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The impact of culture on emotion suppression: Insights from an electrophysiological study of emotion regulation in Japan

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ABSTRACT

Prior theory and evidence suggest that native East Asians tend to down-regulate their emotional arousal to negatively valenced experiences through expressive suppression, an emotion regulation technique focused on suppressing one's emotional experience. One proposed explanation for this choice of regulation strategy and its efficacy is rooted in their commitment to the cultural value of interdependence with others. However, prior work has not yet thoroughly supported this hypothesis using in vivo neural correlates of emotion regulation. Here, we utilized an established electroencephalogram (EEG) correlate of emotional arousal, the late positive potential (LPP), to examine whether down-regulation of the LPP in native East Asians might be particularly pronounced for those relatively high in interdependent self-construal. In this study, native Japanese participants attempted to suppress their emotional reaction to unpleasant images during EEG recording. In support of the hypothesis that emotion suppression among native East Asians is influenced by the cultural value of interdependence, there was a significant effect of interdependent self-construal on the LPP. Specifically, those relatively high in interdependent (versus independent) self-construal exhibited a smaller LPP in response to unpleasant pictures when instructed to suppress their emotions versus a passive viewing condition. However, this effect was negligible for those relatively low in interdependent self-construal, suggesting that cultural values impact the in vivo efficacy of different emotion regulation techniques. These results demonstrate the importance of identifying correspondence between self-report measures and in vivo correlates of emotion regulation in cross-cultural research.

1. Introduction

The ability to regulate one's emotional experience is critical for everyday psychosocial and cognitive functioning (Gross, 2015). This is exemplified by evidence showing that competency in emotion regulation is related to mental health outcomes (Gross & Muñoz, 1995). The relationship between emotion regulation and mental health is complex however, as different emotion regulation strategies are associated with different outcomes (Gross, 2014). Moreover, the effectiveness of such strategies appears to depend on participants' cultural backgrounds. For instance, past work suggests that individuals in East Asian cultures are more likely to benefit from expressive suppression, characterized by actively inhibiting emotion-expressive behavior (Gross, 1998), than those from Western cultures (Hu et al., 2014; Ramzan & Amjad, 2017). These findings are consistent with a recent large-scale self-report study by Tamir and colleagues (2023) showing that the preference for suppressing one's emotions is consistently associated with better mental health in collectivistic societies, but not in individualistic ones. Building on this work, the current study assessed whether the purported effectiveness of emotional suppression in a collectivistic culture (i.e., Japan) would correlate with an established in vivo neural correlate of emotional arousal. Critically for our hypothesis, we then examined whether this effect was driven by each participant's commitment to collectivistic cultural values as assessed by interdependent self-construal.

A salient contrast between Eastern (e.g., Japan) and Western (e.g., the U.S.) cultures is how individuals endorse the degree to which they construe themselves with others (interdependence) versus viewing themselves as distinct from others (independence; e.g., Gardner et al., 1999; Uchida & Kitayama, 2009). The degree to which one views themselves as either independent from or interdependent with their

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social relations is referred to as one's self-construal, with East Asians on average being more interdependent and European Americans more independent (Markus & Kitayama, 1991). For example, compared to Western participants, East Asians, including Japanese, tend to endorse the values linked to collectivism, such as conformity and security, relatively more than those linked to individualism, such as autonomy and sensation seeking (Sagiv & Schwartz, 2022). Moreover, unlike Westerners who tend to associate happiness with personal achievement, Japanese associate it with social harmony (Uchida & Kitayama, 2009). Similar evidence exists for cognition, where consistent with the notion that interdependence with others calls for greater attentiveness to the social surroundings, Japanese are relatively more holistic in cognitive and attentional style than Westerners (Ishii et al., 2003; Kitayama et al., 2003; Masuda & Nisbett, 2001). Notably, this evidence extends to other East Asian societies, such as China (Morris & Peng, 1994), Korea (Choi et al., 2003), and Taiwan (Salvador et al., 2022). Thus, many aspects of cognitive and emotional processing are influenced by one's self-construal.

