Biological Psychology 146 (2019) 107733

Contents lists available at ScienceDirect

Biological Psychology

journal homepage: www.elsevier.com/locate/biopsycho

Interdependent self-construal predicts emotion suppression in Asian Americans: An electro-cortical investigation

Brian Kraus*, Shinobu Kitayama*

University of Michigan, Dept. of Psychology University of Michigan, 530 Church St., Ann Arbor, MI 48109, United States

ARTICLE INFO

Keywords:
Interdependence
Emotion regulation
Late positive potential
Cultural neuroscience

ABSTRACT

Although people with high interdependent self-construal (SC) are often assumed to be competent in emotion suppression, direct evidence is missing. We tested whether interdependent SC would predict the ability to down-regulate emotional arousal. Americans of both East Asian and European descent were shown a series of pictures. They were instructed to suppress or attend to their emotions. Their electroencephalogram was recorded and analyzed. The late positive potential (LPP) evoked by unpleasant (vs. neutral) pictures (a marker of emotional arousal) was reduced in the suppress (vs. attend) condition. This effect of emotion suppression was more pronounced for those high in interdependent SC than for those low in it. Curiously, the resulting valence x condition x interdependent SC interaction was robust among those of Asian descent, but not those of European descent. The 4-way interaction involving culture was statistically significant. Our work suggests that the purported link between interdependent SC and emotion suppression may be culture-bound.

1. Introduction

Emotion suppression is an important strategy of emotion regulation that involves the down-regulation of experienced emotions (John & Gross, 2004). Although some other strategies of emotion regulation such as cognitive reappraisal (Moser, Most, & Simons, 2010) and distancing (Kross, Ayduk, & Mischel, 2005) have received substantial research interest in recent years, relatively little is known about whether people are capable of suppressing emotional arousal that has already been evoked and experienced. If anything, one neuroimaging study suggests that the effort to suppress emotions could backfire to increase the emotional response (Goldin, McRae, Ramel, & Gross, 2008).

In the present work, we seek to fill this gap by focusing on interdependent self-construal (SC) as a significant moderator of the capacity of emotion suppression. Interdependent SC refers to a view of the self as connected with others in significant social relations (Markus & Kitayama, 1991).[1] We tested whether interdependent SC would moderate the effectiveness of suppressing emotional arousal. To examine underlying neural mechanisms, we assessed emotional arousal with an electrocortical measure. Both theoretical and empirical consideration led us to anticipate that people with high interdependent SC would be more competent in emotion suppression than those who are low in this SC. Of importance, we examined whether the predicted relationship between interdependent SC and emotion suppression would be observed across cultures by testing Americans of both Asian and European descent.

The hypothesis that interdependent SC may predict emotion suppression initially came from comparisons of East Asians and European Americans. Kim and colleagues have documented that European Americans are more expressive of their unique individuality than East Asians and Asian Americans (Kim & Markus, 1999; Kim & Sherman, 2007). Applying this work to emotion suppression, one could argue that the suppression of emotions is the opposite of the expression of one's individuality. Hence, emotion suppression may prove to be incongruous with the Western cultural mandate of independence. For the same reason, it may be congruous with the Asian cultural mandate of interdependence. It may therefore be expected that East Asians will more readily suppress emotions, compared to European Americans (Cheung & Park, 2010; Ford & Mauss, 2015; Murata, Moser, & Kitayama, 2013).

Consistent with this reasoning, evidence shows that emotion suppression is linked to depression among European Americans (John & Gross, 2004), but not among Asians. Soto and colleagues have demonstrated this in Hong Kong Chinese (Soto, Perez, Kim, Lee, & Minnick, 2011). Cheung and Park (2010) extended the finding to Asian Americans. Further, Mauss and Butler (2010) tested both Asian Americans and European Americans who varied in the value of emotion

* Corresponding authors.
E-mail addresses: briankraus2024@u.northwestern.edu (B. Kraus), kitayama@umich.edu (S. Kitayama).

[1] Although this construal dimension is often contrasted with independent SC, which refers to the view of the self as separate from others and thus autonomous, the two SCs are often orthogonal and, thus, some people could be either high or low on both dimensions simultaneously (Oyserman et al., 2002; Singelis, 1994).

https://doi.org/10.1016/j.biopsycho.2019.107733
Received 19 June 2018; Received in revised form 7 July 2019; Accepted 22 July 2019
Available online 25 July 2019
0301-0511/

control. The participants were exposed to an anger-evoking event. Consistent with the hypothesis that emotion suppression is culturally congruous, Asian Americans who value emotion control reported less anger and a "challenge" pattern of cardiovascular responses. In contrast, consistent with the hypothesis that emotion suppression is culturally incongruous, European Americans who value emotion control showed no reduction in anger experience. Moreover, they showed a "threat" pattern of cardiovascular responses.

Altogether, the existing evidence is consistent with the hypothesis that suppression is less problematic for Asians than for European Americans. Since Asians are typically higher in interdependent SC than European Americans, it might seem sensible to assume that this SC drives the cultural difference. However, very few previous studies have measured interdependent SC. In a notable exception to this, Cheung and Park (2010) did measure interdependent SC. These researchers found that the association between self-rated emotion suppression and depression is attenuated for those high in interdependent SC in both European Americans and Asian Americans. To the best of our knowledge, no other studies measured interdependent SC. While the assumption that East Asians are higher in independent SC holds in most cases (Kitayama & Park, 2014; Na & Kitayama, 2011; Oyserman, Coon, & Kemmelmeier, 2002; Park & Kitayama, 2012), it is important to measure interdependent SC and relate it to the outcome of interest.

Equally important, very few studies test emotion suppression directly. As noted, Cheung and Park (2010) used self-report of emotional suppression. Another study (Soto et al., 2011) used a similar individual difference measure. These measures assess how commonly or frequently people suppress their emotions. Hence, they do not assess whether emotion suppression is successful when it is performed. More pertinent to the assessment of competence of emotion suppression are a few studies that used an objective measure (Mauss & Butler, 2010) or neural indicator of emotion regulation (Cai, Lou, Long, & Yuan, 2016; Murata et al., 2013). However, none of these studies included a measure of interdependent SC.

In the present work, we used a well-validated electrocortical indicator of emotional arousal, called the late positive potential (LPP). The LPP is a prolonged positive deflection of electrocortical activity observed primarily at midline parietal electrodes beginning around 400 ms post-onset of an emotional stimulus. The LPP is readily elicited in response to emotional images both positive and negative and tends to show a sustained positivity for the entire duration of the stimulus presentation (Hajcak, MacNamara, & Olvet, 2010). The LPP is sensitive to emotional arousal irrespective of the positive or negative valence of a given image (Cuthbert, Schupp, & Bradley, 2000; Schupp et al., 2000). Moreover, given its high correlation with self-reported arousal (Cuthbert, Schupp, Bradley, Birbaumer, & Lang, 2000), the ability to modulate LPP amplitude has proven as a reliable indicator of the regulation of emotional arousal. Indeed, the LPP is sensitive to various emotion regulation strategies including cognitive reappraisal (Dennis & Hajcak, 2009), distraction (Dunning & Hajcak, 2009), and expressive suppression (Murata et al., 2013).

