Culture and the Self: New Insights and Approaches

by

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A dissertation submitted in partial fulfillment
of the requirements for the degree of
Doctor of Philosophy
(Psychology)
in the University of Michigan
2021

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Acknowledgements

I am incredibly grateful for all of the support I have received throughout my graduate studies. First and foremost, I would like to thank my advisor Shinobu Kitayama. Nothing I have accomplished would have been possible without him. There are so many things I learned from Shinobu. One important one is to let yourself enjoy the research process and be driven by exciting questions and techniques. Both Shinobu and I had no idea what spectral power was until Brian Kraus arrived. Many people would just shy away with it, because it is hard. However, Shinobu was very encouraging. Working with Brian and Shinobu on this new approach was humbling (I didn't know what I was doing at first). After some time, it became enriching and provided a new way to do social neuroscience work. I am very thankful to have gotten the opportunity to work with Brian too. Brian taught me many things and made science a lot of fun. He is also strangely good at karaoke. In addition to Brian, I want to highlight the members of the Culture and Cognition lab more broadly, including my lab brother Qinggang. Some of the projects we did on COVID-19 as a team (including Shinobu Kitayama, Qinggang Yu, Martha Berg and Irene Melani) were some of my favorites. I hope to incorporate these team projects in my own lab in the future.

I am also very thankful for having a secondary lab home in Josh Ackerman's Evolutionary Social Psychology Group. I learned a lot from Josh and ESP lab more generally and really appreciated being part of another research group. I am thankful to my amazing teachers and mentors including David Dunning, Carolyn Yoon, Arnold Ho, Ali Earl, Phoebe Ellsworth, Rich Gonzalez and Ethan Kross. Although I mostly got to interact with them in the "zoom world", I have also really enjoyed getting to know some of the recent hires including Nick Camp and Amie Gordon. Michigan is in great hands.

I want to thank my amazing collaborators, including Michele Gelfand, Krishna Savani, Kevin Nanakdewa, Alvaro San Martin, Sandra Idovro Carlier, Carolina Torres Castillo, Jon-Fan Hu, Mayumi Karasawa, and Ariana Orvell, just to name a few. I know my research and thinking has greatly benefited from interactions with them. I am grateful for my cohort and the other psychology department students. In particular, I want to highlight Yuyan Han, Change Kwelese and Kathrina Robotham as well as the "Mahjong Group" including Oliver Sng, Irene Melani, Soyeon Choi, Wilson Merell, Iris Wang, Kaidi Wu and Julia Smith to name a few. More broadly, I am really grateful to the Social Psychology Area Faculty and Students who make Michigan a great place.

I am thankful for all the funding and research support from The Institute for Social Research, Rackham Graduate School and the Department of Psychology. I am also indebted to the amazing research assistants and students I have gotten the opportunity to work with at Michigan. Without their help, many of these studies would not have been possible.

Last but not least, I want to thank my family. I started graduate school not really knowing much about it. My mom only graduated high school so her dream was for me to go to college without really knowing what that meant or what came next. My Dad didn't really know about college let alone graduate school. Nonetheless, both have supported me in every way possible. They helped me with translations at a moment's notice and drove me to various places to collect South American data. They are also always there for me. I am so grateful to my parents and grandparents for everything. I am also grateful to my whole extended family who have always been a source of support. There are too many to name, but I want to highlight my cousin Emma and Aunt Marcela Sanjines who let me stay with them in Colombia and helped me with my projects there. This degree is as much their accomplishment as it is mine.

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Abstract

Some people view the self as primarily independent or autonomous from others, whereas others view the self as interdependent or embedded in close social relationships. These two construal's of the self have several downstream psychological consequences. Here, I address three open questions in this work. In Chapter II, I begin by examining how the view of the self as independent or interdependent influences self-related thought by testing a neural marker known as alpha. In Study 1, I show the validity of the approach by showing that alpha increases when people think about the self (vs. someone else). In Study 2, I extend this work and show how alpha is more pronounced for people high in independent (vs. interdependent) self-construal. In Study 3, I show an application of this method. Specifically, how cultural variation in the classic bias of self-enhancement and criticism is in part explained by cultural differences in alpha in response to successes and failures. Together, this work suggests that alpha may be a promising new approach to study the self and its' associated cultural variation. In Chapter III, I look at how viewing the self as independent or interdependent influences sensitivity to norms. In Study 1, I find that activating interdependent goals increases sensitivity to norms, only when people believe their social context is strict. In Study 2, I examined when interdependence may predict lower sensitivity to norms. Specifically, I show that people who are more interdependent do not show an increased sensitivity to norms in the presence of an external threat. In Study 3, I show perceptions of flexible relational norms linked to independence can have real world consequences, such as predict the spread of COVID-19. Together this work provides new insights into how the view of the self powerfully shapes sensitivity to norms and their

consequences. In Chapter IV, I examine how the view of the self as interdependent manifests in Latin America. Unlike Asians, I find that Latin Americans are more expressive of emotions. However, unlike European Americans they are more expressive of interdependent emotions. I suggest that this type of interdependence is emotionally expressive unlike the East Asian form of interdependence which emphasizes emotional suppression. In combination, this work provides insights into how interdependence influences self-referential thought, sensitivity to norms and varies depending on the cultural context.

Chapter I: Introduction

Three decades of research in cultural psychology has established that people of different cultures vary in how they view the self (Markus & Kitayama, 1991). In Western Europe and North America, the predominant view of the self is independent from others, emphasizing autonomy and disjoint agency (H. S. Kim & Markus, 1999). Conversely, much of the rest of the world shares the view of the self as interdependent, or embedded in social relationships (Hofstede, 1980). These two construals of the self are linked to distinct suite of psychological tendencies across a wide variety of domains, including cognition, emotion and motivation (Kitayama, Mesquita, et al., 2006; Kitayama & Park, 2014; Nisbett et al., 2001). In the present work, I extend this literature in three ways. To understand cultural variation in the self, it is crucial to study how the self is constructed, or self-related thought. In Chapter II, I draw on neuroscience and discuss how one particular electrocortical oscillation of the brain known as alpha can provide new insights into the culturally-distinct conceptions of the self. In particular, I show how alpha is linked to self-related thought, cultural differences in self-construal, and cultural variation in self-enhancement (vs. criticism).

While how people think about themselves is crucial, the self doesn't exist in isolation, but in a social world governed by norms and rules. In Chapter III, I discuss how the view of the self as interdependent can both increase or decrease sensitivity to norms under certain conditions. I extend this work on norms to demonstrate how cultural norms predict the spread of infectious disease. In Chapter IV, I discuss the crucial significance of widening the scope of cultural psychology through detailed empirical studies of how interdependence may manifest outside of

East Asia. I focus specifically on how the view of the self as interdependent in Latin America is linked to a distinct set of psychological tendencies than the form of interdependence in East Asia. In what follows, I will describe the theme of each chapter in greater detail.

Chapter II. Electrocortical Correlates of Self-referential Thought

William James noted that the self is but a stream of consciousness perceived as continuous over time (James, 1890). To understand the nature of the self and its' associated cultural variation, examining self-referential processing is crucial. However, people are often inaccurate in their self-assessments (Kruger & Dunning, 1999). This calls for implicit measures that assess self-referential thought without explicitly asking about it. In Chapter II, I take a neuroscience approach to the study of self-referential processing, by focusing on one particular neural oscillation known as alpha. Alpha is a frequency wave from 8-13Hz that increases in power when attention is directed inwards, such as when people self-report thinking about themselves (Klimesch, 2012; Knyazev, 2013). In Study 1, we tested the hypothesis that alpha preferentially increases when reference is made to the self, as opposed to people in general. We had two groups of European American undergraduates (total N = 93) come to the lab. We asked them to imagine 160 different situations as their EEG was recorded. Importantly, on half of the trials they were asked to imagine an event occurring to the self. On the other half of the trials, they were asked to imagine the same situation happening to a stranger. We quantified the average amount of alpha power as they imagined the sentences. Across both samples, we found greater alpha when people were asked to imagine the scenarios for the self as opposed to another person (Salvador et al., in preparation). Our study provided the first causal evidence that alpha power is linked to self-related thought as opposed to general social thought.

Just like the self, culture is composed of a series of tacit elements that may be barely recognizable to the individual person (Kitayama, 2002). However, substantial cultural differences do exist. One open question is how exactly cultural differences in self-construal arise and are instantiated in the brain. To address this, we once again looked at alpha. Studies have shown that alpha is the predominant frequency band during resting state (Benedek et al., 2014; Compton et al., 2019), a period which has been linked to self-relevant thought (Northoff, 2016). Importantly, how much alpha people have during rest varies substantially across individuals. We sought to test the possibility that individual differences in alpha are predicted by how much people spontaneously think about themselves. Compared to interdependent people, independent people focus more on the autonomy of the self from others and its' individuality (Markus & Kitayama, 1991). Thus, when asked to do nothing, they may spontaneously think about their past and future in reference to their own goals, agency and actions. This analysis would suggest that European Americans and people high in independent self-construal may spontaneously think about the self to a greater degree than East Asians and more interdependent people. In Study 2, we had two samples of East Asians (Taiwanese and Japanese) and two samples of European Americans come to the lab. They all underwent a 4-6 minute resting state period where they were asked to do nothing with their eyes open and closed. After the resting state task, they completed several questionnaires, including the self-construal scale. To test the general hypothesis that people who are more independent (vs. interdependent) engaged in self-referential processing to a greater extent, we tested the correlation between resting state alpha and the self-construal measure. Meta-analytically, we found that people who scored higher in independent (vs. interdependent) self-construal showed higher levels of alpha power during rest (Kraus et al., revise & resubmit). Our finding suggests that alpha may be a critical neural mechanism that underlies cultural differences in the self-construal.

In Studies 1-2 we tested the possibility that alpha could lend new insights to the study of the self and its' cultural variation. Based on our findings, we took this one step further to examine cultural variation in one of the most pronounced and widely studied biases in self-perception, self-enhancement. Prior work has observed that European Americans tend to focus on positive aspects of themselves (Dunning et al., 1989). Conversely, East Asians show an attenuated self-enhancement bias, or sometimes show the opposite tendency of self-criticism (Heine et al., 1999; Kitayama et al., 1997). Despite these consistent findings, the mechanism for this effect is underexplored. To test the mechanism, we examined whether a difference in the spontaneous tendency to engage in self-related processing in response to successes, but not failures, was linked to self-enhancement. In study 3, we had 32 Taiwanese and 32 European Americans come into the lab for a study on self-evaluation. In this study, they were asked to imagine successes and failures that occurred either to the self or someone else. Then, they were asked to rate how much their own self-esteem and that the self-esteem of another person would be influenced. As in prior work by Kitayama and colleagues (1997), we found that Americans perceived successes were more impactful and relevant to their self-esteem. Conversely, Taiwanese showed the opposite pattern and perceived failures to be more impactful to their self-esteem. Importantly, we found that Americans and people high in independent self-construal showed greater spontaneous self-referential processing (i.e., alpha power) in response to successes (vs. failures) for the self. Conversely, Taiwanese and people low in independent self-construal did not. The cultural difference in alpha in response to successes (vs. failures) predicted self-report measures of self-enhancement (vs. criticism). Our findings suggest that the cultural difference in self-enhancement (vs. criticism) is explained in part by a cultural difference in spontaneously allocated self-referential thought (Salvador et al., revise & resubmit). In combination, using the neuroscience approach to examine the self and its' cultural variation provides a new approach to advance the field of cultural psychology.

Chapter III. How The Self Influences Sensitivity to Norms

The self is culturally constructed. One important aspect of a culture are the rules and institutions that regulate the society (Gelfand et al., 2011). In Chapter III, I discuss how the two construals of the self influence perceptions of norms. Social norms have been crucial for the evolution of modern day societies, yet little is known about the conditions in which people become more sensitive to them. One reason for this has been methodological, since people are rarely consciously aware of the influence norms exert on them and cannot always reliably answer self-report questions about them. To overcome this issue, some researchers compare profiles between countries (Gelfand et al., 2011). While this approach has been informative for many questions, country is a rather crude level of analysis, which calls for a complementary approach to uncover the individual-level dynamics. To do so, I take a neuroscience approach by analyzing spontaneous responses to norm violations. This approach has provided new insights that cannot be covered by self-report or country level analyses alone. For example, prior studies show that countries that value interdependence, tend to be tight, or have strict norms (Gelfand et al., 2011). To experimentally test this, in Study 1, we primed interdependence (vs. a control) and found increased sensitivity to social norms, but only for people who think their cultural contexts are already strict (i.e., tight) (Salvador, Mu, et al., 2020). Our work suggests that the link between interdependence and sensitivity to norms is dependent on an individuals' perceptions of the norms in their culture.

Although we found one context in which interdependence upregulates the attunement to social norms, over time this value may also provide a sense of security through social connection (Eisenberger et al., 2007; Uskul & Over, 2014; C. Wang et al., 2014). In Study 2, we primed participants with a disease threat (vs. a control) and found an upregulation in both the spontaneous detection and top-down vigilance to norm violations. This evidence is consistent with evolutionary theories, country-level patterns and some of our recent work that people 'tighten' or increase their sensitivity to social norms in the presence of threat (Gelfand et al., 2011; Murray & Schaller, 2016). However, this effect was attenuated among people high in interdependence (Salvador, Kraus, et al., 2020). Our finding suggests that in the presence of threat, interdependent social relationships can have a powerful analgesic effect.

The study of social norms is crucial not only to understand individual and cultural dynamics, but also to understand changes in times of crisis. The COVID-19 pandemic has impacted all countries throughout the world, but it is clear that some countries have been affected more than others. Many factors are likely involved. For example, countries or cities that have more widespread vaccine policies for related diseases such as tuberculosis (i.e., BCG) (Berg et al., 2020), and less inequality and segregation (Yu et al., 2020) have fared better. Importantly, other factors may be socio-cultural. COVID-19 is primarily transmitted between individuals, thus societies where norms about social relationships tend to be more open may be more vulnerable to the disease. In particular, we hypothesized that relational mobility, or the degree to which people in a society interact with others of their choosing, influences the spread of the virus. We found that societies high in relational mobility (e.g., Mexico and the United States) had a faster spread of the virus than societies low in relational mobility (e.g., Japan and Hungary). Importantly our effects held after a variety of robustness checks, including controls for testing availability, underreporting of cases, cultural and demographic variables (Salvador, Berg, et al., 2020). Our findings show how flexible relational norms can be a liability at the time of the pandemic.

Despite social norms being central in social psychology, little is known about the conditions when people become more sensitive to them. Together, these studies provide important insights into why people become sensitive to social norms. First, social norms enable coordination (Gelfand et al., 2011). This function of social norms can be why people who are more motivated to engage in a relationship with others (e.g., interdependent people) are more sensitive to norm violations, particularly if the norms are strict (Salvador, Mu, et al., 2020). Importantly, if norms indeed allow for coordination, over time this can provide a sense of protection or psychological comfort (Salvador, Kraus, et al., 2020). Thus, when a threat is encountered, interdependent people are presumably less alarmed and less sensitive to norms (H. S. Kim et al., 2016; Salvador, Kraus, et al., 2020). These initial findings provide a promising avenue for research on the conditions when people become more sensitive to norms. This avenue is important not just for theories in social psychology, but to understand important societal consequences like why some societies have been impacted more by COVID-19 than others.

Chapter IV. Varieties of Interdependence

In Chapters II-III, I expand the field of cultural psychology by further examining two psychological domains: the self and social norms. While informative, one big limitation of this work and much of the literature in cultural psychology in general is that it is based almost exclusively on comparisons between East Asians and European Americans (Markus & Kitayama, 1991). This poses an issue to our understanding of culture because the definition of interdependence is currently conflated with the specific way in which interdependence manifests in East Asia. In Chapter IV, I examine how the view of the self as interdependent can take on a different meaning depending on the cultural context. To uncover the varieties of interdependence that exist across world regions, we aim to distinguish between culturally shared features of interdependence, or core, and those that are subsidiary or culturally variable. To begin this larger endeavor, I focus this chapter on our work with Latin Americans.

Latin America is the most populous region in the Americas, with over 641 million people (The World Bank, 2018). It is currently understood that Latin Americans are generally interdependent (Triandis, 1983). However, unlike East Asians who tend to be self-effacing and suppress their emotions, Latin Americans tend to be more expressive (de Oliveira & Nisbett, 2017). We theorized that due to the high levels of ethnic heterogeneity in Latin America (i.e., people of Indigenous, African and European ancestry coexisting in the same locales), the art of emotional communication was mastered to ensure mutual understanding between diverse groups (Niedenthal et al., 2019). When combined with the ethos of interdependence already present in Latin culture, this tendency for emotional expression came to serve the purpose of forging interdependent ties with others (Kitayama & Salvador, 2017). To test this idea, we collected data in Colombia, Japan and the US on a comprehensive set of implicit measures. We found that similar to European Americans and unlike Japanese, Colombians were self-enhancing and emotionally expressive. Importantly, similar to Japanese, and unlike European Americans, Colombians were holistic in cognition and were more expressive of social (e.g., feelings of closeness to others) as opposed to personal (e.g., self-esteem) emotions. Unlike both groups, Colombians were the most emotionally expressive. Together this data suggests that Colombians have a unique form of interdependence, one that uses the expression of emotions to achieve interdependence with others, what we term expressive interdependence (Salvador, Idovro

Carlier, et al., 2020). This insight is crucial because it stands in opposition to the East Asian form of interdependence, that is characterized by emotion suppression and self-criticism (Kitayama et al., 2009; Kraus & Kitayama, 2019).

Summary

The conception of oneself as independent as opposed to interdependent powerfully constitutes a person. I extend this work by analyzing the cultural differences in self-referential thought (Chapter II), how distinct construals of the self influence reactions to norms (Chapter III) and how the view of the self as interdependent manifests differently in Latin America (Chapter IV). Together, this work provides new theoretical and empirical insights to further the understanding of the mutual constitution of culture and the self.

