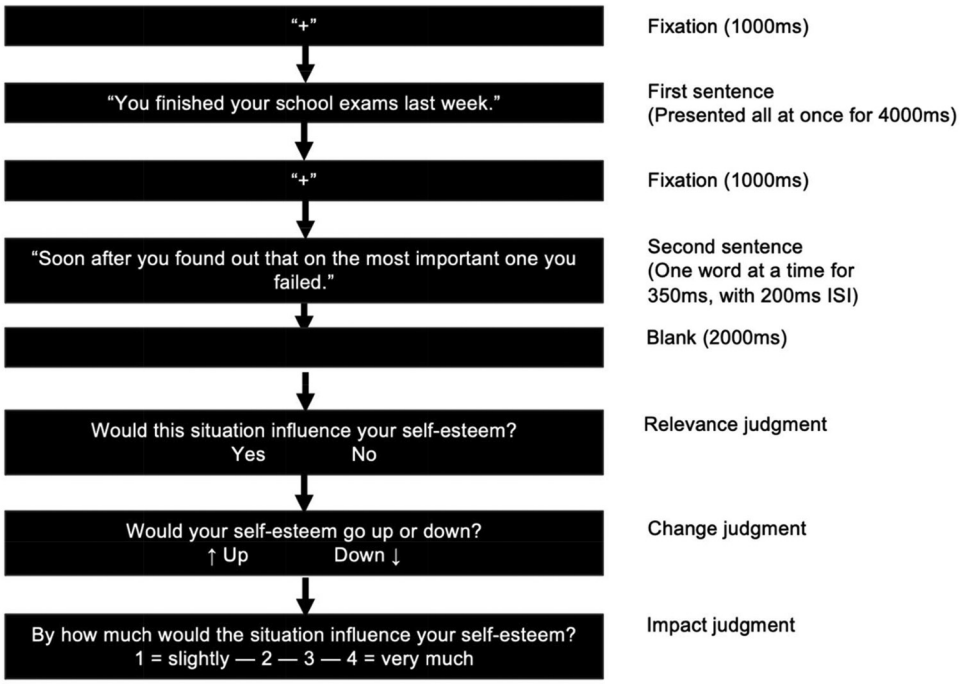
The SE judgment involved three steps. First, participants indicated whether the target's SE would change based on the described situation with a yes/no judgment. If they indicated "no," they moved on to the next trial. However, if they indicated "yes," they moved on to the second judgment wherein they were prompted to indicate whether the target's SE would increase or decrease. Then, in the third step, they indicated the magnitude of the target's change in SE by using a 4-point rating scale (1 = *slightly*, 4 = *very much*). After the SE judgment task, the participants filled out a packet of questionnaires before they were dismissed. The packet included a modified version of the Singelis Self-Construal (SC) Scale (Kitayama & Park, 2014).[1] The scale was composed of a 10-item Independent SC subscale (αs = .742 and .801 for Americans and Taiwanese, respectively; "I do my own thing regardless of what others think") and a 10-item Interdependent SC subscale (αs = .728 and .531 for Americans and Taiwanese, respectively; "I will sacrifice my self-interest for the benefit of the group I am in"). These judgments were made on a 5-point rating scale (1 = *doesn't describe me at all*, 5 = *describes me very much*). Note that the reliability for the Interdependent SC scale was low for Taiwanese; thus, we urge caution in interpreting the correlations with this scale.

EEG Data Recording

At the U.S. site, the EEG was recorded with 32 scalp channels using silver chloride electrodes with a BioSemi Active Two system configured to the 10–20 electrode system. The EEG scalp electrodes for the U.S. group were Fp1, Fp2, F7, F3, Fz, F8, F4,

[1] This packet also included the Rosenberg Self-Esteem Scale, Self-Efficacy Scale, BIS/BAS scale, Need to Belong Scale, Fear of Negative Evaluation Scale, and Regulatory Focus Questionnaire. The remaining scales were included for exploratory purposes unrelated to the current study.

Figure 1
The Trial Structure of the Current Work



FCz, FC1, FC5, FC2, FC6, T7, C3, Cz, C4, T8, CP5, CP1, CPz, CP2, CP6, P3, Pz, P4, O1, Oz, O2, P7, P8, PO3, and PO4. EEG data were recorded at 512 Hz. The electrooculogram was monitored using bipolar VEOG and HEOG electrodes. Impedances during data collection were kept under 10 kΩ and acquired with an online reference unique to the Active Two system. For the Active Two system, the online filter is low pass only and performed by the ADC's decimation filter with a fifth-order sync response with a –3 dB point at one fifth of the selected sample rate.

At the Taiwan site, the EEG was recorded using 30 scalp channels from a Neuroscan system in DC mode with a gain of 19 (range: 263 mV) using a 32-bit ADC and configured to the 10–20 electrode system. The EEG scalp electrodes for the Taiwanese group were Fp1, Fp2, F7, F3, Fz, F8, F4, FT7, FC3, FCz, FC4, FT8, T3, C3, Cz, C4, T4, TP7, CP3, CPz, CP4, TP8, T5, P3, Pz, P4, T6, O1, Oz, and O2. An online bandpass filter was used during recording (.1–200 Hz), and the data were online referenced to the bilateral linked mastoids. The recorded EEG was digitized at 1,000 Hz. The electrooculogram was monitored using bipolar VEOG and HEOG electrodes. Impedances during data collection were kept under 10 kΩ.

EEG Data Processing

The EEG data were first down sampled to 256 Hz. Then, the data underwent an offline low-pass filter of 20 Hz. In the United States, a high-pass filter of .1 Hz was applied since this was not done online. Then, in the U.S. sample, the scalp electrodes were referenced digitally to the average of the two mastoids. This reference was also applied online in the Taiwanese sample. The recorded data were then segmented into epochs of 200 ms before the onset of the final word (or phrase) of the second sentence and 1,000 ms after the onset. Ocular artifacts were corrected using a variation of a standard regression-based algorithm (Gratton et al., 1983). Automatic artifact detection was then performed on the data. Trials were rejected if, for any scalp electrode, the maximum peak-to-peak voltage exceeded 100 μV within a 400-ms moving window with 100-ms steps that moved across the length of each epoch. Trials were also rejected if, at any scalp electrode, the recorded EEG fluctuated more than 30 μV between two sample points or if any scalp channel had little to no activity (±1 μV) over the entire length of the trial. Participants who had less than 20 usable trials (out of 40 in total) remaining in any of the four conditions defined by outcome and target were excluded from data analysis (as noted in the "Participants" section).