To assess the ability of emotion suppression, we exposed participants to extremely unpleasant (or neutral) IAPS pictures while monitoring their electrocortical activity. We compared two conditions. In one condition, participants were instructed to attend to and naturally experience their emotions, and in the other, they were instructed to suppress their emotions. A standard measure of interdependent SC (Singelis, 1994) was used to test whether this SC would moderate competence of emotion suppression. We anticipated that the LPP to unpleasant (vs. neutral) pictures would be attenuated in the suppress (vs. attend) condition. Critically, we also hypothesized that this effect of emotion suppression would be more pronounced for those high in interdependent SC than for those low in this SC.

We were also mindful of the possibility that interdependent SC could be confounded with various individual difference variables, including independent SC and various personality traits. Moreover, personality traits have been demonstrated to affect the choice of emotion regulation strategies (Gross & John, 2003). They are also associated with the effectiveness of emotion regulation when this effectiveness is measured behaviorally (Lopes, Salovey, Côté, & Beers, 2005), via changes in heart rate (Cho, White, Yang, & Soto, 2019), or with the LPP (Cai et al., 2016). We thus controlled for independent SC (Markus & Kitayama, 1991) and the Big Five personality traits (Costa & McCrae, 2008). Effects may be judged robust if they are reliable regardless of the inclusion or exclusion of these control variables.

2. Method

2.1. Participants

We recruited 120 participants through the University of Michigan Introduction to Psychology subject pool. All participants were compensated with course credit for participating. Of these participants, 3 were excluded for reporting the presence of previous mental health diagnoses, 3 were excluded for opting out of the study after consenting, and 13 were excluded for reporting that they were left-handed. After applying these exclusion criteria, 101 participants remained.

In addition to these exclusions, 14 participants were excluded for not meeting ethnicity criteria. For European Americans, participants had to report that they were only of European or European American descent and that they lived in either America or Europe their entire lives. In this sample, no participants were born or raised outside of America. The criteria for East Asians stipulated that they had to report that they were of East Asian descent. No exclusions were made based on generation or number of years in the US. After these exclusions, 87 participants remained in the sample.

During EEG analysis, another 12 participants were excluded for having excessive artifacts in their EEG recordings. These participants had less than 50% of usable trials for neutral or unpleasant pictures in either condition. This left 75 participants with usable data, 42 of European American descent (19 Female, Age $M = 18.6$, $SD = .857$) and 33 of East Asian heritage (19 Female, Age $M = 18.61$, $SD = .966$, Born in US = 10, Years in US $M = 10.22$, $SD = 6.88$[2]). Among the 33 Asians, 9 were Asian Americans (i.e., having been born and raised in the US), whereas the rest were all Asian-born Asians. The sample size was based on prior work in cultural neuroscience, which tended to test approximately 20 participants in each cultural group (e.g., Mu, Kitayama, Han, & Gelfand, 2015; Na & Kitayama, 2011). To ensure that we would have sufficient power, we approximately doubled the sample size.

2.2. Materials

60 neutral low arousing images (valence: $M = 5.08$, arousal: $M = 3.25$) and 60 unpleasant high arousing images (valence: $M = 2.28$, arousal: $M = 6.29$) were selected from the international affective picture system (IAPS) (Lang, Bradley, & Cuthbert, 1999) database.[3] These images have been used in past research examining emotion regulation (Hajcak et al., 2010; Moser, Krompinger, Dietz, & Simons, 2009; Murata et al., 2013). E-Prime 2.0 software (Schneider, Eschman, & Zuccolotto,

[2] Demographic data for one Asian participant was not available

[3] The following IAPS pictures 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).

2002) was used for stimulus presentation. A Logitech web camera was used to monitor participants from an adjacent room during the experiment. Video from this camera was not recorded but was used for the experimenter to monitor whether the participant was viewing the images the entire time they were on the screen. To assess independent and interdependent SC, the Singelis self-construal scale was administered (Singelis, 1994). The five global facets of personality (agreeableness, extraversion, conscientiousness, emotional stability, and openness) were assessed using the FFM Mini-markers scale (Saucier, 1994).[4]

2.3. Procedure

Upon arrival, participants were told that the study would record brain activity during a computer task where they would be observing different pictures on a computer screen. Participants were seated approximately 60 cm from a color computer display and the EEG electrodes were applied. In the attend condition, participants were instructed to pay attention to the picture and naturally experience any emotions elicited by the picture. Specifically, they were told, "Please react normally to each picture. Attend to and be aware of any feelings that each picture elicits." In the suppress condition, participants were instructed to minimize and hide the emotional responses that were naturally elicited by the picture. In particular, they were told, "Please suppress any emotional responses you may have while viewing each picture. Try to remain calm and to diminish any response reflecting your subjective feelings regardless of the affective valence of the picture. We will monitor your facial expressions while you are looking at the pictures. Try to hide any emotional reactions to the picture so that we will not be able to detect what kind of picture you are viewing." To avoid any carry-over effects, participants performed the attend condition first, followed by the suppress condition, as in previous work (Murata et al., 2013). As in previous research, participants were not prompted to rate their emotional suppression during the EEG recording (Krompinger, Moser, & Simons, 2008; Moser, Hajcak, Bukay, & Simons, 2006).

On each trial, a fixation cross was presented for 2000 ms followed by a blank screen interval of 500 ms. After this, either a neutral or unpleasant picture was presented for 4000 ms with a subsequent blank screen interval of 2500 ms. In each block, 20 pictures (10 unpleasant, 10 neutral) were randomly presented, and each condition contained three blocks of pictures. The order of the blocks was counterbalanced across participants. Thus, half of the participants saw each set of pictures in either the attend or suppress condition. Each participant first saw three blocks in the attend condition followed by 3 blocks in the suppress condition. Participants viewed 10 practice pictures at the beginning of the experiment to familiarize themselves with the procedure.

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), and boring (1 = Not boring at all, 7 = Very boring). They were also asked how much they felt engaged in the task (1 = Not engaged at all, 7 = Very engaged). Afterward, participants filled out the questionnaires for independent and interdependent SC and the Big-5 personality traits.

[4] Participants also completed the FFM NEO PI-R Neuroticism scale (Costa & McCrae, 2008), the Affect Valuation Index (Tsai, Knutson, & Fung, 2006), the Suinn-Lew Asian Self-Identity Acculturation scale (Suinn, Rickard-Figueroa, Lew, & Vigil, 1987), the Behavioral Adjustment scale (Kitayama et al., 2018), the Emotion Regulation Questionnaire (Gross & John, 2003), the COPE inventory (Carver, Scheier, & Weintraub, 1989), and the Primary and Secondary Control scale (Wrosch, Heckhausen, & Lachman, 2000). The FFM NEO PI-R Neuroticism scale and the Behavioral Adjustment scale were included to address different questions, whereas the remaining scales were included for exploratory purposes.

2.4. EEG data recording

The EEG was recorded from 32 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 electrode system. EEG data were recorded at 512 Hz. The electro-oculogram (EOG) was monitored using bipolar vertical EOG (VEOG) and horizontal EOG (HEOG) electrodes. 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).