Chapter II: Self-referential Processing

Study 1[1]

"[Self] implies the incessant presence of two elements, an objective person, known by a passing subjective Thought and recognized as continuing throughout time." – William James

Almost 200 years after James' initial proposal, psychologists have begun to uncover how the self is instantiated in the brain. For example, studies with functional magnetic resonance imaging (fMRI) have demonstrated that thinking about the self vs. someone else preferentially activates several brain areas, such as the medial prefrontal cortex and the posterior cingulate cortex (W. M. Kelley et al., 2002; Qin & Northoff, 2011). Recent research with EEG has shown a particular neural oscillation, known as alpha, increases when people self-report thinking about themselves (Knyazev, 2013). In the current work, we aimed to test whether alpha and self-referential thought are directly linked by manipulating the thought content within an event-related paradigm. Specifically, we contrasted situations where participants thought about themselves (self), with those where they thought about another person (other) to test whether alpha was specifically involved in self-related thought. As a secondary aim, we sought to examine whether alpha was linked to self-construal.

Spontaneous EEG Oscillations.

[1] This study is based on: Salvador, C.E., Kraus, B.T. & Kitayama, S. (in preparation) Thinking about the Self Increases Alpha Oscillations.

Prior work examining the link between alpha and self-referential thought has largely tested correlations between a self-reported measure and the neural marker. For example, Knyazev and colleagues (2011) collected resting state activity from 48 Russian participants and administered a short self-report questionnaire. As part of the questionnaire, people were asked about the extent to which they thought about their interpersonal relationships, something pleasant in their future, or general past experiences from their own life. Using source localization, the researchers found that the alpha power component which spatially overlapped with the default mode network predicted higher scores on this questionnaire measure (Knyazev et al., 2011). One limitation of this early study is that the questionnaire had not been closely validated. While all three items were about the self, some asked about the self in the context of social relationships, past experiences and future desires. In order to understand what aspects of the self were linked with alpha, the researchers psychometrically validated and assessed a broader set of constructs through the spontaneous thoughts questionnaire. Four factors emerged. One was negative affect (e.g., "experienced negative emotions"), self-referential thoughts (e.g., "recollected episodes of my own life"), arousal (e.g., "I was almost asleep") and attention to the environment (e.g., "my attention was mostly directed to external stimuli"). Among three samples (two Russian and one Taiwanese), alpha was best predicted by the self-referential thoughts sub-scale (Knyazev et al., 2012). This result is consistent with another study demonstrating that relative to baseline, participants showed higher levels of alpha at rest when they were asked to recollect an episode from their past (Knyazev et al., 2015).

Individual Differences: Self-construal.

The work reviewed above suggests that there may be a link between the engagement in self-related thought and alpha. However, it is possible that this effect is more pronounced for some individuals compared to others. In particular, one important individual difference could be how people construe the self. Some people construe self as independent or autonomous relative to others, whereas others think about themselves as interdependent, or embedded in their groups (Markus & Kitayama, 1991). Research is emerging that there is a tight link between independent (vs. interdependent) self-construal and alpha power. For example, a series of studies on resting state have found that people are more individualistic and presumably self-focused, show greater activity in the default mode network and higher levels of alpha power during rest (Knyazev et al., 2020; Kraus et al., revise & resubmit). This emerging literature suggests that the view of the self as independent (vs. interdependent) is linked with alpha power. Here, we explored whether self-construal predicted the amount of alpha when participants were cued to imagine an event for the self and someone else.

Task-related EEG Activity.

To our knowledge, only one prior study analyzed neural oscillations when people were cued to think about the self compared to someone else. In that study, Mu and Han (2013) conducted two experiments. In both studies, they showed participants the word “self”, their friends’ name, or the word “valence”, followed by an adjective. On some trials, participants had to judge whether the person fit the trait (trait-judgement). On other trials they had to judge whether the trait was positive or negative (valence-judgement). Of interest for the present study, they analyzed whether neural oscillations differed when participants saw the word “self”, “valence”, or their friends’ name. In the first of the two experiments, they found several differences between the self and friend cues across multiple frequency bands (Mu & Han, 2013). Among them, there was some evidence that alpha was greater when people imagined an event for themselves, relative to others. However, they failed to replicate this and other findings in a second experiment. One exception was theta, where they did find significant differences in both experiments. Thus, in addition to alpha, we followed Mu et al. (2013) and examined whether we could find differences in theta when reference was made to the self.

Present Study.

In the current work, we aimed to assess whether self-reference increases alpha power. To test this idea, we analyzed the task related alpha power when people imagined an event occurring to the self and compared it to trials when people imagined an event that occurred to someone else. Importantly, in order to allow for sufficient time for participants to immerse themselves in the situations, we created forty concrete situations that people were to imagine themselves and others in. We predicted that alpha would be greater when they were asked to imagine an event for the self compared to others. To test this hypothesis, we extracted the entire alpha band (8-13 Hz) and explored topographic differences by splitting electrodes into four lobes of the brain (Kraus et al., 2019). Additionally, we examined whether alpha in response to these distinct prompts varied as a function of self-construal. Lastly, we examined whether the comparable effects extended to theta (5-7 Hz) as in Mu et al. (2013).

Methods

Participants

Study 1a

38 University of Michigan students were recruited for the present study. Prior to analyses we excluded participants for self-reported mental health diagnoses (2) and not finishing the task (1). We were left with 35 participants (22 females, 13 males) who varied from 18 to 22 years of age (M = 19.0, SD = 1.04). All participants were right-handed, had no history of psychiatric conditions, were U.S. citizens, and self-identified as European American, Caucasian or White.

They provided written informed consent for their participation in the study in accordance with the Declaration of Helsinki. The study protocol was approved by the Institutional Review Board of the University of Michigan. Data from this sample on a different part of the task has been reported elsewhere (Salvador et al., revise & resubmit).

Study 1b

63 students at the University of Michigan were recruited for the study. We followed the same exclusion and recruitment procedures as in Study 1a. Prior to analyses we excluded participants for psychiatric medication use (3), not meeting ethnicity criteria (1). This left 59 participants (18 male, 41 female) who varied from 18 to 20 years of age (M = 18.64, SD = 0.58).

Procedure

Both studies followed the same procedure and analytic strategy. On each trial, a fixation cross was presented for 1000ms, followed by a sentence describing a situation participants were to imagine themselves (e.g., “You recently moved to a new school”) or someone else (e.g., “Sarah recently moved to a new school”) in. The sentence was presented for 4000ms. The first fixation and first sentence were used for analysis in the present study. After the first sentence a second sentence was presented that describes the outcome of the situation (positive or negative). Finally, participants were asked to make a series of self-reported judgements about self-esteem. The present study focuses exclusively on the analysis of the first sentence. The full set of stimuli, analysis of the additional sentence and self-reported judgements are reported elsewhere (Salvador et al., revise & resubmit).

There were 40 different situations presented in a randomized order. Each situation was presented once with the self as a protagonist and once with another person as a protagonist. The exact same situations were presented twice, for a total of 160 trials. Following the EEG recording, participants filled out a packet of questionnaires including a modified version of the Singelis self-construal scale assessing independence and interdependence (1 = "Doesn't describe me at all", 5 = "Describes me very much" in Study 1a and 1 = "Strongly Disagree", 7 = "Strongly Agree" in Study 1b) (Park & Kitayama, 2014). Due to the different rating scales across studies, the scales were z-scored within each study prior to comparisons. There were other scales included for other purposes that differed across studies (see Kraus et al., revise & resubmit).

EEG Data Processing

EEG was recorded from 32 electrodes using the BioSemi Active Two System as well as four external electrodes used for ocular correction and two mastoid electrodes for re-referencing. The data were analyzed using MATLAB with the EEGLAB plugin and ERPLAB extension. First, an offline bandpass filter with a lowpass of 20 Hz and a highpass of 0.1 Hz was applied. All data were re-referenced to the averaged left and right mastoids. The continuous data were then visually inspected for large non-stereotyped artifacts in preparation for Independent Component Analysis (ICA). Components related to eye blinks and other artifacts were removed. Scalp electrodes that were determined to be unusable were removed and subsequently interpolated with spherical interpolation after ICA. Then, both trials and fixation periods were rejected if the maximum peak-to-peak voltage exceeded 100μV within a 400ms moving window for any scalp electrode with 100ms steps across each epoch. Trials were also rejected if at any scalp electrode the voltage fluctuated more than 30μV between two sampling points. This left a minimum of 5 trials in each condition (self-positive, self-negative, other-positive and other-negative), with an average of (*M* = 65%, *SD* = 17%) of trials in Study 1a and (*M* = 66%, *SD* = 21%) in Study 1b respectively.

Alpha Analysis

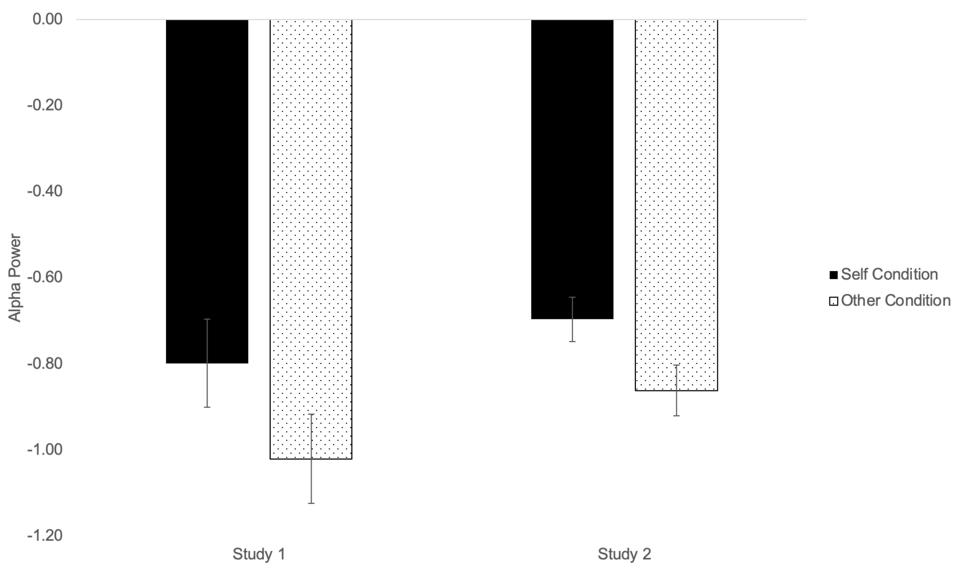
For each participant, data segments corresponding to the first fixation and first sentence were separated. Segments of data which contained artifacts were discarded from further analysis. To retain the most data for analysis, these segments of data were then reflected along the x-axis (M. X. Cohen, 2014) to create enough data to perform a Time-Frequency Analysis (TFA) with complex morlet wavelets and avoid edge effects in the decomposition. For the fixation, this resulted in epochs 835ms pre-stimulus onset to 1835ms post stimulus onset and epochs 835ms pre-stimulus onset to 4835ms post stimulus onset for the first sentence. The TFA was performed using the newtimef function in EEGLAB. Complex Morlet wavelets were used to decompose the signal between 5 and 20 Hz into 61 log-spaced frequencies with zero-padding by a factor of 8. This resulted in a wavelet decomposition of 3 cycles at 5 Hz and 6 cycles at 20 Hz. For each trial, 400 timepoints were extracted from 501ms pre-stimulus onset to 1499ms for the fixation and from 501ms pre-stimulus onset to 4499ms for the first sentence. Task-Related Power (TRP) was calculated separately for each condition by subtracting average alpha power across trials during the fixation period from average alpha power across trials during the first sentence within each condition (Pfurtscheller & Lopes da Silva, 1999). Alpha power (8-13 Hz) was then extracted for each trial for all timepoints that occurred when the stimulus was on the screen (0ms - 1000ms for the first fixation, 0ms - 4000ms for the first sentence) and log transformed. All data and code for the present study are available at: https://osf.io/s7btj/?view_only=ec583ca1b0924fbab898bf496bddd623.

Results

Study 1a

First, we examined whether alpha was greater in the self compared to other conditions in central-parietal midline electrodes (CPz and Pz), where alpha is typically assessed (Salvador et al., 2020). This analysis included alpha as the dependent variable and Protagonist (Self vs. Other) the predictor. There was a significant effect of Protagonist, $F(1,34) = 4.78$, $p = .036$, $\eta_p^2 = .12$, which demonstrated higher levels of alpha in the self ($M = -.96$) relative to other ($M = -1.22$) sentences. A comparable analysis with theta (5-7 Hz), showed no significant effect of Protagonist, $F(1,34) = 1.02$, $p = .320$, $\eta_p^2 = .029$.

Figure 1. *Alpha power when participants imagine events for themselves and others.*



Note. The average alpha power for the first sentence in Study 1a (left panel) and Study 1b (right panel) when participants were asked to imagine situations for the self and someone else.

The pattern across all electrode sites is summarized in Figure 1. Next, we examined whether there were any topographical differences in the effect, by testing whether the average alpha power in the first sentence differed based on Protagonist (Self vs. Other) of the situation, Hemisphere (Left vs. Right) and Lobe (Frontal vs. Parietal). There was a significant effect of Protagonist, $F(1,34) = 7.76$, $p = .009$, $\eta_p^2 = .186$. This showed that alpha was greater when people imagined a situation for the self ($M = -.79$) compared to someone else ($M = -1.01$). There was also a significant effect of Lobe, $F(1,34) = 5.54$, $p = .024$, $\eta_p^2 = .140$. This showed higher levels of alpha in the frontal ($M = -.768$) compared to parietal ($M = -1.03$) lobe. The same analysis was repeated with theta instead of alpha. There was no comparable effect of Protagonist, $F(1,34) = .126$, $p = .724$, $\eta_p^2 = .004$.

Study 1b

As in Study 1a, we first examined midline central-parietal sites (CPz and Pz) to test whether alpha was greater when reference was made to the self, as evidenced by a main effect of Protagonist (Self vs. Other). As in Study 1a, there was a significant effect of Protagonist, $F(1,58) = 5.71$, $p = .020$, $\eta_p^2 = .090$, which demonstrated higher levels of alpha in the self ($M = -.573$) relative to other ($M = -.791$) sentences. A comparable analysis with theta (5-7 Hz) at CPz and Pz, showed no significant effect of Protagonist, $F(1,58) = 1.85$, $p = .18$, $\eta_p^2 = .031$.

To examine potential effects of laterality, we tested whether the average alpha power in the first sentence varied based on Protagonist (Self vs. Other) of the situation, Hemisphere (Left vs. Right) and Lobe (Frontal vs. Parietal). There was a significant effect of Protagonist, $F(1,58) = 5.40$, $p = .024$, $\eta_p^2 = .085$. As shown in Figure 1, this pattern illustrated that alpha was greater when participants imagined a situation for the self ($M = -.693$) compared to someone else ($M = -.857$). There was also a significant effect of Hemisphere, $F(1,58) = 20.88$, $p < .001$, $\eta_p^2 = .265$. This showed higher levels of alpha in the right ($M = -.67$) compared to left ($M = -.88$) hemisphere. The same analysis was repeated with theta. There was no significant effect of Protagonist, $F(1,58) = .871$, $p = .355$, $\eta_p^2 = .015$.

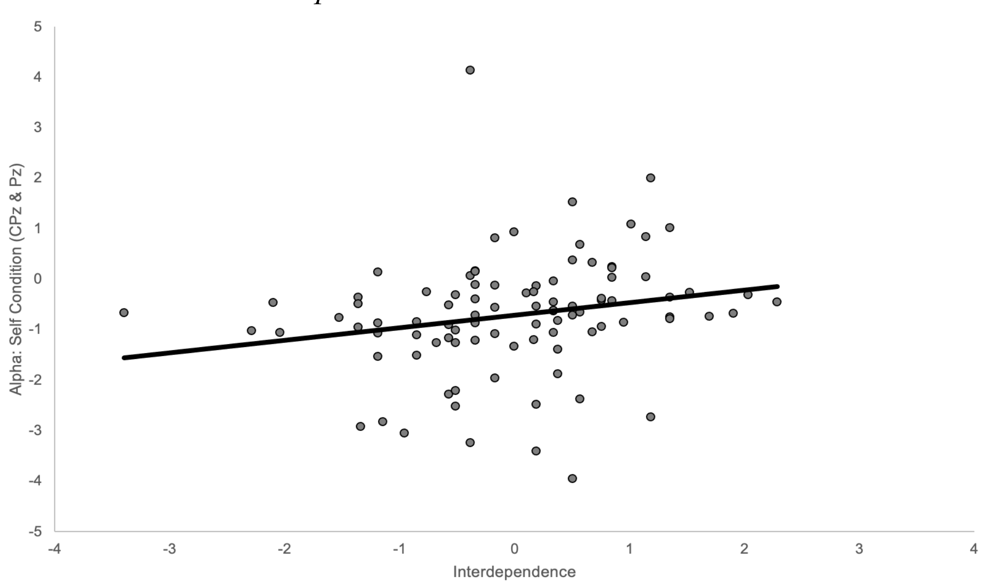
Combined Data.

Lastly, we examined whether alpha varied as a function of independence and interdependence and the difference between the two, herein called self-construal. In order to take into account that the data come from two different studies, we tested the link between alpha and self-construal, controlling for Study (1a and b). As shown in Table 1, the most consistent relationship was that Interdependent self-construal positively correlated with the amount of alpha when people thought about the self, particularly in central-parietal sites. The relationship is plotted in Figure 2.