Measurement of Upper-Alpha Band Power

To measure event-related upper-alpha activity, we performed a time frequency analysis (TFA; Cohen, 2014). First, we created a data segment longer than the time period of interest to perform a TFA with a moving window approach. To do so, we mirrored the data (Cohen, 2014). This involves duplicating the original data segment, reversing it along the *x*-axis (time), and appending it to both ends of the original epoch. This allowed us to create a larger EEG data segment (−4,043 to 4,742 ms) to avoid what are referred to as edge artifacts in the TFA decomposition (Salvador, Kraus, et al., 2020). To decompose the signals, we used complex Morlet wavelets (Cohen, 2014). The wavelets were three cycles wide at the lowest frequency (.5 Hz) and were gradually reduced in size to 24 cycles wide at the highest frequency (20 Hz). We then extracted 313 log-spaced frequencies between .5 and 20 Hz

utilizing zero-padding to a factor of 8. For each trial, the baseline was defined as the 200-ms window prior to the onset of the stimulus. These baseline power values were subtracted from the spectral power value during the critical window at each frequency and time point, and the result of this was then divided by the baseline value. Although the values of absolute spectral power may in part be device dependent, the normalization of the signal that occurs when calculating change from baseline in decibels should mitigate these effects. We followed earlier work assessing upper-alpha power as a measure of external versus internal attention (Salvador, Kraus, et al., 2020) and extracted upper alpha at Pz. We then averaged the event-related spectral perturbation between 200 ms and 700 ms poststimulus onset in the 10.5–13 Hz frequency range.

Analysis of Self-Report Data

We had two self-report measures of self-enhancement: the perceived relevance of the situation on SE and the perceived extremity of SE change. All trials with valid self-report responses are called the full data set. On some of the trials in the full data set, artifacts in the EEG occurred, due plausibly to ocular artifacts and the movement of other facial musculature, overt head movements, and sweat. As noted above in the "EEG Data Processing" section, these EEG artifacts were detected or corrected automatically with standard algorithms. In the current work, one of our primary goals was to link self-referential processing assessed with EEG upper-alpha band power to self-enhancement assessed with patterns of self-report judgment. This analysis called for another, more restricted set of trials by excluding the trials with EEG artifacts. This restricted set of trials is called the valid EEG data set.

On every trial, participants indicated whether their or another person's SE would be impacted (the perceived relevance judgment). There were 10,240 trials in total (160 situations $\times$ 64 participants). The full data set included all these trials. Out of the 10,240 trials, 915 were identified as containing EEG artifacts via our artifact rejection algorithms. Thus, the valid EEG data set for the relevance judgment included 9,325 trials (= 10,240 − 915). Only when the situation was deemed relevant, participants were shown two subsequent questions (8,152 trials). Participants judged whether their or another person's SE would go up or down (SE change judgment) and how much (SE impact judgment).[2] The valid EEG data set (which excluded 679 trials with EEG artifacts) for the analysis of the SE change judgments included 7,296 trials.

We used a logistic generalized linear mixed model to analyze the binary choice of each situation as relevant or not relevant to SE (Jaeger, 2008). We calculated Cohen's d to report effect sizes, referred to as Cohen's d_z for within-subjects tests and Cohen's d_s for between-subjects tests (Lakens, 2013). For F tests of regression coefficients of interactions or main effects involving a within-subjects variable, we used Cohen's d_z to calculate the effect size.

In our study design, trial, the Level-1 variable, was subsumed under two within-subjects (Level-2) variables (condition and outcome). The Level-3 variables included two between-subjects variables (culture and gender). We analyzed the perceived extremity of SE change in a mixed linear model framework (Baayen et al., 2008). In both analyses, we first attempted to fit the maximal model, which included random intercepts for each subject as well as the 40 stimuli and random slopes for outcome and target and their interaction (Judd et al., 2017). This model did not converge in all cases, so the interaction for outcome and target, and random slope for subject was dropped (Bates et al., 2014). This further reduced model did not converge for the impact measure; thus, we dropped the random slope for target, which left us with random intercepts for subject and trial and a random slope for outcome. While we report individual means for transparency, absolute values of both ratings and alpha can vary substantially across cultures for idiosyncratic reasons. Moreover, of particular interest to the present work is to examine the mechanisms underlying the cultural difference in self-enhancement and criticism. Self-enhancement (vs. criticism) is defined as the relative tendency to report experiencing successes as more relevant and impactful than failures. To best capture our construct of interest and avoid cultural differences in absolute numbers, we compared the difference between the two outcomes (i.e., success vs. failures) in the multilevel analyses and created a single score for the tendency of self- and other-enhancement (vs. criticism) in the mediation analyses.

Results

Behavioral Results

Self-Construal

Interdependent and independent SC was assessed using a modified version of the Singelis Self-Construal Scale (Kitayama & Park, 2014). As expected, Americans were more independent than Taiwanese (M = 3.86 vs 3.48), $t(62) = 2.66$, $p = .010$, $d_s = .67$. Conversely, Taiwanese were more interdependent than Americans (M = 3.51 vs. 3.78), $t(62) = -2.36$, $p = .021$, $d_s = .59$.

Proportion of Situations Judged to Be Relevant

First, we tested whether our stimuli were perceived as relevant. The binary decision of whether SE would be influenced or not was first logit transformed and analyzed within a generalized linear mixed model.[3] When this analysis was performed on the full data set, there was a significant main effect of target, $z = -4.76$, $p < .001$, $d_z = .60$. Overall, the situations were judged to be more relevant to the self than to another person (M = .90 and .87). The interaction between target and outcome proved significant, $z = 4.91$, $p < .001$, $d_z = .61$. Failures were judged as more relevant to another person's SE than successes (M = .91 and .82), $z = -6.40$, $p < .001$, $d_z = .80$, but this effect was reversed for the self (M = .89 and .91), $z = 2.05$, $p = .040$, $d_z = .26$. The interaction between outcome and culture also proved significant, $z = 2.17$, $p = .03$, $d_z = .27$. Taiwanese judged failures to be more relevant than successes (M = .92 and .88), $z = -3.91$, $p < .001$, $d_z = .69$. This difference disappeared for Americans (M = .88 and .87), $z = -.36$, $p = .72$, $d_z = .06$. The three-way interaction involving target, outcome, and

[2] At this phase of the judgment task, we found that, on approximately 2% of the trials (177 trials), participants' SE change judgments were opposite in direction to the intended valence of the situations (e.g., they indicated their SE would increase in response to a negative situation). When we re-ran the focal analyses without these trials, the results were no different.