2.5. EEG data processing

For processing, data underwent an offline band pass filter of .1–20 Hz and scalp electrodes were referenced digitally to the averaged left and right mastoid electrodes. Data were then subjected to visual inspection for major muscle and unusual motor/ocular artifacts, which were removed. Independent Component Analysis (ICA) was then used to remove artifacts in the data. Decomposition of the independent components was performed on the continuously recorded EEG in EEGLAB (version 13.6.5) using the 'runica' INFOMAX algorithm (Makeig, Jung, Bell, Ghahremani, & Sejnowski, 1997). For each participant, ICA components were determined for up to 32 scalp electrodes and 4 bipolar EOG electrodes. If any scalp electrodes were deemed unsuitable for analysis, they were removed for interpolation before performing 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 components were visually inspected and artifactual components were rejected. Rejected components were primarily related to eye movements captured by the EOG electrodes and muscle artifacts (McMenamin et al., 2010). All removed channels were subsequently interpolated using spherical interpolation. The recorded data was then segmented into epochs of 400 ms before stimulus onset and 4000 ms afterward. The data was then subjected to automatic artifact rejection. Trials were rejected if, for any scalp electrode, the maximum peak-to-peak voltage exceeded 200μV within a 400 ms moving window for any scalp electrode using 100 ms steps that moved across the length of each epoch. Trials were also rejected if at any scalp electrode they fluctuated more than 30μV between two sampling points, or if any scalp channel had little to no activity (+/−0.5μV) over a 400 ms interval.

Each trial was baseline corrected using a 400 ms pre-stimulus interval. To quantify the LPP, activity at electrodes Cz, CPz, and Pz were averaged for analysis. The time window used for analysis of the early LPP was 400–1000 ms (MacNamara & Hajcak, 2009) and the time window for the late LPP was 1500–3500 ms (Murata et al., 2013).

2.6. Data analysis

We had three between-subject variables (Culture, Interdependent SC, and Counterbalancing order of blocks of IAPS pictures) and three within-subject variables (Condition [suppress vs. attend], Valence [unpleasant vs. neutral], and Time [early vs. late LPP]). Confirmatory hypothesis testing was conducted using random effects models, which allow for the estimation of both nested and crossed random effects on the trial level (Baayen, Davidson, & Bates, 2008). This method allows modeling of the effects of stimuli simultaneously with the effect of subjects. The contributions of stimuli to measured variance are typically estimated as error variance. However, by explicitly modeling the stimulus effects, the mixed effect models can provide a better estimate of the variance accounted for by the fixed effects of interest (Judd, Westfall, & Kenny, 2017). The models were fit using the lme4 package in *R* using restricted maximum likelihood to provide an estimation of

the parameters (Bates, Mächler, Bolker, & Walker, 2015). To specify each model, trial-level data were extracted for the LPP amplitude averaged at the electrodes of interest for each participant. The model specification included random effects for subject and item (Judd et al., 2017). To fit the model, the maximal random effect structure was used (Barr, Levy, Scheepers, & Tily, 2013).[5] The full specification of within-subjects random slopes was included in the model. However, the interaction term between time and condition as a random slope within items was removed in the final model because it made the model too complex to converge. The syntax for the reported model is shown in Appendix A.

As noted, we controlled for independent SC and all the five personality traits in estimating the effects of interdependent SC. For this purpose, we first residualized the effects of these variables from the raw score of interdependent SC separately for East Asians and European Americans using a linear regression. The residuals from this regression were then centered and scaled at the mean within each culture for each model and used to estimate the effect of interdependent SC (Enders & Tofighi, 2007).

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 using the lmerTest package in *R* (Kuznetsova, Brockhoff, & Christensen, 2017). When the fixed effects significantly differed from zero, pairwise post-hoc *t*-tests were used for simple effects tests within each of the interactions that proved significant using the lsmeans package in *R* (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 as well as the main effects of the categorical variables at +1 SD, the mean (0 SD), and – 1 SD of the continuous variable. R^2 values for all multilevel models were calculated using the method outlined by Nakagawa and Schielzeth (2013).

3. Results

3.1. Individual difference measures

The reliabilities of the Singelis SC measure were comparable to previous work that used the same scale (Kitayama & Park, 2014; Na & Kitayama, 2011) for both European Americans ($\alpha = 0.613$ and 0.581 for independent SC and interdependent SC, respectively) and East Asians ($\alpha = 0.658$ and 0.558 for independent SC and interdependent SC, respectively). However, unlike previous work which showed as compared to European Americans, Asians are less independent and/or more interdependent (Kitayama & Park, 2014; Na & Kitayama, 2011; Oyserman et al., 2002; Singelis, 1994), independent SC scores were not significantly different between European Americans ($M = 4.86$, $SD = .684$) and East Asians ($M = 4.61$, $SD = .611$), $t(73) = 1.611$, $p = .112$, $d = 0.372$. Scores on interdependent SC also did not significantly differ between European Americans ($M = 4.86$, $SD = .52$) and East Asians ($M = 4.90$, $SD = .523$), $t(73) = 0.362$, $p = .719$, $d = 0.084$. Among East Asians, we found one peculiar pattern: Those who came to the U.S. relatively recently were particularly low in interdependent SC. There was a significantly positive association between *less* years in the US and *low* interdependence, $r(31) = 0.424$, $p = .016$.

The FFM Mini-markers scale showed good reliabilities in both European Americans and East Asians respectively for agreeableness ($\alpha = 0.854$ and 0.796), extraversion ($\alpha = 0.864$ and 0.771), conscientiousness ($\alpha = 0.824$ and 0.791), emotional stability ($\alpha = 0.807$ and 0.681), and openness to experience ($\alpha = 0.81$ and 0.794). Mean scores and correlations among them are shown in Table 1.

3.2. Behavioral measures

Both European American and Asian participants reported relatively high levels of both interest ($M = 5.1$, $SD = 1.246$ vs $M = 4.82$, $SD = 1.074$), $t(73) = 1.015$, $p = .313$, $d = 0.234$) and engagement in the task ($M = 5.1$, $SD = 1.185$ vs $M = 5.06$, $SD = 1.116$), $t(73) = 0.129$, $p = .898$, $d = 0.03$) and a lower level of boredom ($M = 2.79$, $SD = 1.371$ vs $M = 2.91$, $SD = 1.284$), $t(73) = 0.398$, $p = .692$, $d = 0.092$). The mean task difficulty rating was below the scale midpoint ($M = 2.74$, $SD = 1.515$ vs $M = 2.7$, $SD = 1.591$), $t(73) = 0.114$, $p = .909$, $d = 0.026$) on a 7-point rating scale with 7 = "Very difficult." All means and standard deviations are reported for European American and East Asian participants respectively.

3.3. EEG

To examine whether emotion suppression is moderated by interdependent SC, we first inspected the averaged waveforms for those in upper or lower quartiles of interdependent SC combining the two cultural groups. As can be seen in Fig. 1-A, for those low in interdependent SC, a prominent LPP wave is evident for unpleasant images, but not for neutral images. However, this pattern is virtually identical in both the suppress and attend conditions, suggesting that there was minimal overall effect of the suppress (vs. attend) instructions. In contrast, for those high in interdependent SC (Fig. 1-B), there is a pronounced peak in the LPP (400–1000 ms) especially in the attend (vs. suppress) condition in response to unpleasant (vs. neutral) pictures, which quickly dissipated as time went on. Importantly, this weakening of LPP was more pronounced in the suppress (vs. attend) condition. Thus, the overall pattern provides some credulity to the hypothesis that emotion suppression is more effective for those who score high (vs. low) in interdependent SC. However, it is also clear that there are some additional effects that go beyond this hypothesis. For example, people with high interdependent SC seem to show a strong LPP response especially early on in the attend (vs. suppress) condition.