Table 1. *Correlations between self-construal (Interdependence, Independence and Self-construal) and alpha power for the different conditions at central-parietal electrodes (CPz & Pz, Pz) and all electrodes. Significant correlations are noted in bold (p < .05). Those marginally significant are noted in italics (p < .10).*

Condition	Interdependent Self-construal	Independent Self-construal	Self-construal
Self Condition (CPz, Pz)	**$F(1,91) = 4.35$, $p = .040$**	$F(1,91) = .774$, $p = .381$	*$F(1,91) = 3.210$, $p = .077$*
Other Condition (CPz, Pz)	$F(1,91) = 1.81$, $p = .182$	$F(1,91) = .248$, $p = .119$	*$F(1,91) = 3.15$, $p = .079$*
Self Condition (Pz)	**$F(1,91) = 5.58$, $p = .020$**	$F(1,91) = 1.54$, $p = .218$	**$F(1,91) = 4.82$, $p = .031$**
Other Condition (Pz)	$F(1,91) = 1.77$, $p = .187$	$F(1,91) = 2.67$, $p = .106$	*$F(1,91) = 3.26$, $p = .074$*
Self Condition (All)	*$F(1,91) = 3.70$, $p = .058$*	$F(1,91) = .342$, $p = .560$	*$F(1,91) = 2.16$, $p = .145$*
Other Condition (All)	*$F(1,91) = 2.81$, $p = .097$*	$F(1,91) =1.70$, $p = .196$	*$F(1,91) = 3.34$, $p = .071$*

Figure 2. *The relationship between Interdependent self-construal and alpha power in the self condition across central-parietal electrode sites.*



Discussion

William James noted that the self is in large part a psychological experience, a collection of thoughts that is perceived to be continuous over time. This psychological experience is what many psychologists call autobiographical memory or self-related thought (Q. Wang, 2013). In the present study, we contributed to this literature by showing that a neural correlate of self-referential thought is alpha power. Specifically, we found that alpha was greater when people were cued to imagine a situation for the self, compared to someone else. Moreover, people who showed more alpha when asked to imagine an event for the self tended to be those high in interdependent self-construal. These findings offer a few important insights into the nature of the self.

What are the neural mechanisms underlying self and other perception?

In the present study, we found that alpha may be an important neural mechanism underlying the self. To test the idea that alpha is involved in self-referential thought, we drew on work showing correlations between the two (Knyazev, 2013; Knyazev et al., 2012). Based on this work, we elected to examine the full alpha range (8-13 Hz) and time window when participants imagined events. Unlike Mu et al. (2013), we found that alpha was consistently higher when people were cued to think about the self compared to others. We also failed to find comparable evidence with theta. Our findings suggest that alpha in particular may be an important oscillation involved in self-related thought.

Cultural and Individual Variation.

While we found evidence that alpha is greater when people are cued to think about the self (vs. others), it is important to note that the self is not a fixed entity, but rather varies systematically across cultures (Markus & Kitayama, 1991). Consistent with this proposition, we observed that interdependent people showed higher levels of alpha when cued to think about the self. One explanation for this pattern is that thinking about the self may require more internal attention for interdependent people. This could be because this task is more effortful and less spontaneous for these individuals. This interpretation is consistent with emerging evidence that interdependent (vs. independent) people show lower levels of spontaneous alpha power during rest (Kraus et al., revise & resubmit), presumably because they think about the self less than independent people.

Limitations and Future Directions

We consistently found that alpha was greater when people were asked to imagine the same situation occurring to themselves, compared to others. However, the topographic distribution of this effect was inconsistent. This may be due to the poor spatial resolution in EEG. Future work may benefit from combining EEG and fMRI to further understand the neural mechanisms underlying self-referential thought.

Second, in the present work, we asked participants to imagine themselves or others in a series of situations. This prompt evoked the capacity to imagine themselves or others. However, it is important to note that there are many selves people can imagine. To name a few, there is an ideal self (who people want to be) (Higgins et al., 1994), possible selves (who people could be) (Markus & Nurius, 1986) and actual self (who people are) (Moretti & Higgins, 1990). Moreover, people can think of themselves personally or in the third person which influences their perception, recollection and interpretation of events (D. Cohen & Gunz, 2002). Understanding what neural oscillations come online for these different ways of thinking about the self can deepen the understanding of the different conceptions of the self. Nonetheless, these findings provide causal evidence that self-referential thinking evokes alpha power and provide some evidence that alpha can be a promising neural marker to study the self.

Study 2[2]

In one of the most cherished chapters in his *Principles of Psychology,* William James (James, 1890) examined consciousness and observed, "The universal conscious fact is not 'feelings and thoughts exist,' but 'I think' and 'I feel.' No psychology … can question the existence of personal selves. Thoughts connected as we feel them to be connected are what we mean by personal selves" (Page 221). He thus equated the "stream of consciousness" – our seemingly continuous train of thoughts that transpires from one moment to the next – with the sense of personal agency, or the self. He thus posited that all sentient beings are constituted by the thoughts generated by the self.

This train of self-generated thoughts, or for James, the personal self, is salient especially when people are resting with no immediate task to perform (Smallwood & Andrews-Hanna, 2013). This spontaneous self-generated thought is both internally focused and independent of outside context (Andrews-Hanna et al., 2014). Self-generated thought in humans is arguably universal. However, the evidence is growing that there exists substantial individual and cultural differences in the phenomenological salience of the personal self (Markus & Kitayama, 1991). One crucial dimension of cultural differences is the construal of the self as independent (vs. interdependent). This dimension is important for self-generated thought as previous evidence demonstrates that the personal self is more salient for independent (vs. interdependent) selves. Based on this evidence, we predicted that the independent (vs. interdependent) self-construal

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[2] This study is based on: Kraus, B.T., Salvador, C.E**.**, Kamikubo, A., Karasawa, M., Hu, J.F. & Kitayama,S. (revise & resubmit) Oscillatory Alpha Power at Rest Reveals the Independent Self: A Cross-cultural Investigation, *Biological Psychology*.

(SC) would correlate with a neural index of resting state mental activity that shares a functional and mechanistic overlap with self-generated thought.

Cultural Differences in Self-Generated Thought

SC refers to the predominant mode of construing the self in relation to others (Markus & Kitayama, 1991). Independent SC implies a view of the self as separate from and unique relative to others (H. S. Kim & Markus, 1999). This SC is considered more dominant in Western cultures. In contrast, interdependent SC refers to a view of the self as connected to and embedded in relations with others. This SC is more dominant in Eastern cultures (including East Asian cultures) (Kitayama et al., 2009). Since the two SCs place varying emphases on the internal, personal aspects of the self, they may entail important downstream consequences in both the amount and content of self-generated thought.

In particular, for those with independent SC actions are often experienced as personally chosen and thus internally caused (Savani et al., 2008). That is, preferences, desires, attitudes, and other thoughts and feelings generated by the self are seen as the most significant driver of action. These internal or personal attributes of the self are thus likely to be highly salient. Indeed, as noted above, "(such) thoughts … as we feel them are what we mean by personal selves" ((James, 1890), page 221). Moreover, such thoughts may even serve a potent index of the very presence of the personal self, or as Descartes famously proclaimed, *"je pense, donc je suits* (*I think, therefore I am).*" Conversely, for those with a more interdependent SC, actions tend to be oriented toward others. They are thus motivated to adjust themselves to others' social expectations and norms (Morling et al., 2002; Tsai et al., 2007). Thus, their social roles rather than their personal attributes are a more defining feature of the self. As such, their experience is solicited and motivated by concerns present in their surroundings, such as evaluation apprehension and a need to please others. Their sense of personal agency may be relatively less because more of their attention is claimed by social situations, norms, and others' expectations. In other words, instead of thinking primarily of themselves, interdependent people may think primarily about other people, social norms, and expectations (Savani et al., 2008). Therefore, the content of their self-generated thoughts may be more extended and not as engrossed in thoughts referent to the personal self.

Past work using the 20-statements test suggests that the content of self-generated thought varies across cultures. This test requires people to describe themselves with 20 freeform responses. In this task, European Americans are more likely generate abstract personality traits such as 'smart' and 'kind' compared to East Asians who are more likely to generate relational attributes such as social roles and behaviors embedded within social contexts (Cousins, 1989; Rhee et al., 1995). This is consistent with past work demonstrating that autobiographical memories are experienced as more central to one's identity for those raised in an independent cultural context (Berntsen & Rubin, 2004; Rubin, 2020; Wang & Conway, 2004). Additional evidence for cultural differences in self-generated thought comes from research showing that European Americans are more likely to feel pride and other socially disengaging or independent emotions, whereas East Asians are more prone to experience socially engaging or interdependent emotions, such as relational feelings and respect (Kitayama, Mesquita, et al., 2006). Furthermore, the experience of happiness is related closely to social disengagement for European Americans, but it is related closely to social engagement for East Asians (Uchida & Kitayama, 2009). Altogether, this evidence indicates that European Americans and East Asians differ in the content of their self-generated thoughts, especially thoughts about themselves.

In addition to cross-cultural differences in the content of self-generated thoughts, there is also variability within cultures. In both Western (e.g., Europe, United States) and Eastern (e.g. Japan, China, Taiwan) cultures, the content of self-generated thought has been shown to vary as a function of personality traits (Andrews-Hanna et al., 2013; Blouin-Hudon & Zelenski, 2016; Carciofo et al., 2016; Kane et al., 2017). Some individuals also spend a greater amount of time mind wandering, a state where one is more likely to generate thoughts about the self, compared to others (Kane et al., 2007, 2017). Importantly, the frequency of mind wandering is greater in samples of individuals from Western cultures (Kane et al., 2007, 2017) than those from Eastern cultures (Song & Wang, 2012). Overall, these variations in the frequency and content of self-generated thoughts across cultures are consistent with the hypothesis that compared to East Asians, European Americans are more independent, less interdependent, or both. Yet, so far no direct link between these observed differences in behavior and SC has been demonstrated. To examine the possibility that SC is related to the content and quantity of self-generated thoughts, we measured neural activity at rest when the mind tends to wander.

Alpha and Self-generated Thought

Prior work has shown that self-generated thoughts are linked to increased activity in several central midline structures of the brain that partially comprise the default mode network (DMN; (Andrews-Hanna et al., 2014; Meyer & Lieberman, 2018; Northoff, 2016; Raichle et al., 2001; Wolff et al., 2019)). Importantly, this activity in the DMN increases during rest (Raichle, 2015), or when participants are not currently attending to a particular task. This has led to a hypothesized overlap between areas of the brain that increase in activity during rest and those that are involved in self-referential cognition (Northoff, 2016). Thus, it is likely that neural signals during resting state carry some amount of information relevant to the continuous train of thought which constitutes the personal self.

In electroencephalography (EEG) research, the EEG resting state is dominated by the alpha rhythm, defined as neurons which oscillate (or "fire") in synchrony between 8-13 Hz (Berger, 1929; Fries, 2005). The alpha rhythm is especially dominant when visual stimulation is absent and thus a more interoceptive state becomes dominant (Webster & Ro, 2020). Many studies have directly linked activity in the DMN to EEG activity in the alpha rhythm at rest, showing a moderate positive relationship between these two measures (Jann et al., 2009, 2010; Mantini et al., 2007; Marino et al., 2019; Mo et al., 2013; Scheeringa et al., 2012; Wu et al., 2010). Crucially, multiple studies have also found that increased alpha power, or an increase in the number of synchronized neurons within the alpha rhythm, is linked to ideation related to the self (Bai et al., 2016; Knyazev, 2013). Altogether, this evidence suggests both a functional and mechanistic overlap between oscillatory alpha power and thoughts that are related to the self.

It is important to keep in mind, however, that alpha power has the potential to be influenced by many factors unrelated to self-related ideation (Clayton et al., 2018). For instance, pathways between the cortex and the thalamus, a primary relay for sensory information, are also associated with changes in alpha power (Feige et al., 2005; Liu et al., 2012; Omata et al., 2013; Sadaghiani et al., 2010). This is consistent with the observation that a decrease in the processing of sensory information, or a reduction in externally-oriented attention, is associated with increases in alpha power (Benedek et al., 2014; Liu et al., 2012; William J. Ray & Cole, 1985). For example, alpha power has been shown to decrease during vigilant attention to external events (Salvador, Kraus, et al., 2020). Given this possibility, we decided to test two conditions of resting state alpha power, one with eyes closed and one with eyes open. When the eyes are closed (vs. open) and the salience of external (especially visual) stimuli is reduced (Webster & Ro, 2020), the propensity for self-generated thought should be maximized. As this occurs only when the eyes are closed, this condition would thus be expected to show a larger relationship between SC and alpha oscillations.

Current Study

In the present study, we tested the relationship between oscillatory alpha power during a resting state and independent (vs. interdependent) SC. We anticipated that SC would positively correlate with oscillatory alpha power during a resting state EEG recording, especially when the eyes were closed. In two studies, we recruited participants in East Asia (Taiwan and Japan) and in the United States (US) and quantified their oscillatory alpha power during rest. We then measured the association of oscillatory alpha power and SC both during eyes open and eyes closed conditions. In testing our predictions, we focused primarily on a difference score of SC (independent – interdependent). However, there are inconsistencies across studies and paradigms regarding which aspect of this SC difference score might be driving an observed effect (see (Kitayama et al., 2020; Salvador, Kraus, et al., 2020) for discussions of this evidence). This is because an effect observed with independent SC is sometimes, but not always, mirrored by an opposite effect of interdependent SC and vice versa. Thus, we also examined the association between each of the two SC's (independent and interdependent) and resting alpha power separately. As a secondary aim, our design also allowed us to explore the relevant hypothesized cultural differences in oscillatory alpha power. That is, compared to Asians, European Americans should be relatively more independent, or less interdependent, and thus might be expected to show stronger alpha power during rest.

Study 2a

Method

Participants

We recruited both 45 Taiwanese young adults in Taiwan and 38 American young adults in the U.S. The Taiwanese sample consisted of participants recruited from National Cheng Kung University. They were compensated with NT$ 420 (approximately $14) for their participation. All 45 participants were right-handed, reported being of Asian descent, and were born and raised in Taiwan. Of these participants, 1 was excluded for reporting a current mental health diagnosis and 3 were excluded for excessive artifacts in their EEG. This left 41 participants available for analysis (21 Female, Age: $M = 21.61$, $SD = 2.98$). The 38 U.S. participants were recruited from the University of Michigan psychology subject pool. All participants were right-handed, reported being of European-American descent, and were born and raised in the US. In this sample, 1 participant was excluded for not finishing the study and 2 were excluded for reporting a prior neurological issue or a current mental health diagnosis. This left 35 participants for analysis (22 Female, Age: $M = 19$, $SD = 1.04$).

Materials

To assess SC, participants completed a modified Singelis SC scale (Kitayama & Park, 2014)[3], which is composed of scales which measure both independent and interdependent SC scores. Each item asks participants to endorse a statement about themselves (e.g. "I always try to have my own opinions.") on a scale from 1 (Doesn't describe me at all) to 5 (Describes me very

[3] Participants in all samples also completed a subsample of the self-esteem items from Kitayama et al., (1997), the Rosenberg Self-Esteem scale (Rosenberg, 1965), the Generalized Self-Efficacy scale (R. Schwarzer & Jerusalem, 2010), the Regulatory Focus Questionnaire (Higgins et al., 2001), the Need to Belong scale (Leary et al., 2013), the Fear of Negative Evaluation scale (Leary, 1983), and the Behavioral Inhibition/Activation scale (Carver & White, 1994). These measures were included for other purposes and will not be reported here.

well). The reliabilities of the SC scale were adequate for Taiwanese (α = .77 and α = .604 for independent and interdependent SC, respectively) and for Americans (α = .739 and α = .675 for independent and interdependent SC, respectively).

For data analysis, SC difference scores were created by subtracting each individual's mean score on interdependence from their mean score on independence. Thus, higher scores indicated that scores for independence were higher than interdependence. For Taiwanese participants, the scales were translated and back-translated from English into Taiwanese by bilingual speakers. The resting state procedure was presented using E-Prime 2.0 software (Schneider et al., 2002).

Procedure

Upon arrival, participants were told that they would first be completing a resting state task. Participants were seated approximately 60 cm from a color computer display while the EEG was recorded with the lights on. Participants also completed a cognitive task, the results of which are not reported here.

Each participant completed 3 minutes of eyes open resting state and 3 minutes of eyes closed resting state in alternating 1 minute blocks. Participants were instructed to switch from eyes open to eyes closed or vice versa when they heard a loud tone which was presented every 1 minute. The current condition (eyes closed or eyes open) remained on the screen for the duration of the experiment for the participant's reference. Whether the task started with an eyes closed or eyes open block was counterbalanced across participants. All participants also completed the resting state before performing any tasks. At the end of the study, participants completed the questionnaires outlined above.

EEG Recording

Different EEG recording devices and amplifiers were used in the two locations. In the Taiwanese sample, the EEG was recorded using 32 silver chloride scalp channels from a Neuroscan system in DC mode with a gain of 19 (range: 263 mV) using a 32 bit ADC and configured to the 10–20 electrode system. AFz was used as the ground electrode. The EEG scalp electrodes used for analysis were: Fp1, Fp2, F7, F3, Fz, F8, F4, FT7, FC3, FCz, FC4, FT8, T3, C3, Cz, C4, T4, TP7, CP3, CPz, CP4, TP8, T5, P3, Pz, P4, T6, O1, Oz, O2. An online band-pass filter was used during recording (.1-200 Hz) and data was online referenced to the left mastoid. The recorded EEG was digitized at 1000 Hz. The electrooculogram was monitored using bipolar VEOG and HEOG electrodes (Croft & Barry, 2000). Electrodes were also placed at the left and right mastoids. Impedances during data collection were kept under 10 kΩ.

In the US sample, the EEG recording was taken with 32 scalp 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. The EEG scalp electrodes used were: Fp1, Fp2, F7, F3, F4, F8, Fz, FC5, FC1, FCz, FC2, FC6, T7, C3, Cz, C4, T8, CP5, CP1, CPz, CP2, CP6, P7, P3, Pz, P4, P8, PO3, PO4, O1, Oz, O2. EEG data was recorded at 512 Hz. The electrooculogram was monitored using bipolar VEOG and HEOG electrodes (Croft & Barry, 2000). Electrodes were also placed at the left and right mastoids. 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).

EEG Data Processing

All data analysis was performed using EEGLAB (Delorme & Makeig, 2004). The first step for processing the EEG data was to remove any data from the recording that occurred outside of the resting state procedure. Next, for the Taiwanese data, an offline Butterworth low pass filter was applied at 20 Hz. The data were downsampled to 512 Hz, and the online left mastoid reference was removed. For the US data, a bandpass Butterworth filter was applied with cutoffs at .1 and 20 Hz. Then the data for all participants were visually inspected and large artifacts were manually removed from the data.