[3] As there is no straightforward way to calculate an effect size for a z test in this context, these effect sizes were calculated assuming a t distribution and an N of 64 for tests involving the full sample. Tests of effects within groups (e.g., culture) used the N for the relevant group.

culture did not reach statistical significance, $z = -1.26$, $p = .21$, $d_z = .16$.[4]

We then moved on to analyze the valid EEG data set. This analysis also showed the target main effect, $z = -4.66$, $p < .001$, $d_z = .58$. Further, the two interactions that were significant in the analysis with the full data set also proved significant, $z = 5.35$, $p < .001$, $d_z = .67$ and $z = 2.91$, $p = .004$, $d_z = .36$, for the Target × Outcome and Outcome × Culture interactions, respectively. Of note, these interactions were qualified by a significant three-way interaction involving target, culture, and outcome, $z = -2.27$, $p = .023$, $d_z = .28$. As shown in Figure 2A, success situations were chosen more frequently as relevant only in one of the three cells (i.e., Americans in the self-judgment condition). In this condition, a greater proportion of success situations were judged as relevant than failure situations, $z = 4.00$, $p < .001$, $d_z = .70$. This effect was reversed for Taiwanese in the self-judgment condition, although the outcome effect was negligible, $z = -.873$, $p = .383$, $d_z = .15$. In the other-judgment condition, both Americans and Taiwanese reported that failure situations were more relevant to another's SE than success situations, $z = -3.58$, $p < .001$, $d_z = .63$ and $z = -4.36$, $p < .001$, $d_z = .77$, for Americans and Taiwanese, respectively.

Although the three-way interaction was statistically negligible in the analysis of the full data set, we plotted the relevant percentages for comparison purposes. As can be seen in Figure 2B, the pattern corresponds closely to the pattern in the valid EEG data set. The self-enhancement effect for Americans in the self-judgment condition was still observed, $z = 3.26$, $p = .001$, $d_z = .58$. This effect was still not present for Taiwanese, $z = -.44$, $p = .66$, $d_z = .08$. Finally, the higher likelihood of choosing failure (vs. success) situations as relevant to another person's SE was also reliable in both cultures, $z = -3.67$, $p < .001$, $d_z = .65$ and $z = -5.39$, $p < .001$, $d_z = .95$, for Americans and Taiwanese, respectively. Overall, however, the effect size estimates were smaller in the full data set analysis.

Perceived Extremity of SE Change

A mixed linear model performed on the full data set showed a significant main effect of target, $F(1, 6954.6) = 13.37$, $p < .001$, $d_z = .04$, and outcome, $F(1, 104.7) = 13.42$, $p < .001$, $d_z = .35$, and an interaction between the two, $F(1, 7319.4) = 14.61$, $p < .001$, $d_z = .04$. Another person's SE was perceived as being impacted more by failures than by successes ($M = 2.44$ and 2.23), $t(258.25) = -5.30$, $p < .001$, $d_z = .33$, but this outcome effect was negligible for the self's SE ($M = 2.44$ and 2.42), $t(279.62) = -.52$, $p = .60$, $d_z = .03$. No other effects were significant. In particular, the three-way interaction involving target, outcome, and culture did not reach statistical significance, $F(1, 6611.4) = 3.63$, $p = .057$, $d_z = .02$.

We then moved on to analyze the valid EEG data set. As in the former analysis, there were significant target and outcome main effects, $F(1, 5989.8) = 14.47$, $p < .001$, $d_z = .05$ and $F(1, 109.3) = 9.90$, $p = .002$, $d_z = .30$, respectively. These main effects were qualified by a two-way interaction between outcome and target, $F(1, 6585.6) = 12.57$, $p < .001$, $d_z = .03$. Unlike in the full data set analysis, the three-way interaction involving target, outcome, and culture proved significant, $F(1, 5856.4) = 7.40$, $p = .007$, $d_z = .04$. The pertinent means are shown in Figure 2C. As in the analysis on the proportion of relevant situations, the three-way interaction was driven by Americans in the self-judgment condition. In this condition, Americans reported that successes would impact their SE more than failures, $t(332.11) = 2.20$, $p = .03$, $d_z = .12$. In all the three remaining cells, the outcome effect was reversed. To begin, Taiwanese in the self-judgment condition reported that failures would impact their SE more than successes, $t(345.39) = -2.61$, $p = .010$, $d_z = .14$. Whereas Americans showed a tendency toward self-enhancement (by judging successes to be more impactful than failures), Taiwanese showed a tendency toward self-criticism (by judging failures to be more impactful than successes). In the other-judgment condition, both Americans and Taiwanese reported that failures would impact another person's SE significantly more than successes, $t(208.67) = -3.26$, $p = .001$, $d_z = .22$ and $t(317.79) = -3.17$, $p = .002$, $d_z = .18$ for Americans and Taiwanese, respectively. There was no gender effect, either as the main effect or as an interaction with outcome, $F(1, 59.9) = .49$, $p = .487$, $d_s = .18$ and $F(1, 57.2) = .26$, $p = .615$, $d_z = .07$, respectively.

Although the three-way interaction did not reach statistical significance in the full data set analysis, we plotted the relevant means based on this analysis for comparison purposes (see Figure 2D). Both self-enhancement and criticism for Americans and Taiwanese in the self-judgment condition are evident, but only the Taiwanese pattern was statistically reliable, $t(313.87) = 1.47$, $p = .14$, $d_z = .08$ and $t(329.37) = -2.21$, $p = .03$, $d_z = .12$, respectively. The pattern in the other-judgment condition remained the same. Both Americans and Taiwanese judged failures to be more impactful on another person's SE than successes, $t(295.60) = -3.45$, $p < .001$, $d_z = .20$ and $t(305.45) = -3.77$, $p < .001$, $d_z = .22$, respectively. As was true with the analysis on the proportion of situations judged relevant, the effect sizes tended to be reduced in this full data set analysis compared to the valid EEG data set analysis.

Distribution of EEG Artifacts Across the Conditions

To explore possible reasons for the discrepancy between the analysis with the full data set and the valid EEG data set, we examined whether the proportion of trials rejected due to artifacts in the EEG recording might have been unevenly distributed across conditions. Such a finding would indicate that certain experimental variables might have played a role in producing the EEG artifacts. Moreover, such variables might have also contributed to an increase of noise in the self-report data (which could reduce the effect size estimates).