For emotion regulation in particular, different health outcomes are observed in East Asian countries that are typically high in interdependent self-construal versus more independent Western countries. In a recent survey study across 19 countries, collectivistic societies such as Japan demonstrated a robust positive association between self-reported level of expressive suppression and mental health (Tamir et al., 2023). The findings of this study are consistent with previous evidence that individuals of East Asian descent tend to value low-arousal emotions (Tsai et al., 2006), and that more frequent use of expressive suppression correlates with worse psychosocial functioning for European-Americans but not for East Asians (Soto et al., 2011). In addition to these studies, a growing body of literature also suggests that expressive suppression is relatively more beneficial for East Asians than European Americans (Tsai & Lu, 2018). Overall, the extant evidence is consistent with a broader hypothesis that strong emotions (i.e., strongly arousing emotions such as anger and frustration) are often seen as detrimental to social harmony in East Asian culture (Kitayama et al., 2000). Furthermore, a person's ability to adjust their behavior to better mirror their circumstances is associated with lower biological health risk in East Asian cultures but not European American cultures (Kitayama et al., 2018). Hence, avoiding strongly arousing emotions is consistent with the cultural value of interdependence, and adjusting one's behavior to do so is correlated with lower biological health risk. Altogether, this evidence suggests that expressive suppression is more efficacious for individuals of East Asian descent versus European-Americans.

Although several lines of evidence point to a relationship between individual differences in emotion regulation strategies and well-being, these findings are mostly based on self-report measures. While self-report has its advantages for understanding emotional experience, one of its shortcomings is that it cannot shed light on the moment-to-moment dynamics of affective processing. This is especially important for cross-cultural research, as there is some divergence in the effectiveness of expressive suppression when measured with self-report measures versus in vivo physiological measures (Tsai & Lu, 2018). One likely reason for this disconnect is that if someone reports that they are engaged in expressive suppression, using self-report alone it is difficult to objectively measure how effectively they are suppressing their emotional experience. Additionally, self-report offers no clues about how long it might take expressive suppression as a strategy to be effective, which may provide further clues about when it is most efficacious. Thus, identifying self-report constructs that correlate with the effectiveness of in vivo expressive suppression is central to better understanding the culturally-specific efficacy of different emotion regulation strategies.

To help address these shortcomings, past studies have utilized measures of in vivo brain activity during emotion regulation. One commonly used neural measure comes from electroencephalogram (EEG) recordings, specifically an event-related potential (ERP) component called the late positive potential (LPP), which is typically interpreted as an index of physiological arousal during emotion regulation (Hajcak et al., 2010; Hajcak & Foti, 2020; Schupp et al., 2000). Past work has demonstrated that the LPP is larger for more arousing images which tend to be rated relatively high in positive or negative valence (Cuthbert et al., 2000). The LPP measured in response to these images has also been shown to correlate highly with activity in brain regions that are implicated in affective processing, such as the amygdala and insula (Sabatinelli et al., 2013). Therefore, the ability to downregulate the LPP during stimulus presentation using a given emotion regulation strategy is typically interpreted as successful downregulation of physiological arousal (Foti & Hajcak, 2008; Thiruchselvam et al., 2011).

The LPP has also been shown to persist the entire time that a stimulus is presented (Hajcak & Foti, 2020; Hajcak & Olvet, 2008), and thus can be broken up into "early" and "late" ERP components (Hajcak et al., 2010). The early LPP component is hypothesized to primarily reflect an orienting response (similar to a P300; Bradley, 2009), while the late LPP reflects sustained attention directed towards a particular stimulus (Hajcak & Foti, 2020). As LPP amplitudes during emotion regulation are not always equivalent between these two time windows (e.g., Foti & Hajcak, 2008), this suggests that emotion regulation strategies can differentially impact these distinct processes.

Though several previous cross-cultural studies have examined the LPP during expressive suppression, their results have been somewhat inconsistent. Whereas one study found that participants with East Asian backgrounds more effectively downregulated their LPP via expressive suppression in response to unpleasant (negative valence) images than European Americans (Murata et al., 2013), other studies have failed to observe this pattern (Hampton et al., 2021; Varnum & Hampton, 2017). Another recent study helped clarify this discrepancy by showing that individuals of East Asian descent who were residents of the United States (US) could downregulate their LPP via expressive suppression, but only if they strongly endorsed an interdependent self-construal (Kraus & Kitayama, 2019). One limitation of this study, however, is that it only included East Asians who were residing in the US. Additionally, this study also found that East Asians who had resided in the US for shorter amounts of time were less interdependent, and thus were on average worse at downregulating their LPP via expressive suppression. Hence, it is unclear if interdependence's moderating effect on expressive suppression would extend to native East Asians in Asia. To test this possibility, we measured the impact of interdependent self-construal on the effectiveness of expressive suppression, hypothesizing that Japanese residing in Japan who were relatively high in interdependent self-construal would be the most effective at downregulating their LPP via expressive suppression.