Next, an independent component analysis (ICA; (Makeig et al., 1997)) was obtained for each dataset. For each participant, ICA components were determined for up to 32 scalp electrodes (30 in the Taiwanese dataset) 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 data were then inspected visually and any remaining artifacts in the data were removed. Participants that had less than one minute of data in either the eyes open or eyes closed condition after artifact rejection were discarded (see Participants section).

A current source density (CSD; (Kayser & Tenke, 2006a)) reference was then applied to the continuous data. The CSD reference acts as a spatial filter, helping to enhance the contribution of local activity and attenuate distal activity at each electrode, and it is effective with a typical 32 electrode montage (Kayser & Tenke, 2006b). This allows for better localization of the scalp topography of alpha power versus other reference montages (Smith et al., 2017).

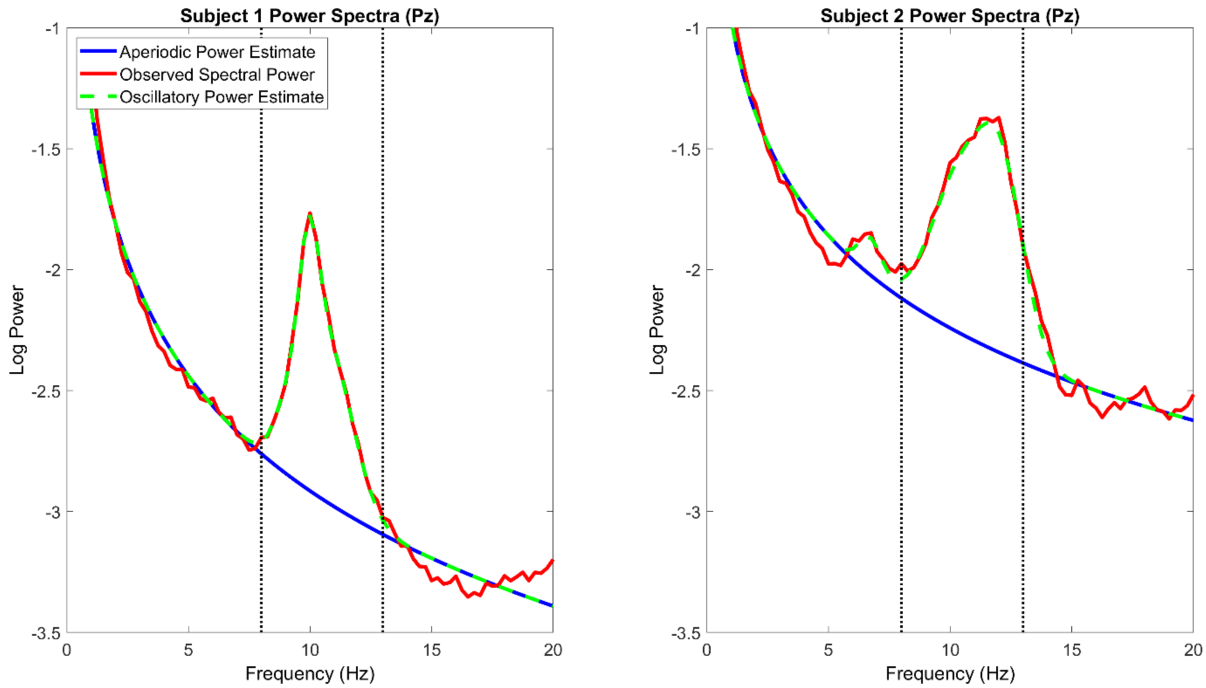
Estimation of Spectral Power

After applying a CSD reference, the data was segmented into 2000ms long epochs which were each offset 500ms from each other. Thus, each epoch shared 75% of its timepoints with the subsequent epoch. Overlapping the epochs in this way minimizes the impact of the Hamming window used in a fast Fourier transformation (FFT) by providing closer to equal weighting for each timepoint in a recording (Smith et al., 2017). A FFT was then applied to the data with 2000ms wide Hamming window and a 75% overlap. Each FFT was zero-padded by a factor of 2. In each FFT, 80 linear-spaced frequencies were extracted between .25 and 20 Hz in .25 Hz steps.

Estimation of Oscillatory Power

One of the issues with analyzing the amplitude of spectral power in discrete frequency bands is that the signal is composed of multiple components. The aperiodic (or background) signal is composed of "scale-free" brain activity which is arrhythmic (He, 2014). This aperiodic signal exhibits a 1/frequency power spectrum and accounts for the majority of observed spectral power (see Figure 1). Conversely, many studies are interested in measuring oscillatory (or periodic) power of a given frequency band (e.g., the alpha band). This refers to the amount of synchronous neural oscillations which are occurring at a given frequency, and thus indicates that the underlying population of neurons are temporally integrated in ongoing processes (Fries, 2005). In practice however, this measurement is contaminated by the presence of aperiodic power in the amplitude of the power spectra (Donoghue et al., 2020), which is especially an issue for relating oscillatory alpha power to individual differences (see Figure 3).

Figure 3. *FOOOF Decomposes the Underlying Components of Spectral Power.*



Note. The estimated power spectra (via FOOOF) are shown for aperiodic power (blue) and oscillatory power (green) for the first 2 participants in the eyes closed condition of the Taiwanese dataset at electrode Pz. The total spectral power values from the observed signals are also shown (red). The alpha band (8-13 Hz) is demarcated with vertical black dotted lines. Notice that although the area under the curve (or amplitude) of the oscillatory signal (green) in the alpha band is similar in size across these 2 subjects, the amplitude of the aperiodic signal (blue) is much larger in subject 2. Thus, a typical spectral power measurement would erroneously conclude that the amplitude (and thus the amount of neurons engaged in synchronized alpha oscillations) are greater in subject 2. By accounting for this aperiodic signal, a more accurate measurement of power from oscillatory activity in the alpha band can be obtained.

To characterize each individual's power spectra, we utilized the fitting oscillations and one over f (FOOOF; (Donoghue et al., 2020)) toolkit. Unlike a typical measure of narrow band power (e.g., alpha) which includes both aperiodic (or background) power as well as oscillatory power, FOOOF attempts to model the slope of the background power and therefore can be used to isolate the contribution of oscillatory power. The use of this method also can help control for the comparison of spectral power across different EEG amplifiers, which can produce different measurements of absolute spectral power due to differences of ground electrodes, amplifier gain settings, and channel calibration differences (Kayser et al., 2003; Luck, 2014).

For each channel in each dataset, a FOOOF model was fit for the extracted power spectra between 1-20 Hz using the default settings. This model showed a good fit at each channel across participants (Taiwanese R^2: M = .984, SD = .016, US R^2: M = .99, SD = .011). From these models, an estimate of alpha power for both the aperiodic and oscillatory signals was obtained by averaging their log-transformed power values for frequencies 8-13 Hz. At each channel, the oscillatory (periodic) alpha power was normalized using the following formula: *(Oscillatory Power – Aperiodic Power)* / |*Aperiodic Power*|. Thus, the estimate of the oscillatory signal corresponding to alpha power was measured in the percent increase in spectral power from the aperiodic signal or its *Relative Power* from baseline (as the periodic power estimate is never less than the aperiodic estimate). For analysis, each subject's relative power in the alpha band was estimated separately for each channel and condition (eyes closed/eyes open). To show the robustness of the results, we also report the final analysis with a standard measure of total spectral power in the alpha band (see *Supplementary Results*). In addition, we also report our results showing the effect of the slope of aperiodic power (power law exponent) as estimated by FOOOF (see *Supplementary Results*).

Data Analysis

To analyze the impact of SC on resting state alpha power, linear mixed effects models were utilized (Baayen et al., 2008). These models were fit using the lme4 package in *R* using restricted maximum likelihood to estimate the parameters (Bates et al., 2014). To fit each model, an estimate of alpha power was extracted from each electrode for each participant. Estimates from all electrodes were included in the model to estimate alpha power for each participant. SC difference scores were standardized within each culture to avoid conflating mean differences in SC scores between groups with any observed effects (Enders & Tofighi, 2007). The model was fit with the fixed effects of Condition (Eyes Open/Eyes Closed), Culture (US/Taiwanese), SC difference scores, and their interactions. To specify the random effects for the model, first the maximal random effects structure was fit to the data (Barr et al., 2013). This amounted to a random intercept being estimated for each participant as well as random slopes specified for each Condition (Judd et al., 2017). This model fit the data well and was used for analysis.

An omnibus type III F-test was used to determine whether any main effects or interactions were significant among the fixed effects of the model using the lmerTest package in *R* (Kuznetsova et al., 2017). When the fixed effects significantly differed from zero, pairwise post-hoc *t*-tests were used for simple effects tests within each of the significant using the lsmeans package in *R* (Lenth, 2016). When continuous variables were involved in interactions, pairwise post-hoc *t*-tests were used for simple slope tests of the continuous variable within each cell of the interaction. R^2 values for all multilevel models were calculated using the method outlined by Nakagawa et al. (2017). Effect sizes are reported from the output of the models as Cohen's *d* (Lakens, 2013).

Results

Behavioral Results

Scores on the independent SC scale were significantly greater in the US group (M = 3.87, SD = .563) versus the Taiwanese group (M = 3.44, SD = .567), $t(74)$ = 3.33, p = .001, d = .76. On the interdependent SC scale, this pattern was reversed with the US group (M = 3.50, SD = .525) reporting significantly lower scores than the Taiwanese group (M = 3.82, SD = .395), $t(74)$ = 3.03, p = .003, d = .70. The SC difference scores (independent SC – interdependent SC) were higher in the US group (*M* = .373, *SD* = .983) than in the Taiwanese group (*M* = -.38, *SD* = .765), *t*(74) = 3.75, *p* < .001, *d* = .86.

Resting State Alpha Power

To test for differences in the relative power of the alpha band during rest across cultures, a multilevel model was fit using the fixed effects of Condition (Eyes Open, Eyes Closed), Culture (US, Taiwanese), SC difference scores, and their interactions (Marginal R^2 = .24, Conditional R^2 = .53). A significant main effect of Condition was observed, *F*(1,71.969) = 258.34, *p* < .001, *d* = 1.87, indicating that relative alpha power was greater in the eyes closed condition (*M* = .163, *SE* = .007) than in the eyes open condition (*M* = .073, *SE* = .005). A significant main effect of the SC difference score was also observed, *F*(1,71.987) = 3.98, *p* = .049, *d* = .23, showing a positive relationship between relative alpha power and SC. The interaction was between Condition and the SC difference score was not significant, *F*(1,71.968) = 2.27, *p* = .137, *d* = .18, indicating that the slope of SC was not significantly different across both conditions. To see if there might be any indication that the effect of SC is greater in the eyes closed than in the eyes open condition, we tested this effect in the two conditions separately. The slope of SC was significantly greater than 0 in the eyes closed condition (β = .014, *SE* = .007), , *t*(72) = 2.19, *p* = .032, *d* = .25, but not in the eyes open condition (β = .006, *SE* = .005), *t*(71.9) = 1.23, *p* = .224, *d* = .14.

Of note, the main effect of Culture was not significant, *F*(1,71.988) = .39, *p* = .535, *d* = .07, indicating that there was no difference in relative alpha power between groups. There was also no significant interaction between Condition and Culture (see Table 2), *F*(1,71.969) = 1.02, *p* = .316, *d* = .12. No other effects in the model were significant.

Table 2. Mean Relative Alpha Power by Culture and Condition in Study 2a.

	Culture	
Condition	Taiwan	US
Eyes Open	.073 (.007)	.073 (.007)
Eyes Closed	.167 (.009)	.155 (.01)

Note. The mean relative alpha power (%) is shown for each culture and condition in Study 1. The standard errors for each value are displayed in parentheses

Study 2b

Method

Participants

We recruited 43 Japanese young adults in Japan and 62 American young adults in the U.S. The Japanese participants were recruited from multiple universities in Tokyo. They were all right-handed and reported being born and brought up in Japan. Ten participants were excluded for having excessive artifacts in their EEG recordings, and another participant was excluded for reporting a current mental health diagnosis. This resulted in 32 participants with usable data (27 Female, Age M = 18.66, SD = 1.13). The American participants were recruited from either the University of Michigan psychology subject pool or compensated with $25 for participating. They were all right-handed, reported being of European-American descent and were born, and raised in the US. Of these participants, three were excluded for reporting current mental health diagnoses. Three additional participants were excluded for having excessive artifacts in their EEG recordings. This left 56 participants with usable data (42 Female, Age M = 18.64, SD = .61).

Materials and Procedure

The materials and procedure in this study were nearly identical to Study 2a. In this study however, the SC measure used had a scale ranging from 1-7 (in contrast with 1-5 in the first study). The reliabilities of the SC scale were adequate ($\alpha = .694$ and $\alpha = .655$ for independent and interdependent SC, respectively) for the US sample. This scale was translated to Japanese and back translated for the Japanese sample which also showed adequate reliability for independence ($\alpha = .754$) and interdependence ($\alpha = .749$). In addition, in this study participants completed 2 minutes of resting state total in each condition (eyes open, eyes closed) versus 3 minutes total for each condition in Study 2a. As in Study 2a, participants were required to have at least one minute of usable data in each condition for analysis. There were no other differences in the materials or resting state procedure from the previous study.

EEG Recording

Different EEG amplifiers and equipment from the same manufacturer (BioSemi) were used for the two samples. In both samples, the recording setup was almost identical to the US system described in Study 1, except the channels used for the recording in Japan were: Fp1, Fp2, AF3, AF4, F7, F3, F4, F8, Fz, FC5, FC1, FCz, FC2, FC6, C3, Cz, C4, T8, CP5, CP1, CP2, CP6, P7, P3, Pz, P4, P8, PO3, PO4, O1, Oz, O2. Everything else was the same across these recordings.

EEG Data Processing and Data Analysis

The EEG data processing steps and data analysis were identical to those used for the US sample in Study 2a. As in Study 2a, the FOOOF model fit well at each channel across participants (Taiwanese R^2: $M = .984$, $SD = .016$, US R^2: $M = .988$, $SD = .01$).

Results

Behavioral Results

Independent SC scores were significantly greater in the US group (*M* = 5.26, *SD* = .607) versus the Japanese group (*M* = 4.49, *SD* = .776), $t(86) = 5.17$, $p < .001$, $d = 1.1$. There were no differences between the US group (*M* = 4.88, *SD* = .605) and Japanese group (*M* = 4.95, *SD* = .696), in Interdependent SC scores, $t(86) = .513$, $p = .609$, $d = .11$. Overall, the SC difference score was greater in the US group (*M* = .385, *SD* = .935) than in the Japanese group (*M* = -.459, *SD* = 1.165), $t(86) = 3.72$, $p < .001$, $d = .79$, indicating that Americans were more independent (vs. interdependent) than Japanese.

Resting State Alpha Power

To test for differences in relative resting state alpha power across cultures, a multilevel model was fit using the fixed effects of Condition (Eyes Open, Eyes Closed), Culture (US, Japanese), SC difference scores, and their interactions (Marginal $R^2 = .25$, Conditional $R^2 = .53$). A significant main effect of Condition was observed, $F(1,84) = 386.84$, $p < .001$, $d = 2.12$, indicating that relative alpha power was greater in the eyes closed condition (*M* = .172, *SE* = .006) versus the eyes open condition (*M* = .083, *SE* = .005). Although the main effect of the SC difference score was not significant, $F(1,83.999) = .07$, $p = .794$, $d = .03$, we found a significant interaction between Condition and SC, $F(1,84) = 4.51$, $p = .037$, $d = .23$, indicating that the slope of the SC difference score was significantly different between the two conditions. In the eyes closed condition ($\beta = .006$, *SE* = .006), the relationship was positive, whereas in the eyes open condition, it was negative ($\beta = -.004$, *SE* = .005). Neither of these slopes were significantly different from zero, $t(84) = 1.07$, $p = .29$, $d = .12$, and $t(84) = -.68$, $p = .496$, $d = .07$, respectively. This interaction was also not qualified by Culture, $F(1,84) = .04$, $p = .836$, $d = .02$.

In this study a significant main effect of Culture was observed, $F(1,83.999) = 4.19$, $p = .025$, $d = .25$, with US participants (*M* = .139, *SE* = .006) showing greater overall relative alpha power than Japanese participants (*M* = .116, *SE* = .008). This significant main effect was qualified by a significant interaction between Condition and Culture, $F(1,84) = 11.01$, $p = .001$, $d = .36$ (see Table 3). Post-hoc simple effects tests showed that relative alpha power in the US group was significantly greater during the eyes open condition (*M* = .102, *SE* = .006) versus the Japanese group (*M* = .064, *SE* = .008), $t(84) = 3.67$, $p < .001$, $d = .4$. However, US participants (*M* = .176, *SE* = .007) and Japanese participants (*M* = .169, *SE* = .009) did not significantly differ from each other in the eyes closed condition, $t(84) = .67$, $p = .508$, $d = .07$. No other effects in the model were significant.

Table 3. *Mean Relative Alpha Power by Culture and Condition in Study 2b*

	Culture	
Condition	Japanese	US
Eyes Open	.064 (.008)	.102 (.006)
Eyes Closed	.169 (.009)	.176 (.007)

Note. The mean relative alpha power (%) is shown for each culture and condition in Study 2. The standard errors for each value are also displayed.

In addition to quantifying the effects of each study separately, we also sought to calculate a meta-analytic estimate of the relationship between relative alpha power and SC scores across all the samples reported in this paper.

Method

Participants

The data from all participants reported in both studies (*N* = 164) are included in this meta-analysis.