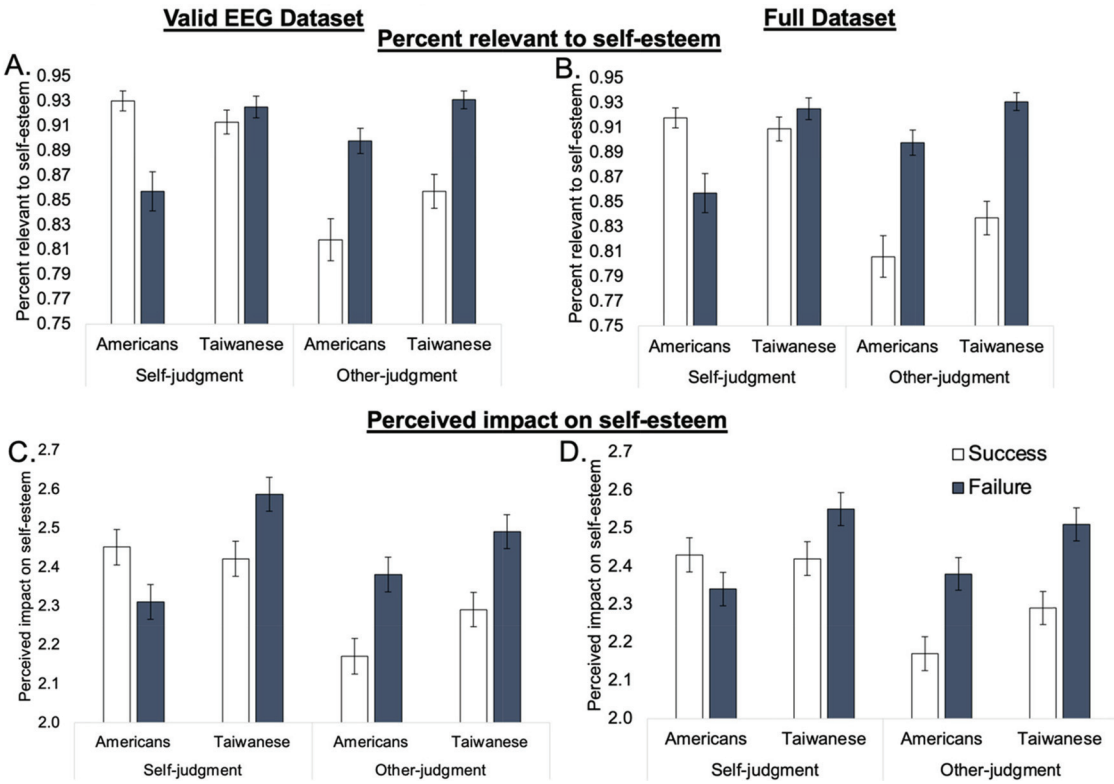
For this purpose, the proportion of the trials with excessive EEG artifacts was regressed on target, culture, outcome, and gender with all 10,240 trials.[5] While the overall percent of trials with artifacts was low (see Figure 3), this analysis uncovered a rather remarkable unevenness in the distribution of the EEG artifacts across the experimental conditions. The main effects of both outcome and culture were significant, $z = 3.38$, $p < .001$, $d_z = .42$ and $z = 2.13$, $p = .032$, $d_s = .53$, and so was

[4] In addition, there was a marginal Gender × Outcome interaction, $z = -1.89$, $p = .059$, $d = .24$. Women were significantly more likely to choose failures than success as relevant to their self-esteem (Ms = 0.91 and 0.86), $z = 2.91$, $p = .004$, $d_z = .49$. There was no such effect for men (Ms = 0.91 and 0.91), $z = -.003$, $p = .99$, $d_z < .001$. This effect is a partial replication of an interaction observed by Kitayama et al. (1997).

[5] When the same analysis was carried out with the data set used for the analysis on SE impact, the results were the same.

Figure 2

The Percent of Situations Judged Relevant to Self-Esteem (A and B) and the Perceived Impact of the Relevant Situations on Self-Esteem (C and D) in the Conditions Defined by Target and Outcome for Americans and Taiwanese



Note. The means are based on either the valid EEG data set (A and C) or the full data set (B and D). See the online article for the color version of this figure.

the interaction between the two, $z = -5.07$, $p < .001$, $d_z = .63$. Two other two-way interactions proved significant, including the Target × Outcome and the Target × Culture interactions, $z = -3.09$, $p = .002$, $d_z = .39$ and $z = -2.55$, $p = .011$, $d_z = .32$, respectively. Importantly, the highest-order interaction involving target, culture, and outcome was highly significant, $z = 3.06$, $p < .001$, $d_z = .38$. As shown in Figure 3, when the target of the judgment was the self, Americans generated EEG artifacts more frequently in the success trials than in the failure trials, $z = -4.49$, $p < .001$, $d_z = .79$, whereas Taiwanese showed a completely reversed pattern, $z = 5.34$, $p < .001$, $d_z = .94$, with the artifacts being significantly more frequent in the failure trials than in the success trials. When the target of the judgment was another person, the pattern was very different. Americans showed no outcome effect, whereas Taiwanese generated more EEG artifacts in the success trials than in the failure trials, $z = .022$, $p = .98$, $d_z = .004$ and $z = -4.56$, $p < .001$, $d_z = .81$, respectively.

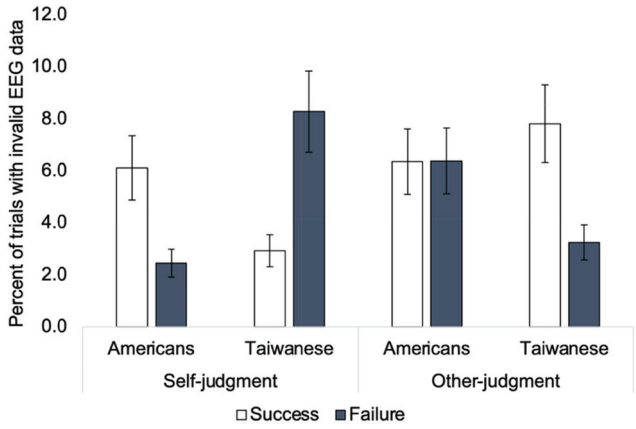
Upper-Alpha Power

The TFA revealed a systematic change in the power of the upper-alpha band, relative to the preceding baseline (between −200 ms preonset and the onset of the last word; see Figure 4). Figures 4A and 4B show this change in each of the four conditions (Target × Outcome) for Americans and Taiwanese, respectively. The power is higher (indicated by warmer colors) in the self-judgment condition for Americans, compared to most other conditions (shown by cooler colors). To perform a statistical test on the observed pattern, we extracted the average upper-alpha band power at 200–700 ms postonset of the last word, yielding a measure of upper-alpha band power increase. The average increase in power was then submitted to an analysis of variance (ANOVA) with two within-subjects variables (target and outcome) and two between-subjects variables (culture and gender). This analysis yielded a significant three-way interaction involving target, outcome, and culture, $F(1, 61) = 5.14$, $p = .027$, $\eta_p^2 = .078$. No other effects were statistically significant.