2. Method

2.1. Participants

From the student population at Kyoto University, 52 native-born and lifelong resident Japanese participants were recruited from 2017–2018. All participants were compensated with 4000 yen for their participation. All informed consent was obtained in-person and this study was approved by the Kyoto University IRB. Of these participants 2 were excluded for self-reporting pre-existing neurological conditions, 4 discontinued participation after consenting, and 2 were excluded for errors during EEG recording. In addition, 8 participants were excluded for having excessive artifacts in their EEG recordings (see *EEG Data Processing*). This left 36 participants with usable data for analysis (21 Female, Age $M = 21.89$, $SD = 1.39$). The number of participants reported here is in line with sample sizes used in previous research (Kraus & Kitayama, 2019; Murata et al., 2013; Varnum & Hampton, 2017) and has been shown in a prior power analysis to be sufficiently powered (see Kraus & Kitayama, 2019). We also performed a post-hoc power analysis here (see Section 1.2 of the Supplement), which suggested that we had adequate power (.88) to measure the effect of interest.

2.2. Materials

The images used in this study were 120 images from the international affective picture system (IAPS; Lang et al., 1999) that have been used in past work on cross-cultural emotion regulation (Kraus & Kitayama, 2019; Murata et al., 2013). Using the normed IAPS ratings, 60 neutral low arousing images (valence: $M = 5.08$, arousal: $M = 3.25$) were chosen as well as 60 unpleasant (negative valence) high arousing images (valence: $M = 2.28$, arousal: $M = 6.29$).[1] E-Prime 2.0 software (Schneider et al., 2002) was used for stimulus presentation. A Logitech web camera was used to monitor participants from an adjacent room during the experiment.

To assess self-construal, a translated Japanese version of the Singelis self-construal scale (Singelis, 1994) was administered. This scale is composed of subscales which measure both independent and interdependent self-construal. For analysis, self-construal scores were created by subtracting each individual's score on the independence scale from their score on the interdependence scale.[2] Thus, greater self-construal scores indicate a higher level of interdependence relative to independence and vice-versa. All of the materials used in this study were administered in Japanese and back-translated to ensure their accuracy.

2.3. Procedure

The procedure used in this study was identical to previous work (Kraus & Kitayama, 2019; Murata et al., 2013). Upon arrival, participants were told that the study would record brain activity during a computer task where they would be observing different images on a computer screen. Participants were seated approximately 60 cm from a color computer display during EEG recording. Each participant viewed 10 practice images at the beginning of the experiment to familiarize themselves with the procedure.

Next, participants viewed a series of IAPS images during both an attend condition and a suppress condition. In the attend condition, participants were instructed to pay attention to the emotional responses that were naturally elicited by the image. Specifically, they were told, 'Please react normally to each image. Attend to and be aware of any feelings that each image elicits'. Participants then viewed 60 images total in three blocks in the attend condition before receiving a brief break. Then, for the suppress condition, participants were instructed to minimize and hide any emotional responses that were naturally elicited by the image. In particular, they were told, 'Please suppress any emotional responses you may have while viewing each image. Try to remain calm and to diminish any response reflecting your subjective feelings regardless of the affective valence of the image. We will monitor your facial expressions while you are looking at the images. Try to hide any emotional reactions to the image so that we will not be able to detect what kind of image you are viewing'. The aforementioned web camera was also present in the experimenter room with the participants in the attend condition. Participants then viewed the same total number of images over three blocks during the suppress condition.

The order of the blocks of pictures presented in each condition was counterbalanced across participants so that half of the participants saw each set of images in either the attend or suppress condition. In order to avoid any carryover effects, participants always performed the attend condition followed by the suppress condition. On each trial, a fixation cross was presented for 2000 ms followed by a blank screen ISI for 500 ms. After the ISI, either a neutral or unpleasant picture was presented for 4000 ms with a subsequent blank screen ITI of 2500 ms. In each block, 20 pictures (10 unpleasant, 10 neutral) were presented in a random order and each condition contained three blocks of pictures.

After the computer task, participants completed a post-experimental questionnaire, reporting the degree to which they found the experimental task to be interesting (1 = Not interesting at all, 7 = Very interesting), difficult (1 = Not difficult at all, 7 = Very difficult), boring (1 = Not boring at all, 7 = Very boring), and how much they felt engaged in the task (1 = Not engaged at all, 7 = Very engaged). In addition, participants filled out questionnaires after completing the picture viewing portion of the study.

2.4. EEG data recording

The EEG was recorded with 64-recording channels using silver chloride electrodes with a BioSemi Active Two system (http://www.biosemi.com; BioSemi B.V., Amsterdam, Netherlands) configured to the 10–20 system. EEG data was recorded at 512 Hz. Impedances during data collection were kept under 10 kΩ and acquired with an online reference unique to the Active Two system (see: http://www.biosemi.com). For the Active Two system, the online filter is low-pass only and performed by the ADC's decimation filter with a 5th order sync response with a –3 dB point at 1/5th of the selected sample rate (see: http://www.biosemi.com/faq/adjust_filter.htm). The electrooculogram was recorded using bipolar VEOG and HEOG electrodes (Croft & Barry, 2000) and recordings were also obtained from electrodes placed on the left and right mastoids (Luck, 2014).