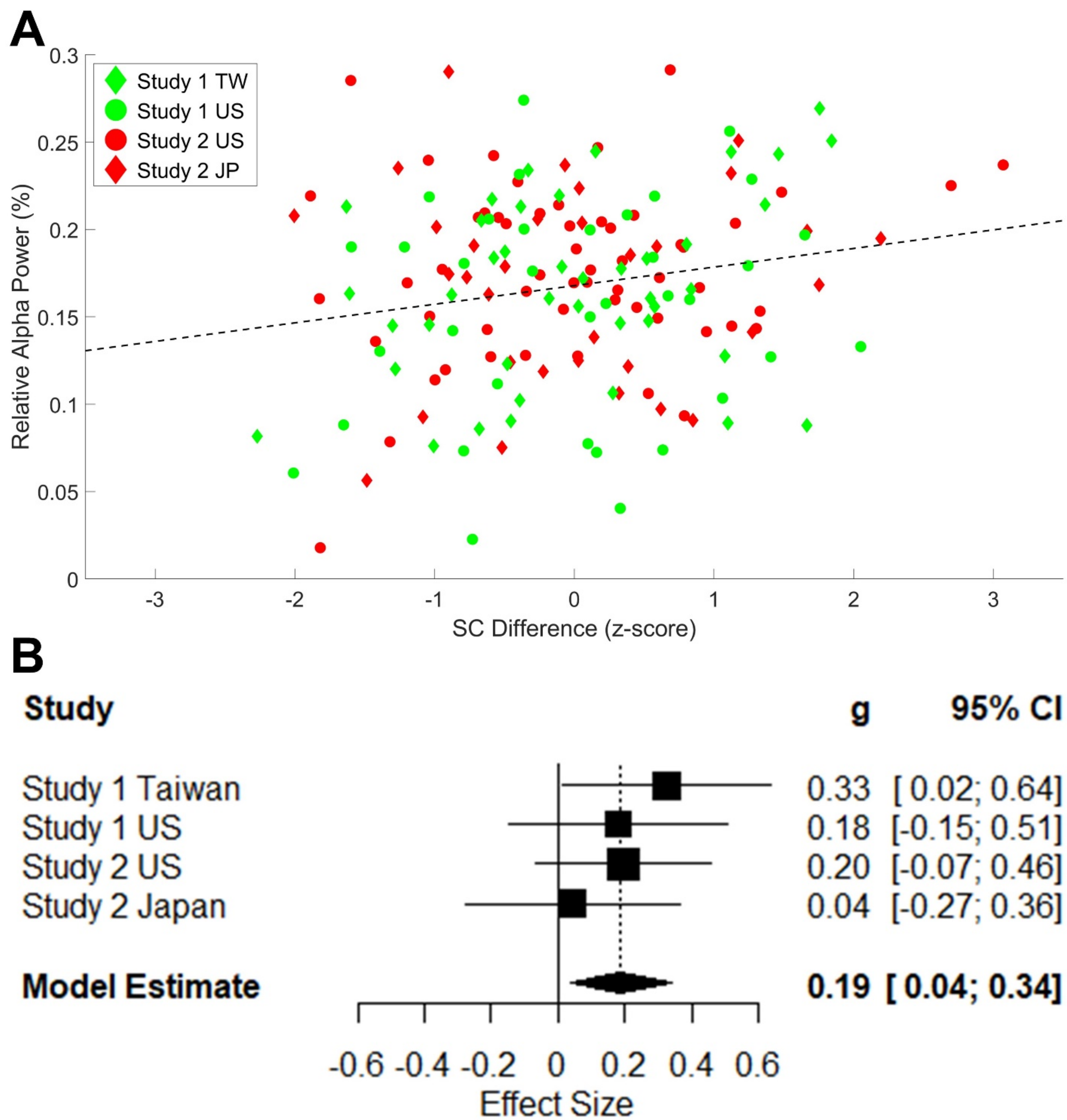
Data Analysis

To perform this meta-analysis, each sample was treated separately so that there were k = 4 samples in total (with each study counting as two separate samples). In each sample, an effect size was calculated for the contrast of the slope of the relationship between SC scores and relative alpha power separately for each condition versus the null hypothesis ($\beta = 0$). The effect sizes for each sample and their associated standard errors were calculated based on the statistics from the reported multilevel models (Altman & Bland, 2011; Lakens, 2013).

The meta-analysis was performed with a random effects model estimated with restricted maximum likelihood using the *meta* package in *R* (G. Schwarzer, 2007). The significance of the effect sizes was calculated using z-tests. Heterogeneity in the distribution of effect sizes was examined using the Q test and I^2 statistic. To examine the impact of relevant variables on the effect sizes across these samples, culture (US, East Asian), country of origin (Taiwan, Japan, US), and EEG amplifier (Neuroscan, BioSemi) were tested as moderators of the observed effect size. Our primary analyses showed the most consistent pattern across both studies occurred in in the eyes closed condition. This is consistent with our supposition that alpha power in the eyes closed (vs. open) condition is likely to serve as a purer index of self-generated thought. We therefore focused on this condition for the meta-analysis (see Figure 4). To ensure the robustness of the findings, we examined whether independent and interdependent SC scores showed the same effects as the SC difference score. Moreover, we also report the same meta-analytic estimates for total spectral power and the aperiodic slope (power law exponent) of the power spectrum (see *Supplementary Results*).

Results

Figure 4. *Meta-analysis of Relative Alpha Power with Eyes Closed and SC Difference Score.*



Note. The relationship between relative alpha power and SC difference scores is plotted in two different ways. In the upper panel (A), a scatterplot of relative alpha power versus SC difference scores for all samples is shown. SC difference scores were standardized within each sample before plotting, as in the reported analyses. The symbol and color corresponding to each sample are noted in the top left corner for United States (US), Taiwanese (TW), and Japanese (JP) samples. Circles correspond to the US samples and diamonds to the Asian samples. Data points for Study 2a (Study 1) are colored in green and Study 2b (Study 2) are colored in red. The line of best fit for all 4 samples combined (black dashed line) is also shown. Below (B), a forest plot of the effect sizes for the relationship between SC and relative alpha power in the eyes closed condition is also shown for all 4 samples reported. The square size indicates the relative weight of a study in the analysis and the lines indicate the range of the confidence interval.

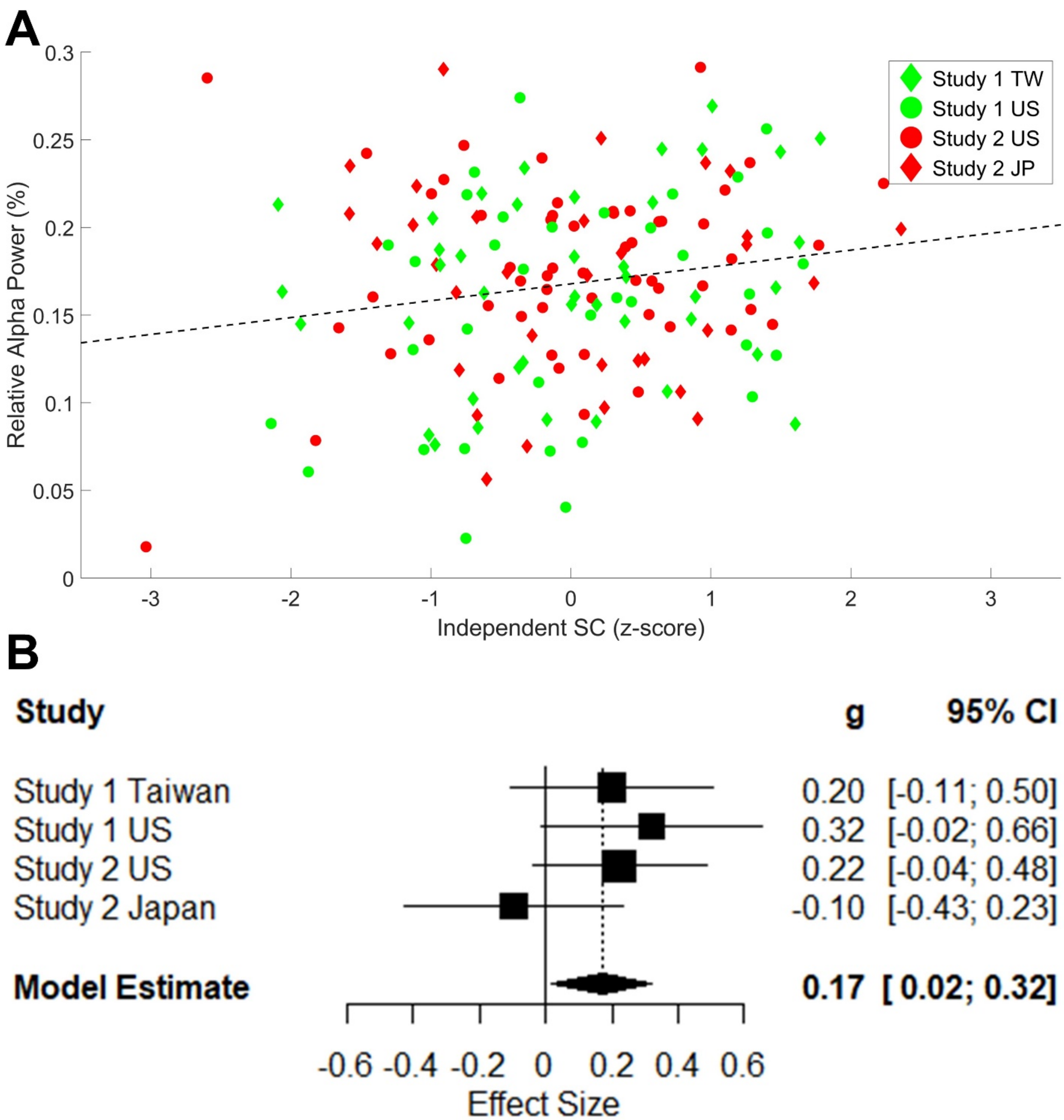
Relationship with the SC Difference Score

The weighted mean effect size (ES) revealed a significant positive association between alpha power in the eyes closed condition and SC difference score, *ES* = .176, 95% CI: [.026-.326], $z = 2.3$, $p = .021$ (Figure 4). The distribution of the effect sizes did not show strong evidence for heterogeneity, $Q(3) = .96$, $p = .811$, $I^2 = 0\%$. We also tested whether the estimated effect sizes systematically differed by Culture (US/East Asian), Country (US/Taiwan/Japan), or EEG Amplifier (Neuroscan/BioSemi). None of these subgroups significantly differed in effect size (all *p*s > .5). Notably, the effect of SC was specific to the eyes closed condition. The same meta-analysis performed for the eyes open condition showed that the weighted mean effect size was not significantly different from zero, *ES* = .025, 95% CI: [-.119-.169], $z = .34$, $p = .734$.

Relationship with the Independent SC Score

The same analysis performed for the Independent SC score (see Figure 5) showed a significantly positive effect between Independent SC score and relative alpha power in the eyes closed condition *ES* = .159, 95% CI: [.006-.311], $z = 2.04$, $p = .042$. The effect sizes in this analysis also did not show strong evidence for heterogeneity, $Q(3) = 3.45$, $p = .328$, $I^2 = 13\%$. We again tested whether the estimated effect sizes systematically differed by Culture (US/East Asian), Country (US/Taiwan/Japan), or EEG Amplifier (Neuroscan/BioSemi). None of these subgroups significantly differed in effect size (all *p*s > .1). The same effect size was also calculated for Independence scores in the eyes open condition. This effect was not significant, *ES* = .032, 95% CI: [-.117-.181], $z = .42$, $p = .671$.

Figure 5. *Meta-analysis of Relative Alpha Power with Eyes Closed and Independent SC Score.*

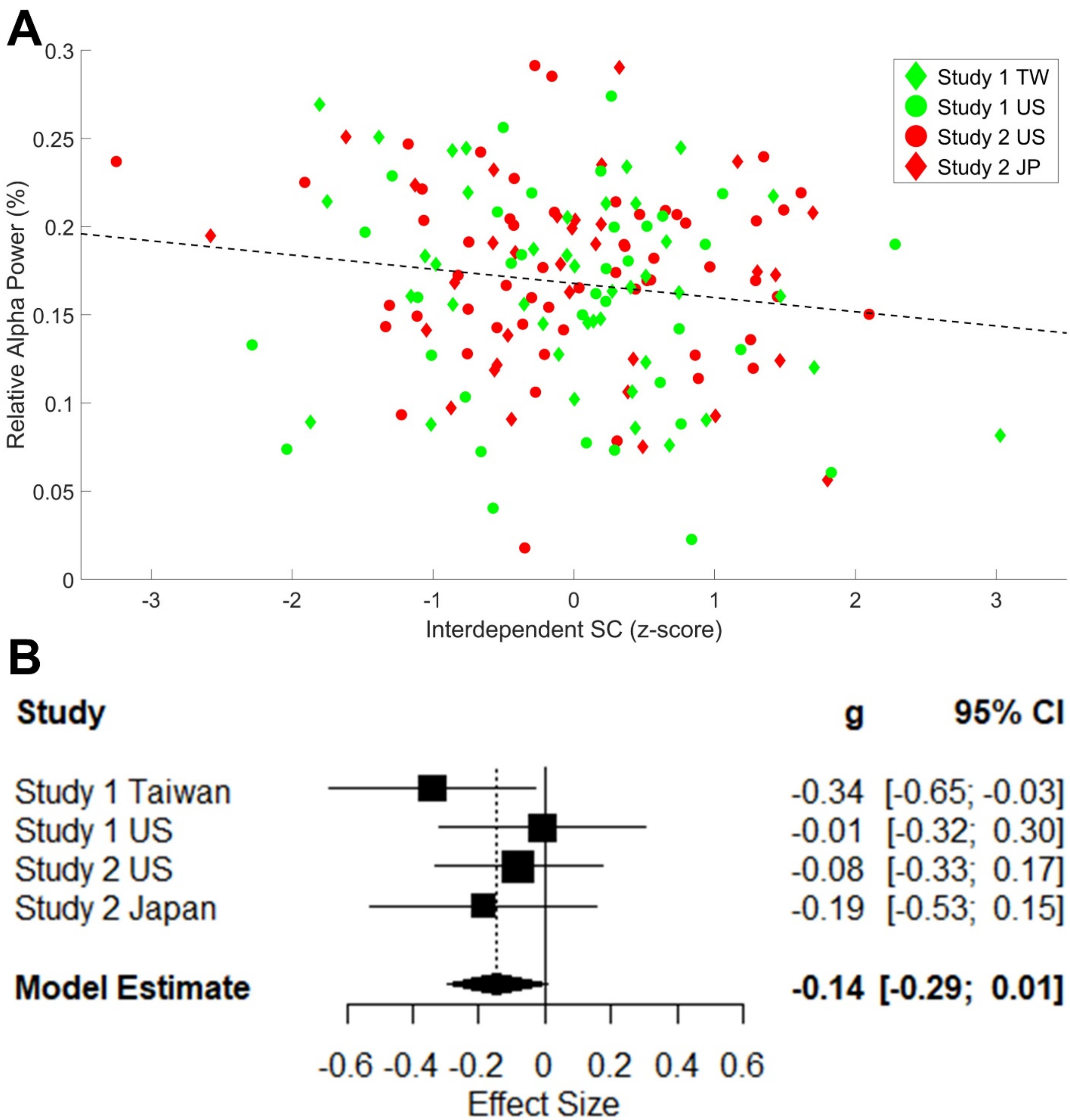


Note. The relationship between relative alpha power and Independent SC is plotted in two different ways. In the upper panel (A), a scatterplot of relative alpha power versus Independent SC for all samples is shown. Independent SC was standardized within each sample before plotting, as in the reported analyses. The symbol and color corresponding to each sample are noted in the top right corner for United States (US), Taiwanese (TW), and Japanese (JP) samples. Circles correspond to the US samples and diamonds to the Asian samples. Data points for Study 2a (Study 1) are colored in green and Study 2b (Study 2) are colored in red. The line of best fit for all 4 samples combined (black dashed line) is also shown. Below (B), a forest plot of the effect sizes for the relationship between Independent SC and relative alpha power in the eyes closed condition is also shown for all 4 samples. The square size indicates the relative weight of a study in the analysis and the lines indicate the range of the confidence interval.

Relationship with the Interdependent SC Score

We also tested the effect size of Interdependence SC score on relative alpha power across all samples (see Figure 6). The Interdependent SC showed a negative effect with relative alpha power in the eyes closed condition. However, this effect was statistically marginal, $ES = -.13$, 95% CI: [-.277-.017], $z = -1.73$, $p = .083$. There was no evidence that the heterogeneity of the effect sizes was problematic, $Q(3) = 1.72$, $p = .633$, $I^2 = 0\%$. We also tested whether the estimated effect sizes systematically differed by Culture (US/East Asian), Country (US/Taiwan/Japan), or EEG Amplifier (Neuroscan/BioSemi). None of these subgroups significantly differed in effect size (all *p*s > .2). This same analysis was also performed for the eyes open condition. This effect was smaller than the effect in the eyes closed condition and not significant, $ES = -.013$, 95% CI: [-.156-.129], $z = -.19$, $p = .849$.

Figure 6. *Meta-analysis of Relative Alpha Power with Eyes Closed and Interdependent SC Score.*



Note. The relationship between relative alpha power and Interdependent SC is plotted in two different ways. In the upper panel (A), a scatterplot of relative alpha power versus Interdependent SC for all samples is shown. Interdependent SC was standardized within each sample before plotting, as in the reported analyses. The symbol and color corresponding to each sample are noted in the top right corner for United States (US), Taiwanese (TW), and Japanese (JP) samples. Circles correspond to the US samples and diamonds to the Asian samples. Data points for Study 2a (Study 1) are colored in green and Study 2b (Study 2) are colored in red. The line of best fit for all 4 samples combined (black dashed line) is also shown. Below (B), a forest plot of the effect sizes for the relationship between Interdependent SC and relative alpha power in the eyes closed condition is also shown for all 4 samples reported. The square size indicates the relative weight of a study in the analysis and the lines indicate the range of the confidence interval.