As shown in Figure 5, Americans showed significantly greater upper-alpha band power (indicative of increased internally directed attention) in the success/self-judgment condition, compared to the failure/self-judgment condition, $F(1, 61) = 8.54$, $p = .005$, $\eta_p^2 = .123$. This difference was negligible for Taiwanese, $F(1, 61) = .001$, $p = .98$, $\eta_p^2 = .00$. Furthermore, Americans showed significantly greater upper alpha in response to success information about the self than Taiwanese, $F(1, 61) = 6.34$, $p = .014$, $\eta_p^2 = .094$. To examine this interaction, we ran follow-up ANOVAs within both of the target conditions separately. The Culture × Outcome interaction was significant in the self-judgment condition, $F(1, 61) = 4.29$, $p = .042$, $\eta_p^2 = .066$. The corresponding interaction was negligible in the other-judgment

Figure 3

Percent of Trials With Electroencephalogram (EEG) Artifacts as a Function of Outcome (Success or Failure), Target (Self or Other), and Culture (Americans and Taiwanese)



Note. See the online article for the color version of this figure.

condition, $F(1, 61) = 1.10$, $p = .298$, $\eta_p^2 = .018$. Gender had no effect, either as a main effect or as part of an interaction with outcome, $F(1, 61) = .099$, $p = .754$, $\eta_p^2 = .002$ and $F(1, 61) = .028$, $p = .869$, $\eta_p^2 = .000$.

Does Self-Enhancement Track Self-Referential Processing?

We next tested the link between the self-referential processing in the success (vs. failure) condition and self-enhancement. As indices of self-enhancement, we computed both (a) the relative proportion of success (vs. failure) situations that were judged relevant to one's SE and (b) the relative impact of success (vs. failure) situations on one's SE (see Figure 6). As can be seen, the relationship between self-referential processing and self-enhancement was highly significant for the impact index of self-enhancement (Figure 6B), $r(64) = .365$, $p = .003$. This association did not significantly differ between the two cultural groups, $t(61) = .986$, $p = .338$, $d_s = .25$. A similar association is evident for the proportion index of self-enhancement (Figure 6A). This association, however, was much weaker and statistically negligible, $r(64) = .155$, $p = .221$. We ran comparable associations in the other-judgment condition. As shown in Figures 6C and 6D, there was no significant correlation with either the percent relevance or impact on SE for other-judgments, $r(64) = -.028$, $p = .827$ and $r(64) = .034$, $p = .787$, respectively.

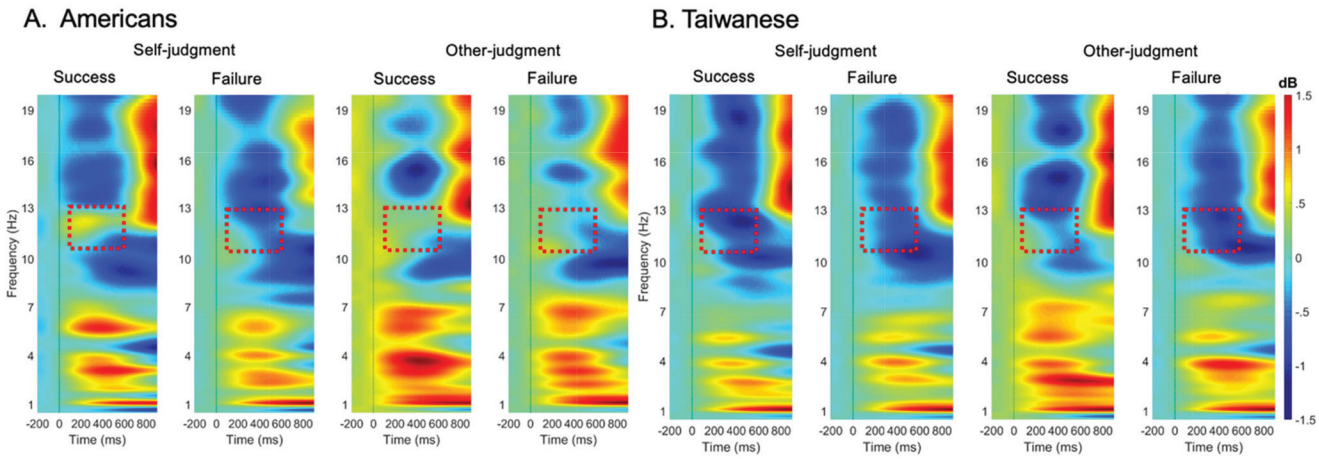
Mediation

So far, we have established three links. First, culture predicts the impact measure of self-enhancement (European Americans > Taiwanese). Moreover, culture predicts the neural index of self-referential processing in the success (vs. failure) condition (European Americans > Taiwanese). Third, self-enhancement tracks the neural index of self-referential processing in response to successes (vs. failures). Importantly, self-referential processing was assessed online, whereas the SE judgment came only afterward. Therefore, the self-referential processing preceded the SE judgment. Hence, the pattern observed is consistent with the hypothesis that the cultural difference in self-enhancement (European Americans > Taiwanese) is mediated by self-referential processing in the success (vs. failure) condition (European Americans > Taiwanese).

To formally test this mediation, we used PROCESS Model 4 (Hayes, 2017), with culture as the predictor, self-enhancement as the dependent variable, and the neural index of self-referential processing during successes (vs. failures) as the mediator. As in all prior analyses, we included gender as a covariate. The total effect of culture on self-enhancement did not achieve statistical significance, $t(61) = 1.71$, $p = .09$, $d_s = .43$. This is likely due to reduced statistical power in the mean estimates with the aggregate analysis since this effect was significant in the multilevel model analysis. This

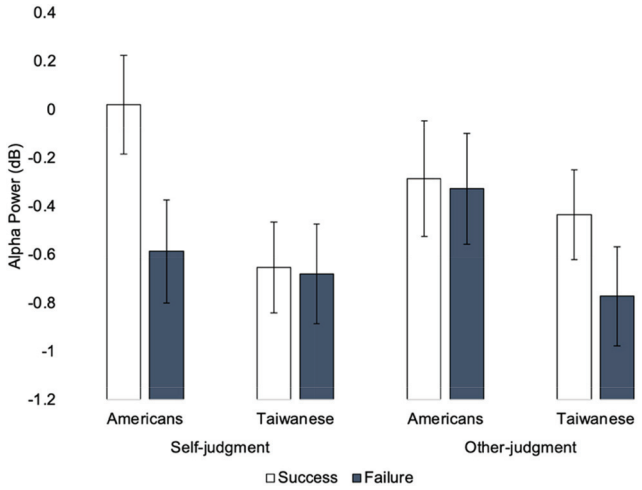
Figure 4

The Time Frequency Plot at Pz in Each of the Four Conditions Defined by Target and Outcome for Americans (A) and Taiwanese (B)



Note. The time window of interest for the upper-alpha (10.5–13 Hz) range is marked with a dotted rectangle. The average change in power across subjects is plotted for all frequencies referenced to a 200-ms prestimulus baseline. See the online article for the color version of this figure.