To follow up on the visual inspection in greater detail with the entire pool of participants, we used a linear mixed-effects model. Multiple versions of this model were tested to investigate the effects of possibly confounding variables on emotion regulation. All models included fixed effects of Condition (Attend/Suppress), Valence (Unpleasant/Neutral), Interdependent SC, Culture, and Time (Early/Late Time Window), as well as Counterbalance Order. The different models tested were as follows: Model 1 included the raw interdependent SC scores centered within culture, Model 2 included interdependent SC scores after independent SC was partialed out, and Model 3 used interdependent SC scores after both the independent SC scores and scores from the FFM were partialed out (see Table 2). The hypothesized effect of Condition moderating the interaction between interdependent SC and valence was significant in all three models. Moreover, the 4-way interaction involving Culture was also significant in all three models, and the results for Model 1 are reported below.

The results of Model 1 (Marginal $R^2 = .04$, Conditional $R^2 = 0.12$) revealed a significant main effect of Valence, showing that the LPP was greater in magnitude for unpleasant ($M = 5.675$, $SE = 0.409$) than neutral images ($M = 1.277$, $SE = 0.391$), $F(1, 64.27) = 163.86$, $p < .0001$, $\eta^2 = 0.386$. The main effect of Condition was also significant, $F(1, 84.47) = 4.95$, $p = .029$, $\eta^2 = .014$, with the LPP being smaller in the suppress condition ($M = 3.039$, $SE = 0.404$) than in the attend condition ($M = 3.914$, $SE = 0.419$). The Culture main effect was also significant, with East Asians ($M = 2.738$, $SE = 0.467$) showing a greater LPP than European Americans ($M = 4.215$, $SE = 0.535$), $F(1, 66.53) = 4.495$, $p = .038$, $\eta^2 = 0.016$. There was also a main effect of Time, with a larger LPP in the early time window ($M = 3.868$, $SE = 0.431$) than in the later time window ($M = 3.084$, $SE = 0.372$), F

[5] Because multiple time windows were extracted from each trial, an intercept for the interaction of subject and item could theoretically be estimated in the model. However, inclusion of this term made the model too complex to converge. Thus, this term was removed from the model.

Table 1
Correlations for East Asians and European Americans for all individual difference measures.

Descriptive statistics and correlations for all self-report measures.

East Asians

	Descriptive Statistics	Agreeableness	Conscientiousness	Emotional Stability	Openness	Extraversion	Independence	Interdependence
Agreeableness	M = 54.21, SD = 9.057	_	_	_	_	_	_	_
Conscientiousness	M = 52.64, SD = 8.124	.044	_	_	_	_	_	_
Emotional Stability	M = 44.14, SD = 9.722	.042	.169	_	_	_	_	_
Openness	M = 51.52, SD = 8.012	−.305	.406 *	.005	_	_	_	_
Extraversion	M = 41.45, SD = 8.167	.215	−.101	−.158	.235	_	_	_
Independence	M = 4.86, SD = .684	−.053	.084	.039	.314	.422 *	_	_
Interdependence	M = 4.86, SD = .52	.556 **	.133	.016	−.183	.025	.061	_

European Americans

	Descriptive Statistics	Agreeableness	Conscientiousness	Emotional Stability	Openness	Extraversion	Independence	Interdependence
Agreeableness	M = 53.85, SD = 8.441	_	_	_	_	_	_	_
Conscientiousness	M = 45.06, SD = 10.71	.074	_	_	_	_	_	_
Emotional Stability	M = 39.58, SD = 8.136	.339 *	.13	_	_	_	_	_
Openness	M = 47.85, SD = 8.012	.384 *	−.096	.092	_	_	_	_
Extraversion	M = 41.45, SD = 9.206	.044	.158	.078	.059	_	_	_
Independence	M = 4.61, SD = .611	−.053	.272	.12	−.037	.536 ***	_	_
Interdependence	M = 4.9, SD = .523	.518 ***	.104	−.017	.117	−.01	.012	_

* P < 0.05.
** P < 0.01.
*** P < 0.001.

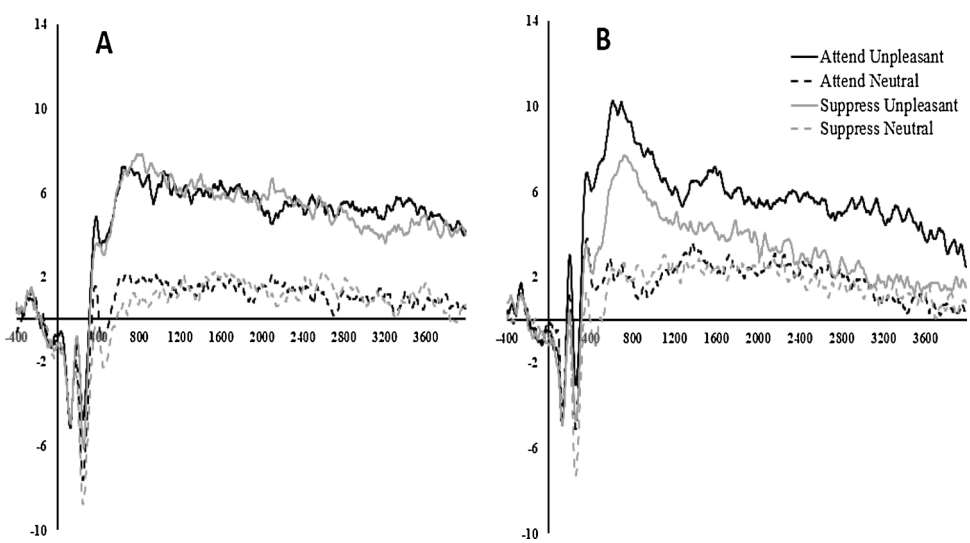

Fig. 1. Grand averaged ERPs for those both low in interdependence (A; $N = 22$) and high in interdependence (B; $N = 20$). Black lines show the LPPs in the attend condition and grey lines the suppress condition. Solid lines represent the LPPs for unpleasant images and dotted lines represent the LPPs for neutral images.

(1, 66.49) = 4.822, $p = .032$, $\eta^2 = 0.018$.

Beyond these main effects, however, evidence for our theoretical predictions must be sought in certain interactions. In particular, the pattern identified in the waveforms above implies a 3-way interaction involving Condition, Valence, and Interdependent SC (LPP due to unpleasant [vs. neutral] images should be weaker in the suppress [vs. attend] condition especially for those high [vs. low] in interdependent SC). In the omnibus model, this key 3-way interaction was significant, $F(1, 71.26) = 8.639$, $p = .004$, $\eta^2 = 0.029$. Interestingly, however, a 4-way interaction involving Culture also achieved statistical significance, $F(1, 71.27) = 4.316$, $p = .0414$, $\eta^2 = 0.015$. No interaction with Time was found, so the reported marginal means for the LPP are an average of the amplitudes in both the early and late time windows.

After establishing the presence of the 4-way interaction, we subsequently tested whether the predicted 3-way interaction would be found when the two cultural groups were tested separately. The predicted 3-way interaction proved highly significant for East Asians (Marginal $R^2 = .04$, Conditional $R^2 = 0.16$), $F(1, 46.03) = 13.79$, $p = .0006$, $\eta^2 = .068$. As shown in Fig. 2-A, in the attend condition, the Interdependent SC x Valence interaction was negligible, $F(1, 28.34) = 1.74$, $p = .198$, $\eta^2 = 0.015$. In contrast, in the suppress condition, this interaction proved significant, $F(1, 29.8) = 6.056$, $p = .02$, $\eta^2 = 0.044$. Whereas the LPP for neutral images did not change as a function of interdependent SC ($b = .733$, $SE = .768$), the LPP for unpleasant images decreased as a function of interdependent SC ($b = -0.944$, $SE = .826$), $t(29.8) = 2.46$, $p = .02$, $d = 0.443$.