2.5. EEG data processing

The EEG data processing here was identical to Kraus and Kitayama (2019) with the exception of one automatic artifact detection threshold used (see footnote 3). For processing, the EEG data underwent an offline 2nd order infinite impulse response (IIR) Butterworth bandpass filter with cutoff frequencies of.1 and 20 Hz (half-amplitude −6 dB; 12 dB/octave roll-off). All scalp electrodes were offline referenced digitally to the averaged mastoids. The data were then subjected to visual inspection for major muscle and unusual motor/ocular artifact, which were removed. Independent component analysis (ICA) was then used to further remove artifacts from the data.

Decomposition of the independent components was performed on the continuously recorded EEG in EEGLAB (version 2019.0) using the 'runica' INFOMAX algorithm (Makeig et al., 1997). For each subject, ICA components were determined for up to 64 scalp electrodes and 4 EoG electrodes. If any scalp electrodes were deemed unsuitable for analysis, they were removed for later interpolation before performing the ICA. The initial learning rate for the ICA was 0.001 and the ICA converged when the weight change was smaller than $1E^{-7}$. The ICA components were then visually inspected and artefactual components were rejected. Rejected components were primarily related to eye movements captured by the EoG electrodes and muscle artifacts (McMenamin et al., 2010). Any previously removed channels were then interpolated using spherical interpolation. The recorded data was then segmented into epochs from 400 ms before stimulus onset to 4000 ms afterward.

Next, automatic artifact detection was performed on the data. Trials were rejected if for any scalp electrode the maximum peak-to-peak voltage exceeded 200μV within a 400 ms moving window for any

[1] The following IAPS images were used: unpleasant (1050, 1090, 1110, 1113, 1120, 1201, 1220, 1300, 1301, 1930, 2205, 2800, 2900, 3000, 3010, 3030, 3051, 3053, 3060, 3061, 3062, 3063, 3064, 3071, 3080, 3100, 3102, 3110, 3130, 3140, 3150, 3170, 3180, 3230, 3261, 3350, 3400, 3500, 3530, 6212, 6230, 6243, 6260, 6313, 6350, 6360, 6370, 6510, 6540, 6560, 6570, 6821, 9006, 9040, 9050, 9140, 9220, 9405, 9410, 9420); neutral (2190, 2200, 2210, 2211, 2214, 2230, 2273, 2280, 2309, 2342, 2359, 2383, 2400, 2480, 2510, 2520, 2521, 2570, 2840, 2880, 5390, 5500, 5531, 5740, 5800, 5900, 7000, 7002, 7004, 7009, 7010, 7012, 7020, 7021, 7025, 7026, 7035, 7050, 7077, 7080, 7092, 7100, 7140, 7150, 7160, 7170, 7175, 7190, 7211, 7217, 7224, 7233, 7235, 7503, 7512, 7550, 7560, 7700, 7950, 9070).

[2] Note that this is the reverse of the typical subtraction (independence - interdependence), but was used here to display the pattern of the results similarly to Kraus and Kitayama (2019).

scalp electrode with 100 ms steps that moved across the length of each epoch. Trials were also rejected if any scalp electrode fluctuated more than 30μV between adjacent sample points, or if any scalp channel had little to no recorded voltage (+/−.25μV)[3] over a 400 ms interval. Participants who had less than 50% of usable trials remaining for neutral or unpleasant images in either condition were excluded from further data analysis. Each trial was then baseline corrected using the 400 ms prestimulus interval. To quantify the LPP, activity at electrodes Cz, CPz, and Pz was averaged for analysis, and mean voltage values in the time windows of 400–1000 ms for the early LPP and 1500–3500 ms for the late LPP were calculated (Kraus & Kitayama, 2019; Murata et al., 2013).

2.6. Data analysis

In this study design there were two between-subject variables (Self-Construal, and the counterbalanced order of blocks of IAPS images) and three within-subject variables (Condition [Attend/Suppress] x Valence [Neutral/Unpleasant] x Time [Early/Late LPP]). To analyze the data in this study, a mixed linear effect model was used for hypothesis testing (Baayen et al., 2008). This model was used to test whether the continuous measure of self-construal correlated with LPP amplitude across different image valences and conditions.