Discussion

Our current data have provided initial evidence that independent (vs. interdependent) SC is positively associated with resting state alpha power. Although prior work speculated that such a link should exist (Bai et al., 2016; Knyazev, 2013; Knyazev et al., 2012; Northoff, 2016), no direct evidence has been provided. Furthermore, this association was reliable while the eyes were closed, but not while they were open. We also observed the predicted cultural difference in resting state alpha power when comparing European Americans vs. East Asians (i.e., Japanese, Study 2b). However, this effect was only reliable in the eyes open condition and was not observed in a comparison of European Americans vs. Taiwanese (Study 2a).

The SC Effect on Resting Alpha Power

The association between SC and resting alpha power observed here is consistent with prior evidence linking SC to DMN activity. For example, Li et al. (2018) showed that for those with higher SC scores, the DMN showed stronger functional connectivity with other regions of the brain as well as greater within-DMN connectivity. Wang et al. (2013) obtained a similar result reporting that strength of within-DMN functional connectivity was moderated by SC. Because alpha power is systematically correlated with DMN activity (e.g., (Mantini et al., 2007; Marino et al., 2019)), we might therefore expect the observed correlation between SC and alpha power. Additionally, alpha power at rest has been shown to be stable for over a decade (Tenke et al., 2018). Taken together, this suggests that like functional connectivity (Laumann et al., 2015; Markett et al., 2018), alpha power may be a correlate of a stable architecture which partially shapes the activity of day-to-day behaviors, many of which are influenced by SC.

We hypothesize that the association between SC and spontaneous resting state activity observed in the present studies is due to the residue of prior experience. Kitayama and Salvador (2017) posit that daily experience consists of various tasks embedded within a larger cultural context. Whereas some tasks (e.g., self-expression and pursuit of personal goals) are believed to promote the view of the self as independent, others (e.g., adjustment to social norms and attunement to various situational cues) are thought to reinforce the view of the self as interdependent. Thus, those with strong independent (vs. interdependent) SC may be expected to engage more frequently and recurrently in tasks associated with independence (vs. interdependence). Repeated engagement in these culturally-influenced tasks may then be expected to gradually change more stable aspects of the brain such as functional connectivity and volume in relevant areas of the brain via neuroplasticity. This general possibility has long been recognized in animal research (e.g. (M. C. Diamond et al., 1964)). More recently, evidence has also been provided for neuroplasticity in humans (see Kitayama & Salvador, 2017, for a review). In the past few years, this concept has also been extended to cross-cultural neuroscience. For instance, recent work has shown that independent (vs. interdependent) SC is correlated with an increase in the volume of specific regions of the DMN, including the orbito-frontal cortex (Kitayama et al., 2017; Yu et al., 2019) and the medial prefrontal cortex (F. Wang et al., 2017). It is therefore plausible that the association between SC and resting state alpha power, as demonstrated in the current paper, is the now stable result from years of gradual changes to relevant structures in the brain. These changes may be promoted, in part, by one’s SC.

The relationship between resting alpha power and the SC difference score was also observed with the independent SC score alone. This evidence suggests that the self's propensity toward independence makes the personal self more salient. Interestingly, interdependent SC showed the inverse relationship with the resting alpha power. It therefore appears that interdependent SC might make the personal self less salient. For example, those high in this SC may think less about personal matters such as private thoughts and feelings. They may even actively inhibit them. Given its statistically marginal status, interdependent SC's effect must be interpreted with caution. Nevertheless, consistent with such a possibility, Kraus and Kitayama (2019) found that interdependent SC significantly predicts the competence in down-regulating emotional arousal among East Asians. Likewise, interdependent SC is related inversely to the gray matter volume of the orbitofrontal cortex – the area known to implicate various functions (e.g., goal pursuit and value-based decision making) that constitute the personal self (Kitayama et al., 2017; Yu et al., 2019).

Cultural Variation in Resting Alpha Power

While the relationship with SC was reasonably robust in our studies, the comparison of resting alpha power between European Americans and East Asians (Taiwanese in Study 2a and Japanese in Study 2b) yielded inconsistent results. There were no significant differences in resting alpha power between European Americans and Taiwanese in Study 2a, even though European Americans were both more independent and less interdependent than Taiwanese. The hypothesis received some support in Study 2b, which showed relative alpha power was stronger for European Americans (who are more independent) than for Japanese (who were less independent). However, whereas SC's effect on relative alpha power was observed in the eyes closed condition, the American vs. Japanese cultural difference was observed only in the eyes open condition.

Thus, more research is needed to investigate the possible cultural variation in the neural correlates of processes related to self-generated thought during rest. One drawback of resting state data might be that activity during the resting period is too unconstrained, and thus suffers from increased noise. As a consequence, the resting state oscillatory alpha power could be the result of many underlying processes, including, but not limited to, the salience of the personal self. This is supported by the results of the current study where the relationship between SC and alpha was stronger in the eyes closed condition, the condition where alpha power overall is much greater (and thus the signal of relative alpha power is less noisy). It is also supported by past work showing that individuals who are higher in trait anxiety show greater alpha power at rest (Ward et al., 2018). Since East Asians tend to be more apprehensive of evaluation by others than European Americans (Kitayama & Park, 2014), this could partially explain why no difference in resting alpha was observed between Taiwanese and Americans in Study 2a. One possibility to address this issue is to test biculturals, for example those with bona fide European American and Asian cultural identities. In this case, we would expect that their resting state alpha power would be greater if their European American identity (vs. Asian) was made salient by priming (Hong et al., 2000). Bicultualism is increasingly commonplace in the globalizing world and can offer an important opportunity for theoretical refinement.

What is Self-Generated about Self-Generated Thought?

Future cross-cultural research in this area may benefit from a more precise definition of the culturally-relevant constructs related to self-generated thought. Broadly, all cognition and affect that arises in the course of information processing is generated by the brain. In this sense, all cognitions and affects are self-generated. However, in line with previous research (Andrews-Hanna et al., 2014), here we refer only to a subtype of cognitions and affects that are generated independently from external stimulation. These thoughts may therefore be more likely to be experienced as being owned by the personal self. Nevertheless, the physical absence of external stimulation may not necessarily entail the lack of cognitive representations of external stimuli. More often than not, all of us do think about, often quite concretely, other people or events. These external stimuli, as internally represented, may be perceived as the driver of our mental activities. In all likelihood, the process of categorizing mental activities as either generated (and owned) by the self or those evoked by external stimulation is thus multifaceted and dynamically contingent on various factors. Such a process has been extensively studied for overt actions (Haggard, 2019). However, this work has yet to be extended to covert, mental states and thoughts. At present, it is unknown whether the recognition of agency is mediated by the same brain mechanisms for both overt behaviors and thoughts.

Another important implication of our findings stems from the incorporation of salient self-generated thoughts and feelings into autobiographical memory. Consistent with the hypothesized dominance of self-generated thought in Western, independent cultures compared to East Asian, interdependent cultures, autobiographical memories have been found to be more elaborate and extend further in the past for Americans than for East Asians (Rubin, 2020; Q. Wang et al., 2010; Q. Wang & Conway, 2004). It is thus an outstanding empirical question whether oscillatory power in the alpha band at rest correlates with the degree to which one's autobiographical memories are elaborate and extensive.

Limitations and Conclusions

We note several limitations of the current work. First, we did not have participants report the content of their thoughts during their resting state recordings. Thus, we cannot directly infer that independent SC leads to the occurrence of more thoughts related to the self during the resting period. Future work must supplement the EEG recording with self-report measures of the content of thoughts and feelings during the resting state.

Second, our findings between SC and alpha power are correlational. Future work may experimentally manipulate independence and interdependence to see how it influences both self-referential thought and alpha power. Further, it would be quite informative to directly manipulate the magnitude of alpha power during rest (e.g., via neurostimulation) to see if this may increase one's independent construal of the self.

Third, prior work suggests that the aperiodic signal (power law exponent) also encodes self-relevant information (Wolff et al., 2019). However, we did not find support for this in the current study (see *Supplementary Results*). Here, we focused on the alpha band because of prior evidence that it is related to both internally oriented attention (Benedek et al., 2014; Compton et al., 2019) and DMN activity (Mantini et al., 2007; Marino et al., 2019). Despite the observed reliable association between SC and alpha power here, many more neural signals aside from alpha inevitably carry self-relevant information. Indeed, here the observed effect size of the relationship between total alpha power (which includes aperiodic power) and SC (see supplemental analyses) was greater than the same effect size for oscillatory power alone (see Figure 4). Thus, it is possible that some element of the observed aperiodic signal is also relevant to SC. Future work must further investigate the various other brain mechanisms that give rise to self-relevant information and any possible cultural variation in self-construal.

Despite these limitations, we have provided the first evidence that the construal of the self as independent (vs. interdependent) is systematically related to the neural correlates of processes underlying self-generated thought at rest. Our finding accords some empirical plausibility to an age-honored claim by William James that the experience of the personal self is actually just the stream of consciousness itself. It therefore helps demystify the otherwise amorphous notion of the self. More importantly, our work shows the potential for a stable neural marker associated with the personal self, thereby adding a new tool for further investigation of the relationship between culture and the self.

Study 3[4]

Self-enhancement (the tendency to overestimate the self's worth) is one of the most robust findings in social psychology. This effect has been repeatedly observed in European American samples (Kruger & Dunning, 1999; Taylor & Brown, 1988). However, it is less robust among East Asians (Heine et al., 1999). Sometimes, East Asians even show the opposite tendency of self-criticism (Karasawa, 2001; Kitayama et al., 1997). At present, it is not clear what mechanisms might account for this cultural variation in self-evaluation. Here, we propose that self-enhancement (vs. criticism) is mediated by a bias in spontaneous cognition that links positive (vs. negative) experiences to the self. This cognitive bias, in turn, may support cultural norms and values of independence (vs. interdependence) (Markus & Kitayama, 1991). These biases in self-referential processing should give rise to subjectively authentic self-evaluations that are either inflated (enhancement) or depreciated (criticism). To test this hypothesis, we examined an electrocortical index of internally oriented attention during self-referential processing.

Self-Referential Processing Hypothesis of Self-Enhancement

European American cultures value the independence of the self from others (Markus & Kitayama, 1991). Independence requires confidence, optimism, and high self-esteem (Heine et

[4] This study is based on: Salvador, C.E., Kraus, B.T., Kamikubo, A., Karasawa, M., Hu, J.F. & Kitayama, S. (revise & resubmit) Self-referential Processing Accounts for Cultural Variation in Self-Enhancement vs. Criticism: An Electrocortical Investigation, *Journal of Experimental Psychology:General*.

al., 1999). Such an emphasis on the self's positive attributes may make such attributes central to ones' self-definition. Through socialization, caretakers draw the child's attention to their strengths rather than weaknesses, and as a consequence, children may gradually internalize the habit of elaborating on their positive attributes (Kitayama & Salvador, 2017; Vygotsky, 1980). Eventually, those socialized in European American contexts may spontaneously contemplate their positive self-attributes, confirm them, and express them a culturally appropriate manner. This self-referential processing may then become a psychological "habit" (W. Wood & Neal, 2007), thereby producing robust self-enhancing tendencies.

In contrast, East Asian cultures value the interdependence of the self with others (Markus & Kitayama, 1991). These cultures do not place much value on the self's positive attributes. Instead, they place a greater emphasis on one's ability and willingness to adjust and conform to social norms (Heine et al., 2001). For example, parents may encourage the child to be attentive, considerate, and to abide by social expectations. They rarely try to boost their child's self-esteem for the sake of doing so (Heine et al., 1999). Instead, they often draw the child's attention to his or her shortcomings and failures since doing so is thought to help the child fit in and abide by social norms. Hence, those socialized in such cultures may acquire a self-referential processing bias that favors attention to the self's negative attributes.

Using EEG to Assess Self-Referential Processing

To test the self-referential processing hypothesis, we turned to electroencephalography (EEG) and focused on the spectral power of the upper-alpha band (Salvador, Kraus, et al., 2020). When people read about a social situation and learn the outcome of the event, they will attend to the description. This externally-oriented attention is captured by a suppression of the α band (8-13 Hz) (Benedek et al., 2014; Klimesch, 2012; W. J. Ray & Cole, 1985). This effect is particularly pronounced in its upper half (10.5-13 Hz) (Salvador, Kraus, et al., 2020). However, when individuals link the outcome to their self-concept and elaborate on it, there is a competing demand to engage in self-referential thought. Support for this possibility comes from studies showing that alpha power assessed at parietal-occipital regions often increases during tasks involving inwardly-oriented attention, such as self-reflection (Bai et al., 2016; Knyazev, 2013; Knyazev et al., 2012, 2015) and mind-wandering (Compton et al., 2019). Accordingly, the demand for endogenous self-referential processing may be expected to require some inward allocation of attention and thus reduce upper-alpha band suppression.

Present Study

In the present work, we drew on an earlier study by Kitayama et al. (1997). In this study, participants read a series of social situations. In each situation, the protagonist experienced either a success or a failure. Participants then reported (i) how much they felt their self-esteem would increase in success situations and (ii) how much they felt their self-esteem would decrease in failure situations. The results showed that European Americans were significantly self-enhancing. These participants estimated that the increase in their self-esteem during success situations would outweigh the decrease in failure situations. In contrast, Japanese showed the opposite tendency and were significantly self-critical. We aimed to show that the foregoing cultural variation in self-evaluation would extend to a comparison between European Americans and Taiwanese.

More crucially, we hypothesized that the key mechanism for self-enhancement is the amount of self-referential processing during episodes when the self experienced a success (vs. failure). Self-referential processing unfolds over time and requires effortful internal processing (Northoff, 2016). To capture a correlate of this deliberate internal processing, we measured upper-alpha band power during the processing of success and failure situations. We expected that upper-alpha band suppression (which would occur during the processing of the outcome) would be reduced (indicating increased internally-oriented attention during self-referential processing) when European Americans process the self's successes (vs. failures). In contrast, Taiwanese would show a reduction of upper-alpha band suppression while processing the self's failures (vs. successes). Our analysis implies that the cultural variation in the processing of the self's successes (vs. failures) would account for the cultural variation in self-enhancement (vs. criticism). This prediction was tested with a mediation analysis. To test whether the foregoing predictions would be unique to the judgment about the self, we included a condition where participants made the same judgments about another hypothetical person's self-esteem.

In addition, we explored two additional questions. First, we hypothesized that self-enhancement is an integral part of holding an independent self. We thus tested whether independent and interdependent self-construal (SC) might be related to both self-referential processing of the self's success attributes and self-enhancement. Second, we tested whether the effects would mirror a marker of self-enhancement proposed by Cai et al. (2016), the late positive potential (LPP). The amplitude of the LPP has been shown to be sensitive to infrequent (and thus "surprising") events (Cacioppo et al., 1993, 1994). We examined whether people, especially European Americans, might have larger LPPs when they experienced a supposedly "unexpected" failure (vs. supposedly "expected" success) (Cai et al., 2016).

Method

Participants

38 European American young adults in the U.S. and 45 Taiwanese young adults in Taiwan participated in the study. All American participants were right-handed, reported being of

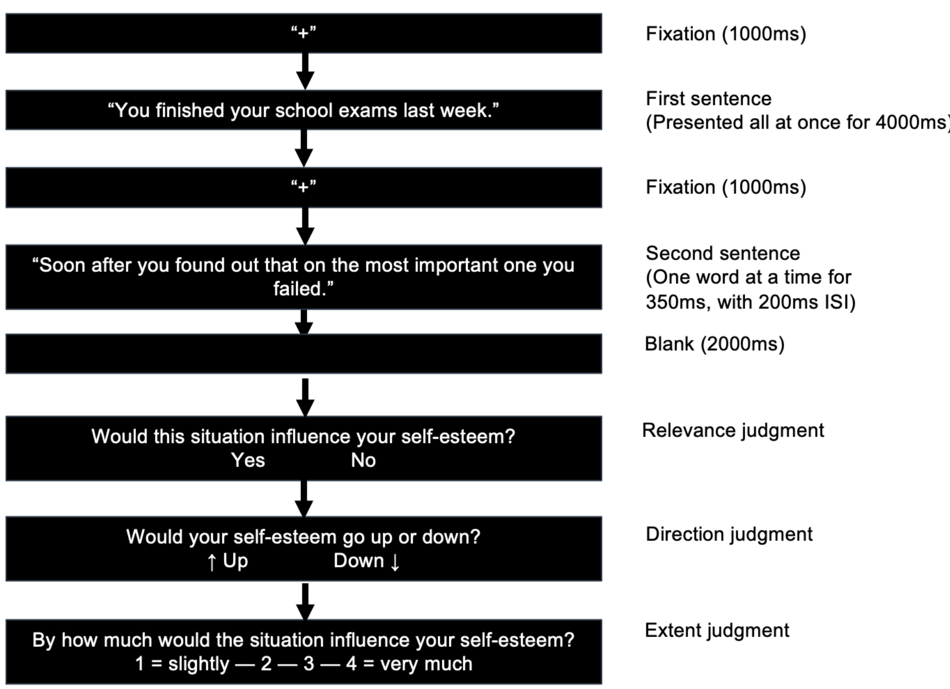
European-American descent, and were born and raised in the US. They were compensated with course credit for their time. All Taiwanese participants were right-handed, reported being Asian born and raised in Taiwan. They were compensated with NT$ 420 (approximately $14). Of the 38 American participants, 6 were excluded for: not finishing data collection (1), reporting neurological issues (2), and excessive artifacts in their EEG recordings (3). This left 32 participants with usable data (20 Female, M_{age} = 18.97, *SD* = 1.09). Of the 45 Taiwanese subjects, 13 were excluded for either having excessive artifacts in their EEG recordings (11) or for use of psychoactive medications (2). This left 32 subjects with usable data (15 Female, M_{age} = 21.78, *SD* = 3.13). An earlier study successfully used upper-alpha suppression as a measure of external attention with N=30 in each experimental condition (Salvador, Kraus, et al., 2020). We set the same target N as that prior study, which was 50% more participants than most prior studies on self-enhancement (e.g., Cai et al., 2016). Materials, scripts for data-analysis, de-identified behavioral and EEG data of the present study are available at: https://osf.io/ahwe7/?view_only=07bd652a8da94d64a73ed2a55b170d81.