Two additional features of Fig. 2-A are noteworthy. First, East Asians who scored high in interdependent SC were quite effective in down-regulating the LPP for unpleasant (vs. neutral) images when asked to suppress their emotions. The LPP difference between the

Table 2
Results for model terms of interest from all three models are reported. The results of Model 1 are reported in the paper. Model 1 includes only interdependent SC, Model 2 includes interdependent SC controlling for independent SC, Model 3 includes interdependent SC controlling for independent SC and all five factors of the FFM. All interdependent SC variables were centered within culture.

	Model 1		Model 2		Model 3	
Model Term	*F*	*p*	*F*	*p*	*F*	*p*
Condition	4.95	.029	4.9	.029	3.89	.052
Valence	163.86	< .0001	163.37	< .0001	108.38	< .0001
Interdependent SC	.27	.603	.25	.618	.15	.701
Time	4.82	.032	4.82	.032	4.52	.037
Culture	4.5	.038	4.45	.039	5.71	.02
Condition x Valence	.39	.534	.35	.554	.16	.69
Condition x Interdependent SC	5.9	.018	6.19	.015	5.1	.027
Condition x Culture	.19	.662	.2	.652	.4	.528
Condition x Time	.46	.498	.46	.496	.3	.586
Valence x Interdependent SC	.34	.565	.33	.568	1.98	.164
Valence x Culture	.55	.462	.54	.468	.35	.554
Valence x Time	22.61	< .0001	22.69	< .0001	21.68	< .0001
Interdependent SC x Culture	.58	.45	.53	.471	.11	.744
Interdependent SC x Time	2.96	.09	3.09	.083	.59	.446
Time x Culture	4.92	.03	4.93	.03	4.45	.039
Condition x Valence x Interdependent SC	8.63	.005	8.8	.004	3.96	.0503
Condition x Valence x Interdependent SC x Culture	4.32	.041	4.42	.039	4.19	.044

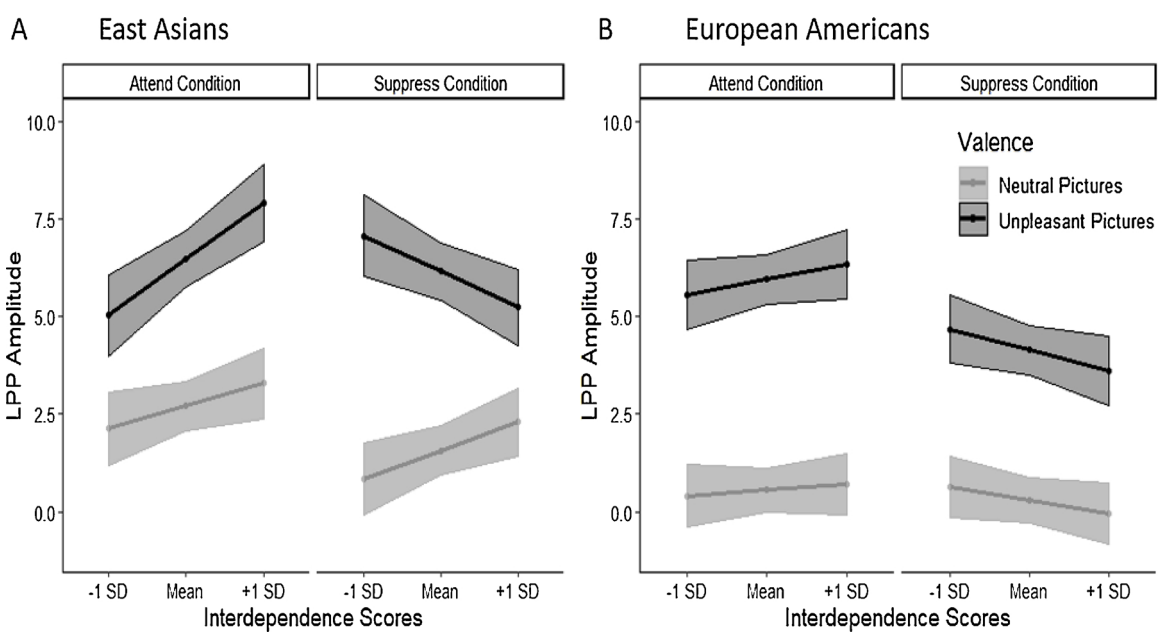

Fig. 2. Marginal means for the Condition x Valence x Interdependence interaction for both East Asians (A) and European Americans (B). The means for unpleasant pictures are plotted in black and the means for neutral pictures are shown in grey. Standard error bars are plotted for each line.

unpleasant and neutral images was no longer significant for those who were 1.5 SDs above the average in interdependent SC, $t(38.96) = 1.864$, $p = .0698$, $d = 0.294$. Second, it is also noteworthy that East Asians who were low in interdependent SC showed a paradoxical increase of LPP to unpleasant (vs. neutral) images in the suppress (vs. attend) condition. For those who were 1 SD below the mean in interdependent SC, the LPP for unpleasant images was greater in the suppress condition ($M = 7.09$, $SE = 1.16$) than in the attend condition ($M = 5.02$, $SE = 1.18$), $t(71) = 2.402$, $p = .0189$, $d = 0.283$. The comparable LPP difference for neutral images was negligible. We will return to this effect in Discussion.

Although the 3-way interaction was statistically significant for East Asians, there is some likelihood of such statistical significance to have resulted from random noise. One way to gauge the viability of such a possibility is to carry out a post-hoc power analysis. We thus estimated the power for the 3-way interaction, given the effect size of the 3-way interaction $\eta^2 = .068$ and the current n = 33. This analysis resulted in an observed power of 0.856.[6] The high post-hoc power provides us with an added assurance that the 3-way interaction we observed was robust.

The pattern for European Americans, shown in Fig. 2-B, was markedly different from the one for Asians (Fig. 2-A). The Condition x Valence interaction is evident in Fig. 2-B, but it was statistically marginal, $F(1, 53.83) = 3.64$, $p = .061$, $\eta^2 = 0.016$. Moreover, the 3-way interaction involving Condition, Valence, and Interdependent SC was

[6] Power for this multilevel model was calculated using the method outlined by Westfall, Kenny and Judd (2014) using the web app maintained by the first author (jakewestfall.org/pangea/). As this app does not support continuous variables, interdependence was treated as a median-split variable when calculating power. Because an assumption of this power analysis is that there is no attrition, a second power analysis was run with n = 28 to approximate the number of ERP trials that were left after data cleaning. This power analysis yielded an estimate of .8.

negligible, $F(1, 40.48) = .44$, $p = .51$, $\eta^2 = .003$. The LPP for unpleasant (vs. neutral) images was marginally smaller in the suppress condition than in the attend condition regardless of the level of interdependent SC. Hence, while somewhat apparent, European Americans' ability to suppress emotions was tenuous at best.