In order to properly specify the mixed linear effect model, trial level data was extracted for the LPP amplitude for each subject. The model specification included random effects for subject and item, which were specified appropriately with the current study design (Judd et al., 2017). To fit each model, first the maximal random effect structure was used for model specification (Barr et al., 2013). In this sample, the maximal model would not converge to the data and so the model was reduced in complexity according to the method outlined by Bates et al. (2015). This resulted in a model with random intercepts estimated for each subject and item. For each subject, random slopes were estimated for the main effects and interaction of Condition, and Valence as well as the main effect of Time. Self-Construal scores were centered at the grand mean (Enders & Tofighi, 2007). These models were fit using the lme4 package in *R* with restricted maximum likelihood to estimate the parameters (Bates et al., 2014).

An omnibus type III F-test was used to determine whether any main effects or interactions were significant for the fixed effects of the model (Kuznetsova et al., 2017). When the fixed effects significantly differed from zero, post-hoc t-tests were used to test the main effects of the categorical and continuous variables within each interaction (Lenth, 2016). When continuous variables were involved in interactions, pairwise post-hoc t-tests were used to test the simple slopes of the continuous variable within each cell of the interaction. The R^2 values reported for all multilevel models were calculated using the method outlined by Nakagawa et al., 2017. Additional details about effect size calculations and the post-hoc power analysis are available in the Supplement (see Section 1.1). All data used for the reported analyses are publicly available at this link: https://osf.io/3fxdy/.

3. Results

3.1. Behavioral Results

Participant responses to the post-experiment questionnaire were calculated based on 7-point scales (see *Procedure*). Overall, participants reported being interested in the experimental task (M = 5.06, SD = 1.19), and engaged (M = 5.44, SD = 1.05). Participants also indicated that they were not bored by the task (M = 3.14, SD = 1.36). The ratings for difficulty were also below the midpoint on the scale (M = 3.06, SD = 1.91).

Interdependent and independent self-construal scores were assessed using the Singelis self-construal scale. The self-construal scores showed similar reliabilities in this sample with past work (e.g. Kraus & Kitayama, 2019) with $\alpha = .57$ for independence and $\alpha = .517$ interdependence. Overall, scores on interdependence (M = 4.64, SD =.8) were slightly greater than those on independence (M = 4.61, SD =.67), but the scores were not significantly different, $t(35) = .183$, $p = .856$, d = .031. Due to the relatively low reliability of the self-construal scales, the reported analyses were also completed after trimming several items to improve the reliability of these scales to typically acceptable levels (Vaske et al., 2017). The results were extremely similar for these trimmed scales versus the untrimmed scales reported here (see Section 1.3 of the Supplement).

3.2. ERP Results

Here, we examined whether the same pattern of results observed in Kraus and Kitayama (2019) would replicate in the current sample. Specifically, we tested if downregulation of the LPP during expressive suppression would be moderated by Self-Construal. The results of the mixed model (Marginal R^2 = .05, Conditional R^2 = .19) showed a significant effect of Valence, $F(1,87.7) = 32.29$, $p < .001$, 95% CI = [1.85 3.85], $\eta_p^2 = .77$, indicating that unpleasant images (M = 3.45, SE = .564) elicited a larger LPP than neutral images (M = .6, SE = .42). A significant main effect of Condition was also observed, $F(1,32) = 8.35$, $p = .007$, 95% CI = [.31 1.73], $\eta_p^2 = .29$, showing that the LPP in the suppress condition (M = 1.52, SE = .457) was significantly lower than the LPP in the attend condition (M = 2.54, SE = .473). There was also a significant effect of Self-Construal, $F(1,31.9) = 4.64$, $p = .039$, 95% CI = [.06 1.67], $\eta_p^2 = .1$, indicating that people with a more interdependent Self-Construal had a smaller LPP overall versus those with a more independent Self-Construal. Fig. 1.

These main effects were further moderated by a Condition x Valence x Self-Construal interaction (see Fig. 2), $F(1,28.9) = 16.1$, $p < .001$, $\eta_p^2 = .58$.[4] To follow up on this interaction, simple slope tests were performed on the slope of Self-Construal between each cell of the Condition x Valence interaction. As hypothesized, in the suppress condition the slope of Self-Construal was significantly more negative for unpleasant images (M = −1.65, SE = .507) versus neutral images (M = −.54, SE = .435), $t(30.3) = 2.91$, $p = .007$, 95% CI = [.35 1.89], $d_z = .44$. The slope of Self-Construal was also significantly more negative for unpleasant images in the suppress condition (M = −1.65, SE = .507) versus the attend condition (M = −.23, SE = .615), $t(31.2) = 3.22$, $p = .003$, 95% CI = [.44 2.31], $d_z = .62$. No relevant main effects or interactions involving Time for the main hypothesis were significant, indicating that the suppression effect was similar during both the early and late time windows. To test whether this 3-way interaction was adequately powered, as in Kraus and Kitayama (2019) a power calculation was carried out using a method for estimating power in multilevel models (see Section 1.2 of the Supplement). This method yielded a power estimate of.88, suggesting that the current experiment was sufficiently powered to measure the effect reported here.