Figure 5
Upper-Alpha Power (Indicative of Internally Directed Attention) for Americans and Taiwanese for Each of the Conditions Defined by Target (Self or Other) and Outcome (Success or Failure)



Note. See the online article for the color version of this figure.

latter analysis is arguably more reliable since it modeled the nuisance variance associated with stimulus situations. Of importance, as shown in Figure 7, there was an indirect effect of culture, which was mediated by an increase in upper alpha in response to successes (vs. failures). Culture significantly predicted the positivity bias in self-referential processing, which in turn predicted self-enhancement. Both indirect paths proved statistically significant, $t(61) = 2.07$, $p = .043$, $d_s = .52$ and $t(61) = 2.63$, $p = .011$, $d_s = .66$, respectively.

Effects of Self-Construal

Next, within each culture, we tested whether independent and interdependent SC might be associated with an increase in upper-alpha band power in response to successes (vs. failures). Further, we also tested whether SC might be associated with the two self-report indices of enhancement in both the self- and other-judgment conditions. Relevant correlations are summarized in Table 1. Among European Americans, independent SC was positively associated with the increase in upper-alpha band power for successes (vs. failures) in the self-judgment condition (i.e., self-referential processing in success vs. failure). This effect was significant with a one-tailed test (which is justifiable given our directional prediction). However, this same correlation was negligible in Taiwan. Interdependent SC had no associations with either of the two self-enhancement measures in both cultures. However, it predicted the proportion index of other-enhancement for European Americans (but not for Taiwanese).

Discussion

Self-Enhancement, Self-Referential Processing, and Culture

Over the last several decades, self-enhancement has proven prevalent and robust (Kruger & Dunning, 1999; Taylor & Brown, 1988). Moreover, many major theories of the field draw on the need to enhance, protect, validate, affirm, or otherwise maintain self-worth as the basic premise. These analyses include self-affirmation theory (Steele et al., 1993), the SE maintenance model (Tesser, 1988), and terror-management theory (Greenberg et al., 1997), among many others. However, one outstanding limitation of this literature is that much of the data is collected from Western societies, particularly the United States, Canada, and a few Western European societies; the field has been predominantly Eurocentric.

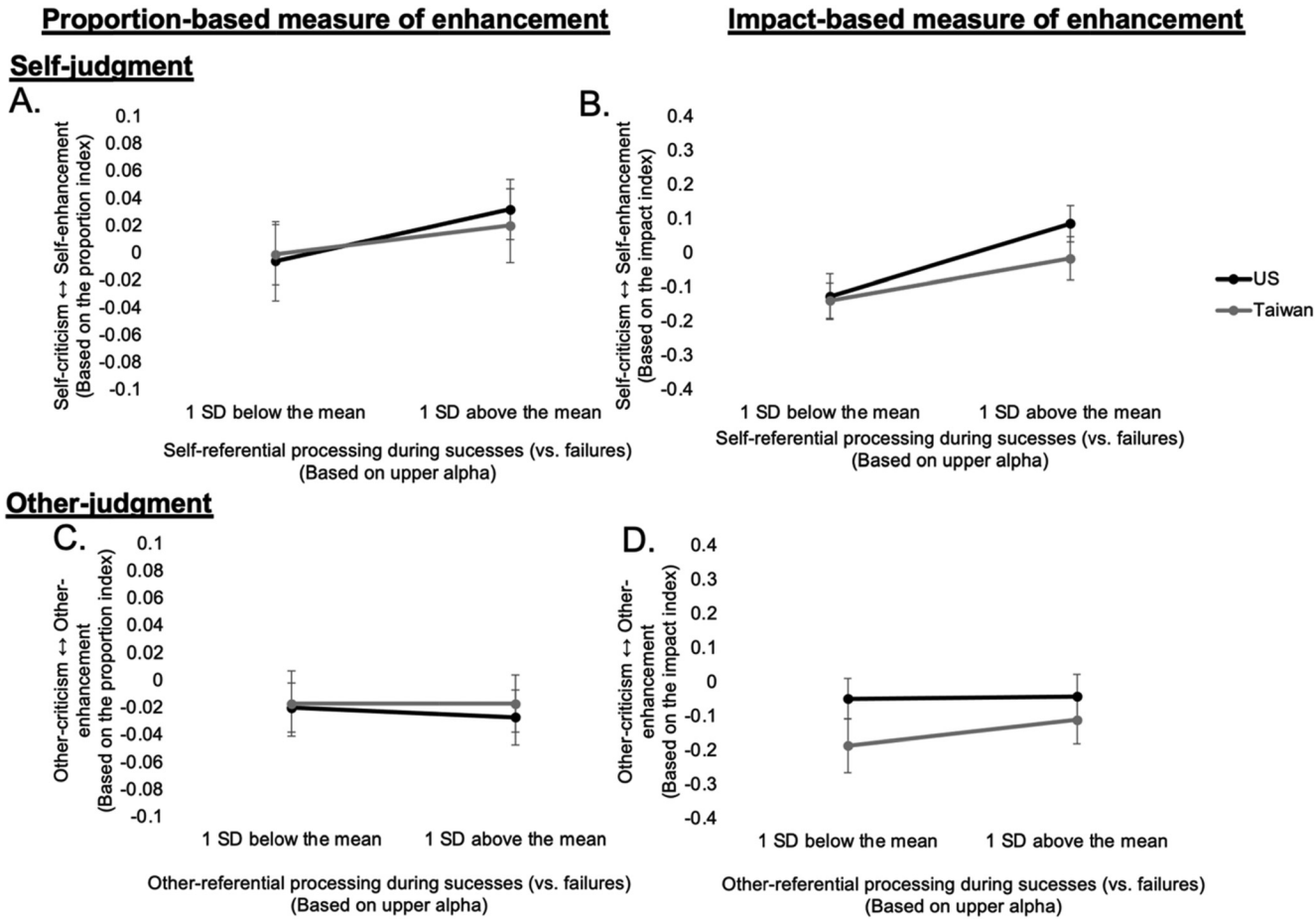
Replicating previous work, we found that Americans judged successes that occur to them as more relevant to their SE than comparable failures. Moreover, they felt their successes were more impactful to their SE than their failures. Notably, however, neither of these effects was apparent in the Taiwanese sample. To the contrary, Taiwanese showed no self-enhancement in the relevance measure, and they even showed evidence of self-criticism in the impact measure. This self-report data replicates the previous evidence obtained in Japan (Kitayama et al., 1997) and extends it to another East Asian country.