4. Discussion

4.1. Interdependent SC and emotion suppression in two cultures

Drawing on prior theoretical and empirical work on culture, self, and emotion regulation (Cheung & Park, 2010; Ford & Mauss, 2015; Murata et al., 2013; Soto, Lee, & Roberts, 2016; Tsai & Lu, 2018), we tested whether interdependent SC might modulate emotion suppression. To objectively assess the competence of emotion suppression, we used an unobtrusive neural index of emotional arousal. Emotion suppression was operationalized as reduced LPP amplitude for unpleasant (vs. neutral) images under the suppression (vs. attention) instructions. We found that emotion suppression became more pronounced as a function of interdependent SC for East Asians. No difference in arousal was observed for unpleasant (vs. neutral) images for those who were 1.5 SDs higher than the group average in interdependent SC. This finding provides initial evidence that interdependent SC is a crucial dimension that determines the effectiveness of emotion regulation among people of Asian descent. Although this possibility was raised in prior theoretical analyses (Cheung & Park, 2010; Ford & Mauss, 2015; Murata et al., 2013; Soto et al., 2016; Tsai & Lu, 2018), ours is the first to provide empirical support for it.

Interestingly, the pattern for European Americans was different. They exhibited only a barely noticeable degree of successful down-regulation of the LPP to unpleasant (vs. neutral) images in the suppress (vs. attend) condition. Moreover, this effect did not depend on interdependent SC. Like all null findings, the absence of the effect of interdependent SC is hard to interpret. It is possible that the measurement of interdependent SC, which was valid for East Asians, might not have been for European Americans. We found this unlikely because this scale was initially developed based on both East Asians and European Americans (Singelis, 1994). Moreover, it has since been successfully used for both cultural groups (Kitayama & Park, 2014; Na & Kitayama, 2011). It is also possible that the emotion suppression instructions, which were valid for East Asians, might not have been for European Americans. We found this also unlikely for two reasons. First, European Americans were just as engaged in the suppression task and found the task just as interesting as East Asians did. Further, European Americans were successful, at least marginally, in emotion suppression. We tentatively suggest that the European American finding might reflect strong and pervasive cultural norms of expressing emotions. Emotion suppression goes directly against these cultural norms. As a consequence, most European Americans may never be sufficiently "trained" in the cultural task of emotion suppression regardless of their levels of interdependent SC.

In an earlier LPP study, Murata and colleagues (2013) observed that emotion suppression is evident among Asians, but not among European Americans. Our finding is consistent with this observation among East Asians who were relatively high in interdependent SC. As noted above, however, those low in interdependent SC showed a greater LPP to unpleasant (vs. neutral) images in the suppress (vs. attend) condition. Evidently, when trying to suppress emotions, these East Asian individuals inadvertently up-regulated emotional arousal.

4.2. Why does suppression paradoxically amplify arousal?

A similar paradoxical effect of suppression instructions on emotional arousal has been reported in one study (Goldin et al., 2008). In this study, American participants were asked to reduce emotions by either cognitive appraisal or suppression. The activity of the amygdala (a measure of emotional arousal) was successfully down-regulated in the cognitive appraisal condition. In the suppression condition, however, this activity was up-regulated. It is possible that Americans in this study found the instructions to suppress emotions as incongruous with personal preference for emotion expression, incompatible with cultural norms, or both. They might have experienced extra negative arousal due to cognitive dissonance or mismatch with cultural norms when trying to carry out what they regarded as an imposition by the experimenter. This extra negative arousal would then show itself in the over-activation of the amygdala.

It is worthy of mention that our East Asian sample was rather uncharacteristic of this cultural group. A relatively large number of people in our sample scored low in interdependent SC. It might be the case that East Asian students who come to U.S. universities from East Asia are increasingly less interdependent and/or more independent. This possibility may be particularly applicable to Chinese young adults, most of whom were raised as single children. Evidence indicates that China's One Child Policy has contributed to increasing individualism among recent generations of Chinese (sometimes described as "little emperors or empresses") (Cameron, Erkal, Gangadharan, & Meng, 2013; Xu & Hamamura, 2014). Moreover, among these contemporary Asians who are low in interdependent SC, those who come to the U.S. could be particularly low in this regard (Kitayama, Ishii, Imada, Takemura, & Ramaswamy, 2006). As noted earlier, in the current sample, Asian-born Asians who had come to the US relatively recently were the least interdependent. These observations are consistent with another recent study, which shows that East Asian-born Asian sojourners in the US are highly independent or individualistic, even in comparison with European Americans (Hitokoto, Glazer, & Kitayama, 2016).

Altogether, we speculate that some of our East Asian participants – especially those who score low in the dominant East Asian value dimension of interdependence – might have been wedded to certain aspects of American culture, including the value of self-expression, to a greater extent than our European Americans were. This commitment to such aspects of American culture might have led them to feel an unusually strong sense of cultural and personal incongruity in carrying out emotion suppression.

4.3. Limitations

We wish to note some limitations of the present work. First, future work should test pleasant, as well as unpleasant, emotional images. It is not clear whether East Asian interdependence may be served better by down-regulating pleasant as well as unpleasant emotional arousal. The current EEG measure of emotional arousal may powerfully supplement self-report-based cultural analyses on the topic in the future.

Second, our work is based on static pictures as stimuli. It is therefore unclear how generalizable the current findings might be to more realistic emotional situations. For example, will interdependent East Asians be effective in hiding their emotions when exposed to highly insulting comments on their mothers? Although a self-report based study does suggest an affirmative answer (Cheung & Park, 2010), this observation must be confirmed with more unobtrusive, neural indicators of emotion suppression.

Third, our work focused exclusively on emotion suppression, which is only one of several notable strategies of emotion regulation. Theoretically, others such as cognitive appraisal could modulate emotional arousal without compromising the sense of the self, such as being independent and thus expressing the true, genuinely felt inner feelings of the self. Hence, the ability to regulate emotion via cognitive appraisal might be modulated differently as a function of independent or interdependent SC. Future work may test this and other possibilities by utilizing various methods, including the one used in the current work.

Fourth, the reported reliabilities for interdependence were lower than is typically seen for other scales. Thus, it is possible that the construct was not adequately assessed by the measure. However, we

find this unlikely as the reported reliabilities were consistent with other studies (Kitayama & Park, 2014; Na & Kitayama, 2011).

4.4. Future directions

The above limitations notwithstanding, our work provides the first unequivocal evidence that interdependent SC is linked to emotion suppression in Americans of Asian descent. The use of an ERP indicator of emotional arousal, along with the use of cutting-edge trial-wise statistical analysis of ERP data, gives additional credibility to our thesis.

There are many possible extensions of the present evidence. One of the most important would be to test Asians in Asia. As noted above, Asians who choose to come to Western societies for various career-related reasons may be peculiar in some specific ways. They may be more independent or less interdependent, and thus, relatively more comfortable with European American norms of openly expressing their emotions. Unlike Asians in the U.S., Asians in Asia may be more deeply embedded in an interdependent culture. Further, this culture may more strongly sanction emotion suppression and, thus, more thoroughly "train" its members for this strategy of emotion regulation. These individuals may eventually become highly capable of suppressing their emotions. Indeed, as much as the inability of emotion suppression among European Americans did not depend on interdependent SC, the high competence of emotion suppression might also not depend on this individual difference variable.