Procedure

Participants were told that they were recruited for a study on self-evaluation. Upon arrival at the lab, participants filled out pre-screening questions on medication use, history of seizure disorders, head injury, ethnicity and handedness. Participants were seated approximately 60 cm from a color computer display while the EEG was recorded. After the EEG was set up, participants completed a resting state task reported elsewhere. Participants then performed a self-esteem judgment task, wherein they read a two-sentence story describing a situation that varied in the Outcome (success vs. failure) and the Protagonist (self vs. other) of the situation. Then they were asked to make a series of judgements about the protagonist's self-esteem. Before the

ERP task, participants completed 4 practice trials to learn the procedure and asked any questions they had. The task was modeled after an earlier self-report study on self-esteem (Kitayama et al., 1997). A random subset of 40 situations were selected from Kitayama et al., (1997) and adapted for this study. A total of 160 stimuli were created out of these 40 situations by manipulating the Protagonist (self and other) and Outcome (success or failure) of the situation. The stimuli were presented in a randomized order. They were presented with a restriction that a variation of all 40 situations was shown in each of the 4 experiment blocks and no situations were repeated on consecutive trials. We manipulated the Protagonist (self or other) by asking participants to either imagine themselves or a stranger (e.g., Alyssa) in the situation. We varied the Outcome (success or failure), by changing only the last word of the sentence. Aside from changing the words specifically manipulating the protagonist or outcome, the sentences in all of the conditions were kept identical. All stimuli were presented in English for US participants and in Chinese for Taiwanese participants and are listed in the Supplement.

Figure 7. Trial structure of the current work.



As shown in Figure 7, on each trial of the ERP task, a fixation cross was presented for 1000ms, followed by an introductory sentence describing a situation. Participants imagined either the self or another person as the protagonist in the situation (e.g., “You/Alyssa finished your school exams last week”). The introductory sentence was presented for 4000ms. After the introductory sentence, another fixation cross was presented for 1000ms. This was immediately followed by a second sentence, which described either a success or failure for the protagonist (“Soon after you/she found out that on the most important one you/she failed/passed”). Unlike the introductory sentence, the second sentence was presented one word at a time, every 350ms with a 200ms inter-stimulus-interval (ISI). So as to eliminate any motor artifacts on the recording of the critical stimulus, participants waited 2000ms after the completion of the last phrase of the second sentence before being asked to judge how the situation would influence either their own or the other person’s self-esteem.

The self-esteem judgement involved several steps. First, participants indicated whether the protagonist’s self-esteem would change based on the described situation with a Yes/No judgement. If they indicated Yes, they would then be prompted to indicate whether the protagonist’s self-esteem would increase or decrease. Then, they would indicate the magnitude of the protagonist’s change in self-esteem by using a 4-point rating scale (1 = Slightly and 4 = Very much).

After the self-esteem judgment task, the participants filled out a packet of questionnaires. The packet included a modified version of the Singelis Self-Construal (SC) scale (Kitayama & Park, 2014), composed of a 10-item Independent self-construal subscale (αs = 0.742 and 0.801 for Americans and Taiwanese, respectively, “I do my own thing regardless of what others think”) and a 10-item Interdependent SC subscale (αs = 0.728 and 0.531 for Americans and Taiwanese, respectively, “I will sacrifice my self-interest for the benefit of the group I am in.”). These judgments were made on a 5-point rating scale (1 = Doesn’t describe me at all, 5 = Describes me very much). The two SC scales were centered at the grand mean prior to analyses.

Behavioral Analysis

A logistic generalized linear mixed model (GLMM) was used to analyze the binary choice of each situation as relevant or not relevant to self-esteem (Jaeger, 2008). Trials, the level-1 variable, were subsumed under two within-subjects (level-2) variables (Condition and Outcome). The level-3 variables included two between-subjects variables (Culture and Gender). The extremity of SE change was also analyzed in a mixed linear model (MLM) framework (Baayen et al., 2008). For both analyses, we first attempted to fit the maximal model which included random intercepts for each subject as well as all 160 trials, and random slopes modeling the outcome and protagonist of the situation and their interaction for each subject (Judd et al., 2017). This model was too complex to converge in all cases, so the interaction slope was dropped from the subject term. This further reduced model did not converge for the impact measure, thus we dropped the random slope for the protagonist from the model and were left with random intercepts for subjects and trials and a random slope for the outcome of the situation for each subject. In our main analysis, we drew on the trials for which both self-report data and usable EEG data were available (i.e. trials where participants indicated a self-esteem change consistent with the outcome and no EEG artifacts were present). For the analysis of the self-report data, we performed a subsidiary analysis using all the trials. The results did not differ unless noted otherwise.

EEG Data Recording

In the US group, the EEG recording was taken with 32 scalp channels using silver chloride electrodes with a BioSemi Active Two system configured to the 10–20 electrode system. The EEG scalp electrodes for the US group were: Fp1, Fp2, F7, F3, Fz, F8, F4, FCz, FC1, FC5, FC2, FC6, T7, C3, Cz, C4, T8, CP5, CP1, CPz, CP2, CP6, P3, Pz, P4, O1, Oz, O2, P7, P8, PO3, PO4. EEG data was recorded at 512 Hz. The electrooculogram was monitored using bipolar VEOG and HEOG electrodes. Electrodes were also placed at the left and right mastoids. Impedances during data collection were kept under 10 kΩ and acquired with an online reference unique to the Active Two system. For the Active Two system, the online filter is low-pass only and performed by the ADC's decimation filter with a 5th order sync response with a –3 dB point at 1/5th of the selected sample rate.

In the Taiwanese group, the EEG was recorded using 30 scalp channels from a Neuroscan system in DC mode with a gain of 19 (range: 263 mV) using a 32 bit ADC and configured to the 10–20 electrode system. The EEG scalp electrodes for the Taiwanese group were: Fp1, Fp2, F7, F3, Fz, F8, F4, FT7, FC3, FCz, FC4, FT8, T3, C3, Cz, C4, T4, TP7, CP3, CPz, CP4, TP8, T5, P3, Pz, P4, T6, O1, Oz, O2. An online band-pass filter was used during recording (.1-200 Hz) and the data were online referenced to the left mastoid. The recorded EEG was digitized at 1000 Hz. The electrooculogram was monitored using bipolar VEOG and HEOG electrodes. Electrodes were also placed at the left and right mastoids. Impedances during data collection were kept under 10 kΩ.

EEG Data Processing

For the US group, the EEG data was first downsampled to 256 Hz. Then, the data underwent an offline band pass filter of .1 to 20 Hz and scalp electrodes were referenced digitally to the averaged mastoids. The recorded data was then segmented into epochs of 200ms before the onset of the final word of the second sentence and 1000ms after the onset. Ocular artifacts were corrected using a variation of the algorithm outlined by Gratton et al. (1983). Automatic artifact detection was then performed on the data. Trials were rejected if for any scalp electrode the maximum peak-to-peak voltage exceeded 100μV within a 400ms moving window with 100ms steps that moved across the length of each epoch. Trials were also rejected if at any scalp electrode the recorded EEG fluctuated more than 30μV between two sampling points, or if any scalp channel had little to no activity (+/- 1μV) over the entire length of the trial.

For the Taiwanese group, the EEG data was first downsampled to 256 Hz. The data then underwent an offline low pass filter of 20 Hz and the scalp electrodes were re-referenced digitally to the averaged mastoids. The same artifact correction and rejection criteria were used for the US and Taiwanese EEG data. Participants who had less than 50% of usable trials remaining in any condition were excluded from data analysis.

Measurement of Upper-alpha Suppression

To measure event-related upper-alpha activity, a time frequency-analysis (TFA) was used (M. X. Cohen, 2014). First, we created a data segment longer than the time period of interest to perform a TFA with a moving window approach. To do so, we mirrored the data (M. X. Cohen, 2014). This involves duplicating the original data segment, reversing it along the x-axis (time), and attaching it to both ends of the original epoch. This allowed us to create a larger EEG data segment (-4043 to 4742ms) to avoid artifacts known as edge artifacts in the TFA decomposition (Salvador, Kraus, et al., 2020). To decompose the signal, we used complex Morlet wavelets (M. X. Cohen, 2014). The wavelets were 3 cycles wide at the lowest frequency (.5 Hz) and were gradually reduced in size to 24 cycles wide at the highest frequency (20 Hz). We then extracted 313 log-spaced frequencies between .5 and 20 Hz utilizing zero-padding to a factor of 8. For each trial, the baseline was defined as the 200ms window prior to the onset of the stimulus. These baseline power values were subtracted from the spectral power during the critical window. To extract upper-alpha, we averaged the event-related spectral perturbation (ERSP) between 200ms and 700ms post-stimulus onset in the 10.5 – 13Hz frequency range. A decrease in upper-alpha, known as upper-alpha suppression would indicate greater externally-oriented attention (Klimesch, 2012). Conversely, an increase in upper-alpha power would indicate more internal attention, such as when people engage in self-referential thought (Knyazev, 2013).

Results

Behavioral Results

Self-construal. Interdependent and independent SC scores were assessed using a modified version of the Singelis self-construal scale (Kitayama & Park, 2014). As expected, Americans were more independent than Taiwanese (M = 3.86 vs 3.48), $t(62) = 2.66$, $p = .010$, $d = .66$. Conversely, Taiwanese were more interdependent than Americans (M = 3.51 vs. 3.78), $t(62) = -2.36$, $p = .021$, $d = .59$.

Proportion of situations judged to be relevant. The binary decision of whether self-esteem would be influenced or not was first logit-transformed and analyzed within a generalized linear mixed model (GLMM), which showed a significant 3-way interaction involving Protagonist, Outcome, and Culture, $z = -2.27$, $p = .023$[5], $d = .28$. As shown in Figure 8-A, success situations were more likely to be chosen as relevant only in one of the three cells (i.e., Americans in the self-judgment condition). In this condition, a greater proportion of success

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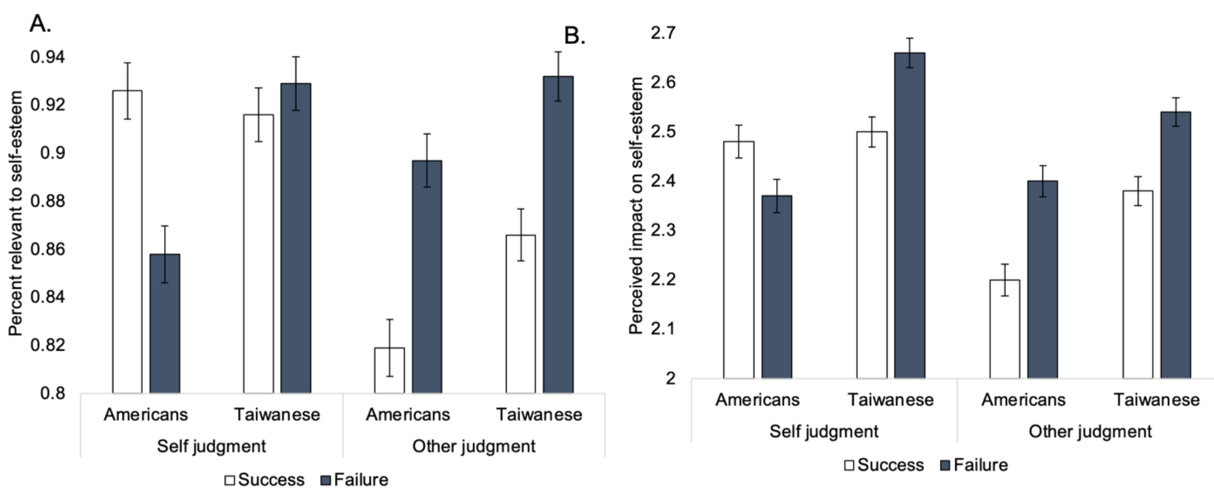
[5] As there is no straightforward way to calculate an effect size for a z-test in this context, these effect sizes were calculated assuming a t-distribution and an N of 64

situations were judged as relevant than failure situations, $z = 4.00$, $p < .001$, $d = .50$. This effect was reversed for Taiwanese in the same condition, although the effect of Outcome was negligible, $z = -.873$, $p = .383$, $d = .11$. In the other-judgment condition, both Americans and Taiwanese reported that a larger proportion of failure situations were relevant to their self-esteem than success situations, $z = -3.58$, $p < .001$, $d = .45$ and $z = -4.36$, $p < .001$, $d = .55$, for Americans and Taiwanese, respectively. Consistent with the pattern observed here, two 2-way interactions, Culture x Outcome and Protagonist x Outcome, proved significant, $z = 2.91$, $p = .004$, $d = .36$ and $z = 5.35$, $p < .001$, $d = .67$, respectively.

Figure 8. *Self-reported ratings on the percent of situations that were judged to be relevant to self-esteem (A), and how impactful the situations were on self-esteem (B). The bars represent the average across all the situations with analyzable data that differed in Outcome (success or failure), Protagonist (self or other), and Culture (Americans and Taiwanese).*



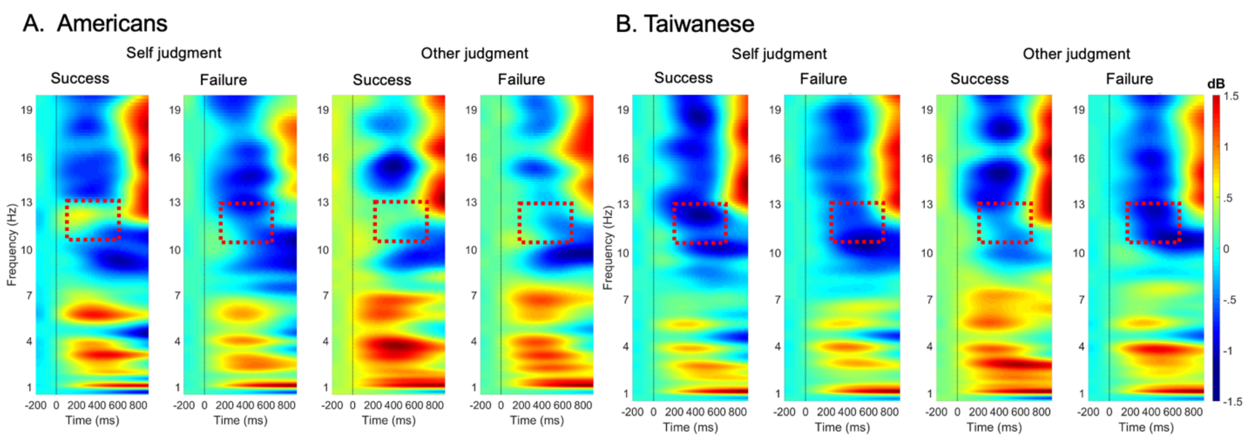
In addition, there was a marginal Gender x Outcome interaction, $z = -1.89$, $p = .059$, $d = .24$. Women were significantly more likely to choose failures than success as relevant to their self-esteem (Ms = 0.906 and 0.864), $z = 2.91$, $p = .004$, $d = .36$. There was no such effect for men, (Ms = 0.907 and 0.907), $z = -.003$, $p = .998$, $d < .001$. This effect is a partial replication of an interaction observed by Kitayama et al. (1997).

When the analysis included the all trials, including those that generated unusable EEG data, the 3-way interaction did not reach statistical significance, $z = -1.26$, $p = .208$, $d = .15$. However, the pattern remained the same. The self-enhancement effect for Americans in the self-judgment condition was still observed, $z = 3.26$, $p = .001$, $d = .38$. This effect was still not present for Taiwanese, $z = -.440$, $p = .660$, $d = .05$. Finally, the higher likelihood of choosing failure (vs. success) situations as relevant to another person's self-esteem was also reliable in both cultures, $z = -3.67$, $p < .001$, $d = .946$ and $z = -5.39$, $p < .001$, $d = .67$.

Extremity of SE change. The extremity of SE change was also analyzed using a mixed linear model (MLM), which showed a significant 3-way interaction involving Protagonist, Outcome, and Culture, $F(1, 5725.7) = 5.41$, $p = .020$, $d = .03$. The pertinent means are shown in Figure 8-B. As in the analysis on the proportion of relevant situations, the 3-way interaction was driven by Americans in the self-judgment condition. In this condition, Americans tended to report that successes would impact their self-esteem more than failures, although this outcome effect was statistically marginal, $t(321.24) = 1.93$, $p = .055$, $d = .11$. In all the three remaining cells, the Outcome effect was reversed. To begin, Taiwanese in the self-judgment condition reported that failures would impact their self-esteem more than successes, $t(334.81) = -1.99$, $p = .047$, $d = .11$. Thus, whereas Americans showed a marginal tendency toward self-enhancement (by judging successes to be more impactful than failures), Taiwanese showed a significant tendency toward self-criticism (by judging failures to be more impactful than successes). In the other-judgment condition, both Americans and Taiwanese reported that failures would impact another person's self-esteem significantly more than successes, $t(295.01) = -3.12$, $p = .002$, $d = .18$ and $t(304.49) = -2.92$, $p = .004$, $d = .17$ for Americans and Taiwanese, respectively. Consistent with this pattern, the Outcome x Protagonist interaction proved significant, F(1, 6401.9) = 12.57, $p < .001$, $d = .04$. There was no Gender effect, either as the main effect or as an interaction with Outcome, $F(1, 59.8) = .53$, $p = .468$, $d = .09$ and $F(1, 57.7) = .171$, $p = .681$, $d = .05$, respectively.

When the trials that had unusable EEG data were added to the analysis, the 3-way interaction did not reach statistical significance, $F(6455.2) = 2.61$, $p = .106$, $d = .02$. The reason for this is that both self-enhancement and criticism for Americans and Taiwanese in the self-judgment condition were no longer reliable, $t(298.6) = 1.19$, $p = .236$, $d = .07$ and $t(313.5) = -1.63$, $p = .103$, $d = .09$, respectively. The pattern in the other-judgment condition remained the same. Both Americans and Taiwanese judged failures to be more impactful on another person's self-esteem than successes, $t(277.7) = -3.42$, $p < .001$, $d = .20$ and $t(287.37) = -3.44$, $p < .001$, $d = .20$, respectively.