The above results show that Self-Construal significantly moderated the ability to suppress the LPP to unpleasant images versus the attend condition, and versus neutral images in the suppress condition, across the early and late time windows. Specifically, those with a more

[3] The threshold for this criterion was lowered from .5μV in the previous paper (Kraus & Kitayama, 2019) due to an excessive rejection of trials that did not contain artifacts upon visual inspection. This is likely due to the denser 64 channel montage used in this paper, which can result in low observed amplitudes at sensors not included in our previous 32 channel montage (e.g., P10) due to their proximity to the mastoid reference.

[4] As in Kraus and Kitayama (2019), we also performed this analysis after regressing Self-Construal on the scores from all five factors of the NEO-FFM. Controlling for all five factors, this interaction only approached significance, $F(1,32.5) = 3.81$, $p = .059$, $\eta_p^2 = .18$.

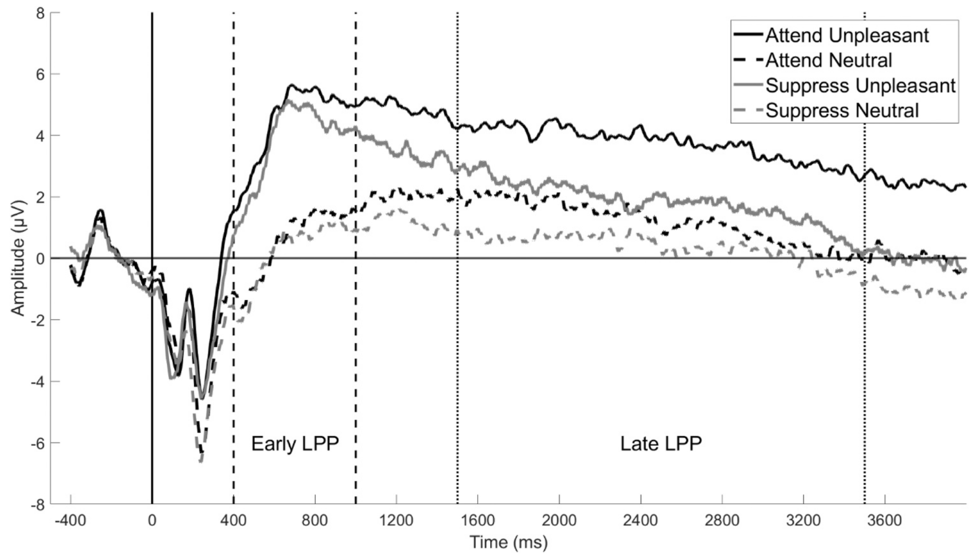

Fig. 1. The grand average ERP waveforms are plotted above for the average of electrodes Cz, CPz, and Pz. The lines represent unpleasant images in the attend condition (black, solid), neutral images in the attend condition (black, dashed), unpleasant images in the suppress condition (gray, solid), and neutral images in the suppress condition (gray, dashed). The time windows for the early (dashed line) and late (dotted line) LPP are also shown with vertical lines and labeled. For comparison, the ERP waveforms are also shown separately using a median split for participants low and high in Self-Construal scores (see Fig. S1).