More generally, future work should explore dynamic ways in which emotion regulation is intertwined with personal, interpersonal, and socio-cultural variables. In this effort, emotion and emotion regulation must be tested not only at subjective, self-report levels but also at neural and physiological levels. Only in this way will we be able to understand how emotion regulation could be instantiated within the brain. Doing so would be a critical initial step toward understanding how the brain is conditioned to achieve adaptation within various socio-cultural contexts. In this endeavor, the ERP method developed in the current study could be a great asset. Moreover, the conceptual framework emphasizing interdependent SC would serve as a powerful compass for further exploration of the dynamic interface among emotion, brain, and culture.

Author notes

This work was supported by grants from the National Science Foundation (BCS 0717982 and SES 1325881).

Declaration of Competing Interest

No conflicts of interest exist for any of the authors of this manuscript.

Appendix A

The syntax in the lme4 package for creating the reported model (Model 1 in the results):

```
FullModel1 <- lmer(Midline_LPP ~
        Condition * Valence * Time * Interdependence * Culture * Order +
        (Condition +
        Valence +
        Time +
        Condition:Valence +
        Condition:Time +
        Valence:Time +
        Condition:Valence:Time | Subject) +
        (Condition +
        Time | Item),
        data=CombinedLPPLMM,
        REML = TRUE,
        control = lmerControl(optCtrl = list(maxfun = 100000)))
```

References

Baayen, R. H., Davidson, D. J., & Bates, D. M. (2008). Mixed-effects modeling with crossed random effects for subjects and items. *Journal of Memory and Language, 59*(4), 390–412. https://doi.org/10.1016/j.jml.2007.12.005.

Barr, D. J., Levy, R., Scheepers, C., & Tily, H. J. (2013). Random effects structure for confirmatory hypothesis testing: Keep it maximal. *Journal of Memory and Language, 68*(3), 255–278. https://doi.org/10.1016/j.jml.2012.11.001.

Bates, D., Mächler, M., Bolker, B., & Walker, S. (2015). Fitting linear mixed-effects models using lme4. *Journal of Statistical Software, 67*(1), 1–48. https://doi.org/10.18637/jss.v067.i01.

Cameron, L., Erkal, N., Gangadharan, L., & Meng, X. (2013). Little emperors: Behavioral impacts of China's one-child policy. *Science, 339*(6122), 953–957.

Cai, A., Lou, Y., Long, Q., & Yuan, J. (2016). The sex differences in regulating unpleasant emotion by expressive suppression: Extraversion matters. *Frontiers in Psychology, 7*, 711. https://doi.org/10.3389/fpsyg.2016.01011 e22812.

Carver, C. S., Scheier, M. F., & Weintraub, J. K. (1989). Assessing coping strategies: A theoretically based approach. *Journal of Personality and Social Psychology, 56*(2), 267.

Cheung, R. Y. M., & Park, I. J. K. (2010). Anger suppression, interdependent self-construal, and depression among Asian American and European American college students. *Cultural Diversity & Ethnic Minority Psychology, 16*(4), 517–525. https://doi.org/10.1037/a0020655.

Cho, S., White, K. H., Yang, Y., & Soto, J. A. (2019). The role of trait anxiety in the selection of emotion regulation strategies and subsequent effectiveness. *Personality and Individual Differences, 147*, 326–331.

Costa, P. T., & McCrae, R. R. (2008). The revised NEO personality inventory (NEO-PI-R). London In G. Boyles, G. Matthews, & D. Saklofske (Eds.). *The SAGE handbook of personality theory and assessment: Volume 2 — Personality measurement and testing* (pp. 179–199). .

Cuthbert, B. N., Schupp, H. T., & Bradley, M. M. (2000). *Brain potentials in affective picture processing: Covariation with autonomic arousal and affective report52*, 95–111. Retrieved from http://dionysus.psych.wisc.edu/lit/Articles/CuthbertB2000a.pdf.

Cuthbert, B. N., Schupp, H. T., Bradley, M. M., Birbaumer, N., & Lang, P. J. (2000). Brain potentials in affective picture processing: Covariation with autonomic arousal and affective report. *Biological Psychology, 52*(2), 95–111.

Dennis, T. A., & Hajcak, G. (2009). The late positive potential: A neurophysiological marker for emotion regulation in children. *Journal of Child Psychology and Psychiatry, 50*(11), 1373–1383. https://doi.org/10.1111/j.1469-7610.2009.02168.x.

Dunning, J. P., & Hajcak, G. (2009). See no evil: Directing visual attention within unpleasant images modulates the electrocortical response. *Psychophysiology, 46*(1), 28–33. https://doi.org/10.1111/j.1469-8986.2008.00723.x.

Enders, C. K., & Tofighi, D. (2007). Centering predictor variables in cross-sectional multilevel models: A new look at an old issue. *Psychological Methods, 12*(2), 121–138. https://doi.org/10.1037/1082-989X.12.2.121.

Ford, B. Q., & Mauss, I. B. (2015). Culture and emotion regulation. *Current Opinion in Psychology, 3*, 1–5. https://doi.org/10.1016/j.copsyc.2014.12.004.

Goldin, P. R., McRae, K., Ramel, W., & Gross, J. J. (2008). The neural bases of emotion regulation: Reappraisal and suppression of negative emotion. *Biological Psychiatry, 63*(6), 577–586. https://doi.org/10.1016/j.biopsych.2007.05.031.

Gross, J. J., & John, O. P. (2003). Individual differences in two emotion regulation processes: Implications for affect, relationship, and well-being. *Journal of Personality and Social Psychology, 85*(2), 348–362.

Hajcak, G., MacNamara, A., & Olvet, D. M. (2010). Event-related potentials, emotion, and emotion regulation: An integrative review. *Developmental Neuropsychology, 35*(2), 129–155. https://doi.org/10.1080/87565640903526504.

Hitokoto, H., Glazer, J., & Kitayama, S. (2016). Cultural shaping of neural responses: Feedback-related potentials vary with self-construal and face priming.