One notable limitation of the existing self-enhancement literature was that it focused nearly exclusively on outcome measures of self-enhancement, with scant attention paid to the underlying mechanisms. To address this gap, we proposed the self-referential processing hypothesis of self-enhancement and reported the initial evidence for it. Specifically, we built on prior work on upper-alpha band power (Klimesch et al., 1999) to hypothesize that an increase in power in this band during self-related judgments is a reliable index of self-referential processing. We then showed that a self-report index of self-enhancement (the relative impact of success [vs. failure] on SE) tracks upper-alpha band power in response to successes (vs. failures) in the self-judgment condition. This pattern provided evidence that European Americans self-enhance because they elaborate more deeply on positive self-relevant outcomes. They also dismiss or at least do not elaborate on negative outcomes as much. Importantly, among Taiwanese, the engagement in self-referential processing was no different between the success and failure conditions. Consistent with the hypothesis that self-enhancement results from self-referential processing of positive (rather than negative) self-relevant information, the cultural difference in self-referential processing as assessed with the upper-alpha band power, was statistically correlated with self-enhancement. Moreover, self-referential processing (as assessed via alpha) temporally preceded the SE change judgment. Hence, the data suggest a causal role of self-referential processing in self-enhancement. Compared to Taiwanese, Americans were more likely to elaborate on positive self-relevant information, which in turn led to self-enhancement.

Notably, the mediation evidence was robust for the impact measure of self-enhancement (how much SE would increase or decrease in success or failure). However, it was not for the preceding binary decision of whether each situation would be relevant to the self. The mediation evidence was absent in this latter measure, even though this measure showed clear evidence of the cultural difference in self-enhancement. It would seem possible that self-referential processing comes into play only when a given situation is judged as relevant to the self. In this view, the relevance judgment is a precursor of self-referential processing. The motivation for self-positivity leads to self-enhancement in the relevance judgment. Positive self-relevant information in the relevant situations

Figure 6

The Correlations Between the Upper-Alpha Band Power in Response to Successes (Versus Failures) and the Two Indices of Self-Enhancement (Proportion Based and Impact Based) in the Self- and Other-Judgment Conditions



may then be elaborated on with self-referential processing to yield self-enhancement in the impact ratings.

Psychological Meaning of EEG Artifacts

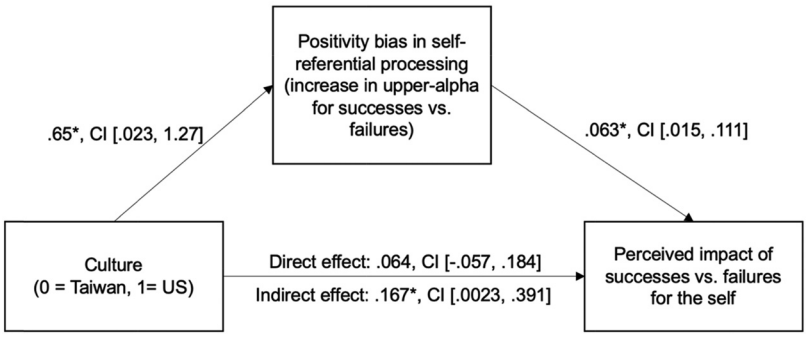
We should add that the cultural variation in self-enhancement, as assessed with self-report, was most clearly visible when only those trials with clean EEG data were analyzed. When we added the trials with EEG artifacts to the analysis, we found a very similar pattern, but the three-way interaction was no longer statistically significant. Therefore, the trials containing EEG artifacts may have entailed extra noise in self-report response.

One potent source of noise in self-report data is emotional arousal. According to an influential analysis of the topic by Simon (1967), strong emotional arousal may cause disruption of cognitive processing. Thus, such arousal may compromise the fidelity of cognitive processing (Simon, 1967). Note that EEG artifacts are often related to movements of the head and eyes, as well as electrodermal responses. All these sources of EEG artifacts are potentially related to emotional (physiological) arousal (Lang et al., 1997). Hence, it is safe to posit that extreme emotional arousal caused such artifacts, including subtle facial muscle movements (Yu & Kitayama, 2021).[6] This explains why SE-change judgments may have become noisier when the outcome information caused strong emotional arousal (thereby entailing EEG artifacts).

The analysis above implies that the frequency of trials with EEG artifacts should be variable across conditions. We hypothesized that European Americans are self-enhancing, responding more strongly to their success (vs. failure). Thus, these individuals may experience particularly strong emotional arousal (which produces EEG artifacts) in the self-success condition than in the self-failure condition. Conversely, we hypothesized that Taiwanese are self-critical, responding more strongly to their failure (vs. success). Thus, these individuals should experience particularly strong emotional arousal (which produces EEG artifacts) in the self-failure condition than in the self-success condition. Our exploratory analysis revealed the first evidence for this: EEG artifacts were more frequent in the self-success (vs. failure) condition for European Americans and the self-failure (vs. success) condition for Taiwanese.

[6] We may expect that EEG artifacts should produce cognitive noise only if they are "emotional." Unfortunately, we could not trace the sources of the artifacts definitively in the current work.

Figure 7
A Mediation Model Testing the Indirect Effect of Culture (0 = Taiwan, 1 = United States) on Self-Enhancement Through Upper Alpha in Success Versus Failure



Note. The paths with confidence intervals that do not cross zero are statistically significant. CI = confidence interval.
* $p < .05$.

Notably, Taiwanese showed significantly more EEG artifacts on the success trials than on the failure trials in the other-judgment condition. These individuals appear to have responded more strongly to another person's success than to their failure. Thus, the pattern is indicative of other-enhancement. Consistent with this observation, prior work found that East Asians are sometimes altruistic or prosocial, either seeking to enhance others (Endo et al., 2000) or respond more strongly to positive rather than negative information about other people (Hampton & Varnum, 2018). One important caveat is that there was no other evidence of other-enhancement in the current study. Future work must address possible boundary conditions for other-enhancement in East Asians.