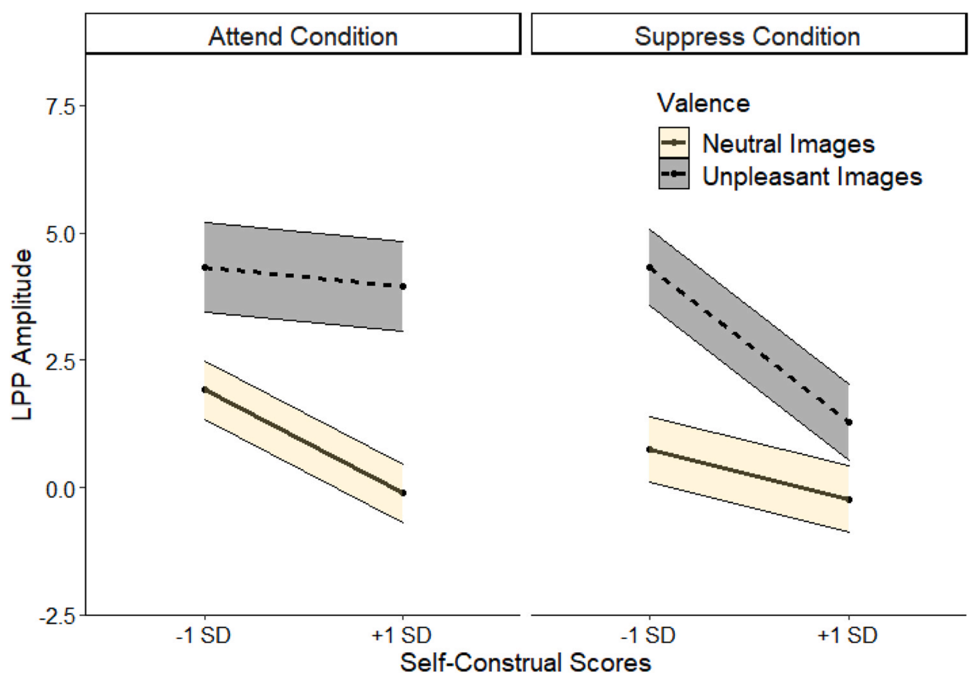

Fig. 2. The marginal means for the Condition x Valence x Self-Construal interaction and their standard errors are shown here. The means for the LPP in the attend condition are shown on the left and on the right are the means for the suppress condition. Mean LPP amplitudes for unpleasant images are plotted with a dotted line and neutral images with a solid line. These values are plotted as a function of low (−1 SD) versus high (+1 SD) Self-Construal scores. In this figure, greater Self-Construal scores indicate higher interdependence scores relative to independence scores.

interdependent Self-Construal were able to downregulate their LPP to unpleasant images, but not for neutral images or in the attend condition. The other significant effects in this model were secondary to the hypothesis of the paper and are reported in the Supplement (see Section 2.1 of the Supplement).

4. Discussion

Building on previous work examining emotion regulation via expressive suppression (Hampton et al., 2021; Murata et al., 2013; Varnum & Hampton, 2017), we examined the capacity of native East Asians to downregulate their LPP in response to unpleasant images. Consistent with previous findings (Kraus & Kitayama, 2019), we observed that effective modulation of the LPP during expressive suppression was evident among East Asians who strongly endorsed an interdependent (versus independent) self-construal. Additionally, as in Kraus and Kitayama (2019), this result was consistent during both the early and late time windows, indicating that the effects of expressive suppression were present even during the early stages of affective processing. This supports the hypothesis that interdependent self-construal plays a critical role in facilitating expressive suppression in East Asian individuals, regardless of the cultural context in which they are tested. Thus, our results highlight the robust and generalizable nature of this phenomenon.

The role of interdependence for the in vivo effectiveness of expressive suppression for East Asians has important implications for cross-cultural theories of emotion regulation. Although some studies have found a weaker link between self-reported suppression and negative health outcomes in East Asians than for those of European descent (e.g., Butler et al., 2007; Cheung & Park, 2010; Soto et al., 2011), conflicting evidence suggests this relationship is not straightforward (e.g., English & John, 2013; Juang et al., 2016). However, these results contrast with physiological correlates of expressive suppression, which frequently show East Asians experience less arousal during suppression than Europeans (e.g., Mauss & Butler, 2010; Murata et al., 2013; Soto et al., 2016). One explanation for these seemingly conflicting results is that the long-term consequences of expressive suppression may depend the degree of congruity between the amount an individual practices suppression and how much they desire to express their emotions (Tsai & Lu, 2018). This would suggest that individuals who do not desire to express their emotions, such as those higher in interdependent self-construal (or higher in interdependence relative to independence), may experience more long-term benefits from expressive suppression than those with a greater desire to express their emotions. This is consistent with recent work showing that for more interdependent Japanese individuals, suppression is associated with better mental health outcomes (Schunk et al., 2022). Thus, to better understand the correspondence between self-reported and in vivo emotion regulation effectiveness, future work should focus on identifying associations between these two types of measures.

Notably, the study by Kraus and Kitayama (2019) reported a similar effect of interdependent self-construal on expressive suppression among East Asians in the US. This suggests that East Asians may share certain elements of their traditional cultural values and practices, irrespective of their place of residence. Expressive suppression may thus be one of these shared elements, potentially representing a common practice embodying the concept of interdependence among East Asians both in their home countries and abroad. Though the results here provide support for a link between expressive suppression and interdependence for negative emotions, the picture is much less clear for positive emotions. Multiple previous studies have reported that East Asians failed to downregulate their arousal to positive images when instructed (Hampton et al., 2021; Varnum & Hampton, 2017). However, neither of these studies measured self-construal, which for expressive suppression to negative images appears to be a key moderator for effectiveness in East Asians. Future work should examine the effect of similar cross-cultural moderating variables during expressive suppression in response to positive images.