Psychophysiology, 53, 52–63. https://doi.org/10.1111/psyp.12554.
John, O. P., & Gross, J. J. (2004). Healthy and unhealthy emotion regulation: Personality processes, individual differences, and life span development. *Journal of Personality, 72*(6), 1301–1334.
Judd, C. M., Westfall, J., & Kenny, D. A. (2017). Experiments with more than one random factor: Designs, analytic models, and statistical power. *Dx.Doi.org, 68*(1), 601–625. https://doi.org/10.1146/annurev-psych-122414-033702.
Kim, H. S., & Sherman, D. K. (2007). "Express yourself": Culture and the effect of self-expression on choice. *Journal of Personality and Social Psychology, 92*(1), 1–11. https://doi.org/10.1037/0022-3514.92.1.1.
Kim, H., & Markus, H. R. (1999). Deviance or uniqueness, harmony or conformity? A cultural analysis. *Journal of Personality and Social Psychology, 77*(4), 785–800. https://doi.org/10.1037/0022-3514.77.4.785.
Kitayama, S., Ishii, K., Imada, T., Takemura, K., & Ramaswamy, J. (2006). Voluntary settlement and the spirit of independence: Evidence from Japan's" northern frontier. *Journal of Personality and Social Psychology, 91*(3), 369.
Kitayama, S., & Park, J. (2014). Error-related brain activity reveals self-centric motivation: Culture matters. *Journal of Experimental Psychology General, 143*(1), 62–70. https://doi.org/10.1037/a0031696.
Kitayama, S., Park, J., Miyamoto, Y., Date, H., Boylan, J. M., Markus, H. R., ... Ryff, C. D. (2018). Behavioral adjustment moderates the link between neuroticism and biological health risk: A US–Japan comparison study. *Personality & Social Psychology Bulletin, 44*(6), 809–822.
Krompinger, J. W., Moser, J. S., & Simons, R. F. (2008). Modulations of the electrophysiological response to pleasant stimuli by cognitive reappraisal. *Emotion, 8*(1), 132.
Kross, E., Ayduk, O., & Mischel, W. (2005). When asking "why" does not hurt distinguishing rumination from reflective processing of negative emotions. *Psychological Science, 16*(9), 709–715.
Kuznetsova, A., Brockhoff, P. B., & Christensen, R. H. B. (2017). lmerTest package: Tests in linear mixed effects models. *Journal of Statistical Software, 82*(1), 1–26. https://doi.org/10.18637/jss.v082.i13.
Lang, P. J., Bradley, M. M., & Cuthbert, B. N. (1999). *International affective picture system: Instruction manual and affective ratings. The center for research in affective psychophysiology.* University of Floria.
Lenth, R. V. (2016). Least-squares means: The R package lsmeans. *Journal of Statistical Software, 69*(1), 1–33. https://doi.org/10.18637/jss.v069.i01.
Lopes, P. N., Salovey, P., Côté, S., & Beers, M. (2005). Emotion Regulation Abilities and the Quality of Social Interaction. *Emotion, 5*(1), 113–118. https://doi.org/10.1037/1528-3542.5.1.113.
MacNamara, A., & Hajcak, G. (2009). Anxiety and spatial attention moderate the electrocortical response to aversive pictures. *Neuropsychologia, 47*(13), 2975–2980. https://doi.org/10.1016/j.neuropsychologia.2009.06.026.
Makeig, S., Jung, T. P., Bell, A. J., Ghahremani, D., & Sejnowski, T. J. (1997). Blind separation of auditory event-related brain responses into independent components. *Proceedings of the National Academy of Sciences, 94*(20), 10979–10984.
Markus, H. R., & Kitayama, S. (1991). Culture and the self: Implications for cognition, emotion, and motivation. *Psychological Review, 98*(2), 224–253.
Mauss, I. B., & Butler, E. A. (2010). Cultural context moderates the relationship between emotion control values and cardiovascular challenge versus threat responses. *Biological Psychology, 84*(3), 521–530.
McMenamin, B. W., Shackman, A. J., Maxwell, J. S., Bachhuber, D. R. W., Koppenhaver, A. M., Greischar, L. L., ... Davidson, R. J. (2010). Validation of ICA-based myogenic artifact correction for scalp and source-localized EEG. *NeuroImage, 49*(3), 2416–2432. https://doi.org/10.1016/j.neuroimage.2009.10.010.
Moser, J. S., Hajcak, G., Bukay, E., & Simons, R. F. (2006). Intentional modulation of emotional responding to unpleasant pictures: An ERP study. *Psychophysiology, 43*(3), 292–296.
Moser, J. S., Krompinger, J. W., Dietz, J., & Simons, R. F. (2009). Electrophysiological correlates of decreasing and increasing emotional responses to unpleasant pictures. *Psychophysiology, 46*(1), 17–27. https://doi.org/10.1111/j.1469-8986.2008.00721.x.
Moser, J. S., Most, S. B., & Simons, R. F. (2010). Increasing negative emotions by reappraisal enhances subsequent cognitive control: A combined behavioral and electrophysiological study. *Cognitive, Affective & Behavioral Neuroscience, 10*(2), 195–207.
Mu, Y., Kitayama, S., Han, S., & Gelfand, M. J. (2015). How culture gets embrained: Cultural differences in event-related potentials of social norm violations. *Proceedings of the National Academy of Sciences, 112*(50), 15348–15353.
Murata, A., Moser, J. S., & Kitayama, S. (2013). Culture shapes electrocortical responses during emotion suppression. *Social Cognitive and Affective Neuroscience, 8*(5), 595–601. https://doi.org/10.1093/scan/nss036.
Na, J., & Kitayama, S. (2011). Spontaneous trait inference is culture-specific: Behavioral and neural evidence. *Psychological Science, 22*(8), 1025–1032. https://doi.org/10.1177/0956797611414727.
Nakagawa, S., & Schielzeth, H. (2013). A general and simple method for obtaining R2 from generalized linear mixed-effects models. *Methods in Ecology and Evolution, 4*(2), 133–142.
Oyserman, D., Coon, H. M., & Kemmelmeier, M. (2002). Rethinking individualism and collectivism: Evaluation of theoretical assumptions and meta-analyses. *Psychological Bulletin, 128*(1), 3–72. https://doi.org/10.1037/0033-2909.128.1.3.
Park, J., & Kitayama, S. (2012). Interdependent selves show face-induced facilitation of error processing: Cultural neuroscience of self-threat. *Social Cognitive and Affective Neuroscience, 9*(2), https://doi.org/10.1093/scan/nss125 nss125–208.
Saucier, G. (1994). Mini-markers: A brief version of Goldberg's unipolar big-five markers. *Journal of Personality Assessment, 63*(3), 506–516. https://doi.org/10.1207/s15327752jpa6303_8.
Schneider, W., Eschman, A., & Zuccolotto, A. (2002). *E-Prime User's Guide.*.
Schupp, H. T., Cuthbert, B. N., Bradley, M. M., Cacioppo, J. T., Ito, T., & Lang, P. J. (2000). Affective picture processing: The late positive potential is modulated by motivational relevance. *Psychophysiology, 37*, 257–261.
Singelis, T. M. (1994). The measurement of independent and interdependent self-construals. *Personality & Social Psychology Bulletin, 20*(5), 580–591. https://doi.org/10.1177/0146167294205014.
Soto, J. A., Lee, E. A., & Roberts, N. A. (2016). Convergence in feeling, divergence in physiology: How culture influences the consequences of disgust suppression and amplification among European Americans and Asian Americans. *Psychophysiology, 53*(1), 41–51.
Soto, J. A., Perez, C. R., Kim, Y.-H., Lee, E. A., & Minnick, M. R. (2011). Is expressive suppression always associated with poorer psychological functioning? A cross-cultural comparison between European Americans and Hong Kong Chinese. *Emotion, 11*(6), 1450–1455. https://doi.org/10.1037/a0023340.
Suinn, R. M., Rickard-Figueroa, K., Lew, S., & Vigil, P. (1987). The Suinn-Lew Asian self-identity acculturation scale: An initial report. *Educational and Psychological Measurement, 47*(2), 401–407.
Tsai, J. L., Knutson, B., & Fung, H. H. (2006). Cultural variation in affect valuation. *Journal of Personality and Social Psychology, 90*(2), 288.
Tsai, W., & Lu, Q. (2018). Culture, emotion suppression and disclosure, and health. *Social and Personality Psychology Compass, 12*(3), https://doi.org/10.1111/spc3.12373 e12373.
Westfall, J., Kenny, D. A., & Judd, C. M. (2014). Statistical power and optimal design in experiments in which samples of participants respond to samples of stimuli. *Journal of Experimental Psychology General, 143*(5), 2020.
Wrosch, C., Heckhausen, J., & Lachman, M. E. (2000). Primary and secondary control strategies for managing health and financial stress across adulthood. *Psychology and Aging, 15*(3), 387.
Xu, Y., & Hamamura, T. (2014). Folk beliefs of cultural changes in China. *Frontiers in Psychology, 5*, 1066.