The possibility that EEG artifacts resulted from excessive emotional arousal that produced some somatic response implies that participants were engaged in these scenarios. As in all other domains of life, a story is psychologically real if treated as such. Moreover, a story that is treated as real will also seem real in its consequences. This consideration may amount to a truism when applied to myths and narratives of a culture (e.g., "Protestant Ethic" or "American Dream"). As humans, we live by our stories and narratives (Lakoff & Johnson, 2003; McAdams, 2006). Stories are not always mere fictions detached from reality. To the contrary, they can constitute reality itself, thereby engaging raw emotions and lively imagery. In the present case, the situations we prepared were stories generated directly by the relevant populations. They were designed to be engaging. Indeed, a vast majority (nearly 90% on average; see Figures 2A and 2B) were perceived to be relevant to SE. In all likelihood, they resonated with our participants. Thus, there is every reason to believe that the participants treated the stories as real.

Negativity Bias in Social Perception

In the judgments of another's SE, both European Americans and Taiwanese judged a larger number of failure (vs. success) situations as relevant to another's SE. Moreover, they estimated failure (vs. success) situations as more impactful on another's SE. This prevailing pattern is consistent with negativity bias in social attention (Fiske, 1980; Ito et al., 1998). People pay more attention to negative information than to positive information supposedly

Table 1
Correlation Coefficients for the Relationship Between Independent and Interdependent Self-Construal (SC) and the Two Measures of Self-Enhancement and Alpha

	Self-judgment		Other-judgment	
Measure	United States	Taiwan	United States	Taiwan
Upper-alpha increase in successes (vs. failures)				
Independent SC	**0.315**	0.083	−0.245	−0.074
Interdependent SC	−0.239	0.223	−0.031	−0.03
Proportion index of self-enhancement				
Independent SC	0.153	−0.056	−0.254	0.226
Interdependent SC	0.218	0.174	**0.421**	0.04
Impact index of self-enhancement				
Independent SC	0.082	−0.194	0.006	−0.033
Interdependent SC	−0.066	0.168	0.082	−0.263

Note. Significant correlations based on one-tailed tests are bolded.

because negative information is both less frequent and potentially more consequential. The negativity bias is quite pervasive and thought to be the default in social perception. The pervasiveness of this negativity bias may explain why Taiwanese were self-critical. Taiwanese responded to failures (vs. successes) more strongly regardless of the target (self vs. other) in their impact judgments. In all cases, Taiwanese reported that failures would be more relevant or impactful to the person's SE. Only European Americans showed a reliable positivity bias for self-referential information. This positivity bias appears to be strong enough to overcome the negativity bias, thereby leading to self-enhancement.

The current analysis clarifies why self-criticism is not always observed among East Asians. Many prior studies used comparative judgments between the self and others and found that European Americans judge the self as "better than average." The better than average effect is typically attenuated or vanishes among East Asians (Heine et al., 1999). Interestingly, East Asians are rarely self-critical: They do not judge the self to be any less worthy than "average others." However, it should be noted that in experimental procedures such as the better than average effect, participants are not given any concrete social information. They are merely asked to judge the self and others on abstract dimensions, such as competence and sociability. Since no negative or positive information about the self is presented, there is no room for the negativity bias to come into play. In contrast, our current paradigm involves the presentation of either positive or negative self-relevant information (i.e., success or failure). This might explain why we observed a self-criticism, whereas in most other studies self-criticism is not observed.

Self-Construal

Self-enhancement is a psychological tendency thought to be linked to the construal of the self as independent (Heine et al., 1999). Hence, it would seem reasonable to anticipate that independent people show this effect more in part because they elaborate on positive (vs. negative) self-relevant information. Our findings were suggestive that, at least among Americans, there was some evidence showing that independent SC predicts the EEG measure of self-referential processing in successes (vs. failures). Of note, even though independent SC predicted self-referential processing, which our results suggest leads to self-enhancement, there was no association between this SC and self-enhancement. Although this might seem puzzling, it is consistent with prior evidence that SC can predict neural measures better than self-report measures (Kitayama & Salvador, 2017; Kitayama & Uskul, 2011). We should hasten to add, however, that a comparable pattern was absent among Taiwanese. Moreover, interdependent SC predicted the proportion index of other-enhancement among Americans (but not among Taiwanese). Overall, the present evidence is inconclusive, and more work is needed to clarify the relationship between SC and self-enhancement.

Limitations and Future Directions

There are several limitations in the current study. First, the current evidence suggests that an increase in upper-alpha band power during self-judgment is a reliable indicator of self-referential processing. Future work may seek to manipulate this neural response directly to see if it would result in changes in self-enhancement. Second, we tested the relationship between self-report indicators of self-enhancement and a neural correlate of self-referential processing in a single study. Future work must extend this approach to other domains, including holistic attention (Goto et al., 2010), causal attribution (Na & Kitayama, 2011), reactivity to norm violations (Salvador, Mu, et al., 2020), and cognitive dissonance (Kitayama et al., 2004). Third, the current work only compared Eastern and Western cultures. Future work must examine neural mechanisms underlying self-evaluative biases in other cultural contexts. Fourth, the stimuli used in the current work were designed to be particularly relevant to the college student samples in both the United States and East Asia. This might explain, in part, why these situations were engaging and even sometimes evoking strong emotions. Future work must test what about these situations engages the self, including whether this effect is more pronounced for some types of situations.

In conclusion, our work shows that self-referential processing assessed with EEG is associated with self-enhancement among European Americans. Moreover, we showed that the same mechanism can explain why self-enhancement is often absent among East Asians. The current evidence reinforces the supposition that the influence of culture can be uncovered by examining their relevant neural correlates (Kitayama & Salvador, 2017), thereby underscoring the significance of neuroscience in the investigation of culturally divergent psychological processes.

Context of the Research

People sometimes overestimate the value of the self. Interestingly, this tendency of self-enhancement is more pronounced for European Americans than for East Asians. The present work addressed why such a cultural difference exists by identifying neural mechanisms that might explain this cultural difference. We asked Americans and Taiwanese to report how impactful numerous success and failure experiences would be on their SE as their electrocortical activity was recorded. Americans were self-enhancing (i.e., successes were more impactful than failures), but Taiwanese were self-critical (i.e., failures were more impactful than successes). A neural response indicative of internally directed attention during self-referential judgments was visible only when Americans judged a success's impact, but not a failure's impact. Moreover, this neural response statistically accounted for their self-enhancement. Our findings show that Americans are more likely than Taiwanese to self-enhance since they show increased self-referential processing of successes (vs. failures) that occur to the self.

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