It is also plausible that the link between expressive suppression and interdependence is relatively unique to East Asian cultural groups. While other cultural groups, such as Latin Americans, may also emphasize interdependence, their means of achieving this culturally valued state may differ. Indeed, for Latin Americans, the expression (rather than suppression) of various social emotions, such as friendly feelings, compassion, and sympathy, could be a more prominent feature of interdependence (Kitayama et al., 2022). This idea is consistent with the findings of Hampton et al. (2021), who observed that Latin Americans were capable of upregulating their physiological arousal (assessed via the LPP) when instructed to do so. Additional work will be necessary to better characterize the neural correlates of emotion regulation across different cultures.

Although the results from Kraus and Kitayama (2019) for East Asians and the current results for Japanese exhibit substantial similarity, one important difference should be acknowledged. In Kraus and Kitayama (2019), interdependent self-construal was measured as the mean of the interdependent self-construal subscale, whereas in the current study it was represented as the difference score between the interdependent and independent subscales. Conceptually these two measures are akin as the self's independence may sometimes involve a refusal to be interdependent or, conversely, the self's expression of interdependence may often manifest by inhibiting one's independence. However, the three-way interaction reported here was not statistically significant when the same interdependence score from Kraus and Kitayama (2019) was used[5] (see Section 2.2 of the Supplement). Together, these results suggests that there may be systematic cultural differences between Japanese in Japan and Asian Americans in terms of how interdependence is expressed. Whereas Asian Americans may express interdependence by positively showcasing their interdependent propensities, Japanese in Japan may do so not only by positively showing their interdependence but also by inhibiting their independence. This potential cultural variation in how interdependence is actualized warrants further investigation, and may explain why only relatively greater interdependence was a significant moderator in both studies.

The results of our study also have important practical implications in several domains. For instance, understanding the relationship between interdependent self-construal and expressive suppression in collectivistic cultures can inform therapeutic approaches for individuals from these backgrounds. Mental health professionals can tailor interventions that respect and leverage the cultural values of interdependence, potentially leading to more effective emotional regulation strategies and improved mental well-being. Moreover, our research underscores the importance of cultural sensitivity in cross-cultural interactions, highlighting the need for individuals from individualistic cultures to recognize and respect the emotion regulation preferences of their collectivistic counterparts. This awareness can contribute to more constructive interpersonal relationships and effective communication within diverse cultural contexts. Ultimately, this facilitation of cross-cultural understanding may provide valuable insights for developing culturally informed mental health interventions while fostering intercultural understanding in an increasingly interconnected world.

Our work has several limitations that warrant acknowledgement. While it extends the understanding of interdependence and expressive suppression to a new cultural context, it remains limited to a single country. A multicultural and multi-site study of emotion regulation will be needed to further generalize these findings. Future work should utilize EEG and other neural measures to better elucidate how findings from self-report measures relate to physiological processes. Second, it is important to acknowledge that the scales used to measure independent and interdependent self-construals are, at times, somewhat nebulous and prone to low reliability (Hardin et al., 2004). Although our findings remained robust when more reliable versions of the scale were used (see Section 2.3 of the Supplement), there may exist narrower facets of these constructs that are associated with cross-cultural differences in emotion regulation. Consequently, future research should examine the specific facets of interdependence that are associated with emotional regulation processes across different cultures.

Despite these limitations, this study reinforces the claim that interdependent self-construal is related to the effectiveness of in vivo expressive suppression in East Asian cultures. Future work should seek to identify additional measures that are associated with the effectiveness of in vivo measures of culturally endorsed (versus unsanctioned)

[5] It is also worth noting that, just as reported here, the interdependence effect reported in Kraus and Kitayama (2019) remained significant even when statistically controlling for independence scores as covariates (see models 2 and 3 in Table 2 of Kraus & Kitayama, 2019). Furthermore, given the conceptual similarity between the residuals of interdependence regressed on independence and the difference score used in this study (Meyer et al., 2017), it is reasonable to conclude that the results from these two studies are consistent as both reported significant effects of interdependence when controlling for independence.

emotion regulation strategies.

CRediT authorship contribution statement

Kongmeng Liew: Writing – review & editing, Validation, Formal analysis, Data curation. **Shinobu Kitayama:** Writing – review & editing, Supervision, Project administration, Methodology, Conceptualization. **Brian Kraus:** Writing – review & editing, Writing – original draft, Visualization, Software, Methodology, Investigation, Formal analysis, Conceptualization. **Yukiko Uchida:** Writing – review & editing, Supervision, Resources, Project administration, Funding acquisition, Conceptualization.

Declaration of Generative AI and AI-assisted technologies in the writing process

No generative AI or AI-assisted technologies were used in the drafting or editing of this manuscript.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

The data is available on OSF via a link provided in the manuscript.

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Appendix A. Supporting information

Supplementary data associated with this article can be found in the online version at doi:10.1016/j.biopsycho.2024.108767.

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