Figure 9. The time frequency plot at Pz. The time window of interest for the upper-alpha (10.5-13Hz) range is marked with a red rectangle. The average change in power across subjects is plotted for all frequencies referenced to a 200ms pre-stimulus baseline as a function of Outcome (success or failure) and Protagonist (self or other) for European Americans (A) and Taiwanese (B).

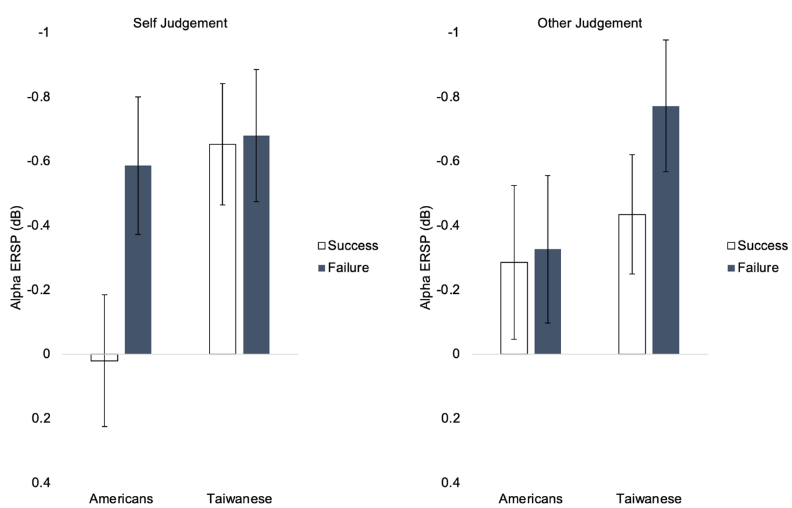


Upper-alpha Suppression

The TFA revealed a systematic change in the power of the upper-α-band, relative to the preceding baseline (between -200ms pre-onset and the onset of the last word). Figures 9-A and B show this change in each of the four conditions (Protagonist x Outcome) for Americans and Taiwanese, respectively. The decrease of upper-α power (between 10.5Hz and 13Hz), indicated by the cooler colors in the plot, is evident at approximately 200-700ms post onset of the last word. This effect, called upper-α suppression, suggests that attention was externally allocated during this time period. In the present experiment, an internal allocation of attention was most likely related to processing and integrating the outcomes (success or failure) of each situation. As can be seen in Figure 9-B, the upper-α suppression occurred in all of the conditions for Taiwanese. However, the effect appears reversed itself in the success/self-judgment condition for Americans (as indicated by the warmer colors in this plot).

To perform a statistical test on the observed pattern, we extracted the average upper α-band power at 200-700ms post onset of the last word. The average upper α-band power was then submitted to an ANOVA with two within-subjects variables (Protagonist and Outcome) and two between-subjects variables (Culture and Gender). This analysis yielded a significant 3-way interaction involving Protagonist, Outcome, and Culture, $F(1,61) = 5.14$, $p = .027$, $\eta_p^2 = .078$.

Figure 10. *The Event-related Spectral Perturbation (ERSP) in the upper alpha band is shown for Americans and Taiwanese for each Protagonist (self or other) and Outcome (success or failure). Smaller numbers on the y-axis indicate greater suppression of upper alpha power (more externally-oriented attention).*

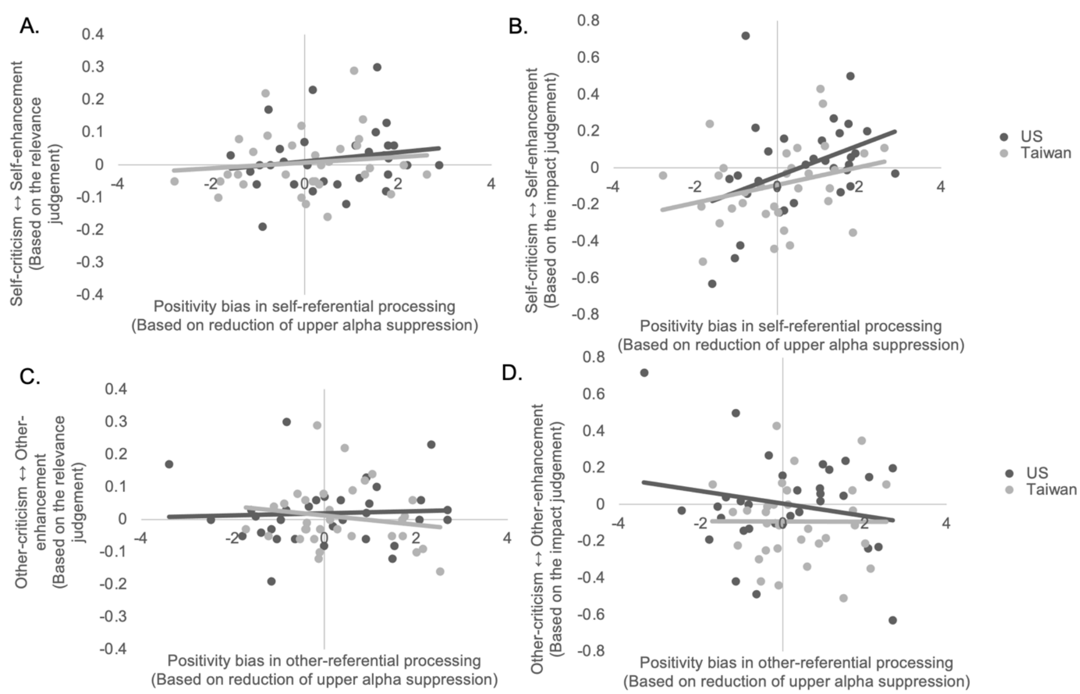


As shown in Figure 10, Americans showed significantly less alpha suppression, indicative of increased internally-oriented attention in the success-ending/self-judgment condition, compared to the failure-ending/self-judgment condition, $F(1,61) = 8.54$, $p = .005$, $\eta_p^2 = .123$. Furthermore, Americans showed significantly less alpha suppression to success information about the self than Taiwanese, $F(1,61) = 6.34$, $p = .014$, $\eta_p^2 = .094$. The Culture x Outcome interaction was significant in the self-judgment condition, $F(1,61) = 4.29$, $p = .042$, $\eta_p^2 = .066$. The corresponding interaction was negligible in the other judgement condition, $F(1,61) = 1.10$, $p = .298$, $\eta_p^2 = .018$. Gender had no effect, either as the main effect or as an interaction with Outcome, $F(1,61) = .099$, $p = .754$, $\eta_p^2 = .002$ and $F(1,61) = .028$, $p = .869$, $\eta_p^2 = .000$, respectively.

Do Behavioral Indices of Self-enhancement Track the Reduction of the Upper-alpha Suppression?

To test the link between the processing the self's successes (as revealed in the reduction of the upper-alpha suppression) and self-enhancement, we first subtracted the upper-alpha band power in the failure/self-judgment condition from the corresponding value in the success/self-judgment condition. To quantify self-enhancement vs. criticism, we computed both (i) the relative proportion of success (vs. failure) situations that were judged relevant to one's self-esteem and (ii) the relative impact of success (vs. failure) situations on self-esteem judgements for the self. Figures 11-A and B show the relationship in the self judgement condition between internally-allocated attention during successes of the self and the two indices of self-enhancement. As can be seen, the relationship between the reduction of upper-alpha suppression in the self-success (vs. failure) condition and self-enhancement was highly significant for the impact index of self-enhancement (Figure 11-B), $r(64) = .365$, $p = .003$. The correlation between alpha and self-enhancement did not significantly differ between the two cultural groups, $t(61) = .986$, $p = .338$, $d = .25$. A similar trend is evident for the proportion index of self-enhancement, but the relationship was statistically negligible, $r(64) = .155$, $p = .221$. We ran a comparable set of correlations in the other judgement condition by subtracting upper-alpha band power in the failure/other-judgment condition from the corresponding value in the success/other-judgment condition to create an index of other-enhancement. As shown in Figures 5-C and D, there was no significant correlation with either the percent relevance or impact on self-esteem for other judgements, $r(64) = -.028$, $p = .827$ and $r(64) = .034$, $p = .787$, respectively.

Figure 11. *The correlations between upper-alpha suppression in response to successes (vs. failures) and the two self-report indices of self-enhancement. The top panels (A, B) include the self judgement condition, and the bottom panels (C, D) include the other judgement condition. The self-report indices include perceived relevance of successes (vs. failures) to self-esteem (left) and perceived impact of successes (vs. failures) self-esteem (right).*

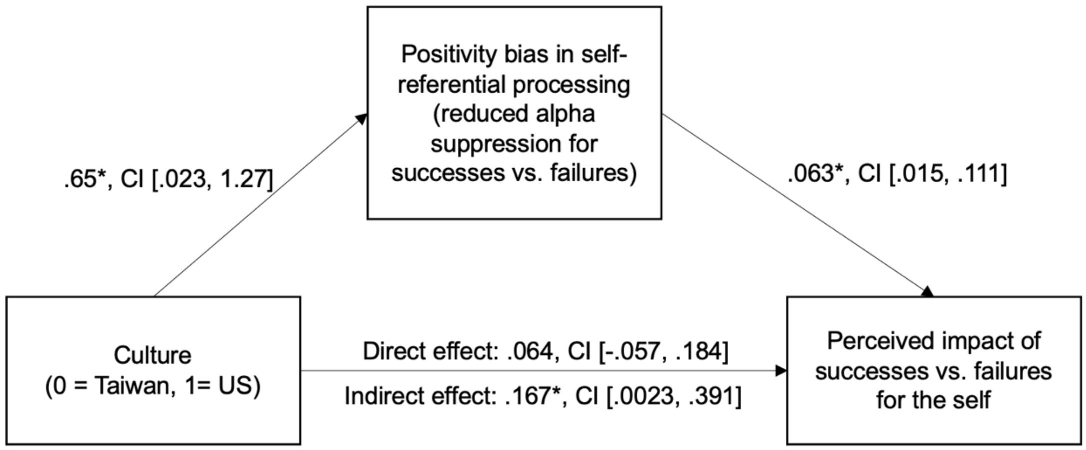


Mediation

In the previous sections we showed three links. First, Culture predicts the impact measure of self-enhancement (European Americans > Taiwanese). Moreover, Culture predicts the reduction of alpha suppression during the processing of the self's successes (vs. failures) (European Americans > Taiwanese). Third, self-enhancement tracked the reduction of alpha suppression during the processing of success (vs. failure) information about the self. This is consistent with the hypothesis that the cultural difference in self-enhancement (European Americans > Taiwanese) is mediated by the reduction of alpha suppression during the processing of the self's' successes (vs. failures).

To formally test this mediation, we used PROCESS model 4 (Hayes, 2017), with Culture as the predictor, self-enhancement as the dependent variable, and the reduction of alpha suppression as the mediator. As in all prior analyses we included Gender as a covariate. The total effect of Culture on self-enhancement did not achieve statistical significance, $t(61) = 1.71$, $p = 0.09$, $d = .22$. This is likely due to reduced statistical power with the aggregate analysis, since this effect was significant in a multi-level linear analysis that used the single-trial data and controlled for the variance associated with stimulus situations. Of importance, as shown in Figure 12, the indirect effect of Culture was mediated by the reduction of alpha suppression achieved statistical significance. Culture significantly predicted the reduction of upper-alpha suppression, which in turn predicted self-enhancement. Both of these two indirect paths proved statistically significant, $t(61) = 2.07$, $p = .043$, $d = .26$ and $t(61) = 2.63$, $p = .011$, $d = .33$, respectively.

Figure 12. *This model tests the indirect effect of Culture (0 = Taiwan, 1 = US) on self-enhancement through upper-alpha suppression by using a 95% confidence interval with 10,000 bootstrapped samples. The confidence interval for the indirect effect does not cross zero, indicating significant mediation. *p < 0.05.*



Effects of Self-Construal

We addressed two additional questions. First, we tested whether independent and interdependent SC might be associated with the processing of the self's successes (vs. failures) and self-enhancement. Relevant correlations are summarized in Table 4. Somewhat consistent with this expectation, independent SC was associated positively with the self-enhancement effect in the upper-alpha band. However, it was not associated with either of the behavioral measures of self-enhancement. Thus, even though independent SC predicted the positivity bias during self-referential processing, which in turn predicted self-enhancement, this construal did not predict self-enhancement. We will return to this effect in the discussion. Interdependent SC was associated positively with the proportion (%) measure of other-enhancement (choosing more success vs. failures situations as relevant to another's self-esteem), but it was not associated with any of other measures.

LPP

In the second analysis, we explored whether the LPP elicited from the last word in the second sentence was associated with self-enhancement. We found no evidence that the LPP was larger in the failure condition than in the success condition, regardless of the judgment condition (see Supplementary Information). Thus, our results did not replicate previous evidence implicating the LPP as a measure of a universal positivity bias (Cai et al., 2016).

Table 4. *Correlation coefficients for the relationship between Independent and Interdependent self-construal (SC) and the two measures of self enhancement and alpha. Correlations are for the full sample (collapsed across cultures). The indices are the difference scores for the success (vs. failure) conditions. The measures from left to right include the percent of situations relevant to self-esteem, the perceived impact on self-esteem, and changes in alpha power. Correlation coefficients in bold denote significant correlations.*

	Self judgment			**Other judgment**		
	Positivity %	Positivity impact	Positivity Alpha	Positivity %	Positivity impact	Positivity Alpha
Independent SC	0.063	0.022	**0.253**	-0.029	0.05	-0.197
Interdependent SC	0.173	-0.039	-0.106	**0.267**	-0.094	0.003

Discussion

Self-Enhancement, Self-Referential Processing, and Culture

In the present work, we showed that cultural variation in self-enhancement is explained in part by increased inwardly-oriented attention during self-referential processing of successes vs. failures. Compared to Taiwanese, Americans were more likely to link successes (vs. failures) to the self. In turn, this cognitive bias predicted self-enhancement, i.e., a greater perceived impact of the successes vs. failures on self-esteem.

Unlike Taiwanese, self-enhancement was also evident among European Americans in the measure of each situation's relevance to self-esteem. They chose a significantly larger proportion of success (vs. failure) situations as relevant to their self-esteem. This effect however, was not predicted by the EEG index of internal attention. This may be due to less information in this binary outcome variable versus the continuous measure of perceived impact. We speculate that relative to East Asians, European Americans may hold an optimistic belief that successes (rather than failures) are more relevant to the self (Heine & Lehman, 1995).

Negativity Bias in Social Perception

In the judgments of another's self-esteem, we found a reliable negativity bias. Both European Americans and Taiwanese judged a larger number of failure (vs. success) situations as relevant to another's self-esteem. Moreover, they estimated failure (vs. success) situations as more impactful on another's self-esteem. The negativity bias is quite pervasive in social perception and is thought to result from either the relative rarity of negative (vs. positive) information, the need to actively cope with negative (vs. positive) events, or both (Fiske, 1980; Ito et al., 1998). This negativity bias may therefore be a default in social perception.

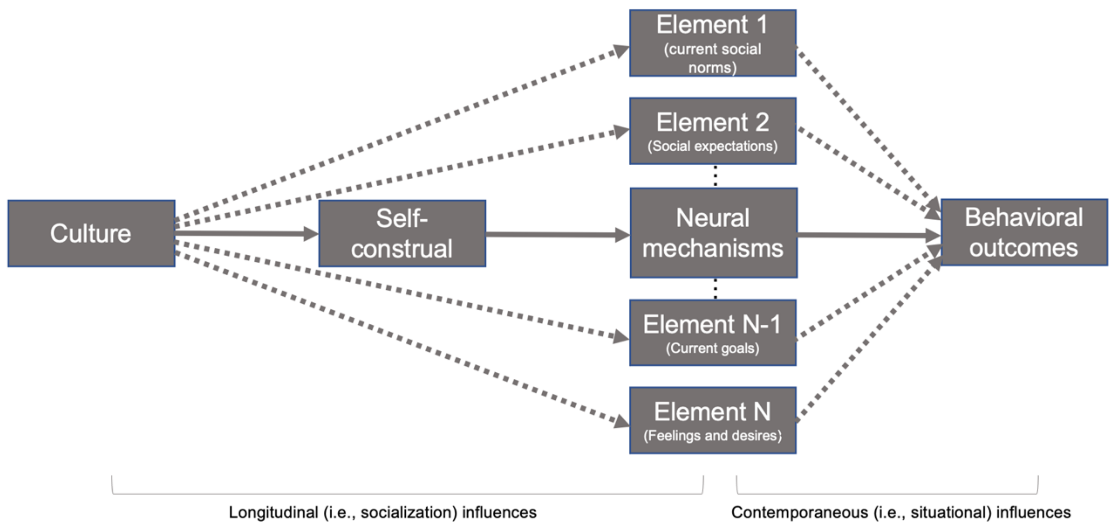
The pervasiveness of this negativity bias may explain why Taiwanese were self-critical. They responded to negative (vs. positive) information more strongly regardless of the target (self vs. other) in their impact judgments. Only European Americans showed a reliable positivity bias in self-referential information. This positivity bias appears to have overcome the negativity bias, thereby leading to self-enhancement. The current analysis clarifies why self-criticism is not always observed among East Asians. Many prior studies used comparative judgments between the self and others and found that European Americans judge the self as "better than average." This self-enhancement effect is typically attenuated or vanishes among East Asians (Heine et al., 1999). Interestingly, East Asians are rarely self-critical. That is, they do not judge the self to be less worthy than "average others." This result may be expected if negativity bias operates equally for the self and others.

Self-Construal

One subsidiary finding deserves scrutiny. We found that independent SC predicts a reduction of upper-alpha suppression in response to successes (vs. failures). Moreover, independent SC was significantly higher for Americans than Taiwanese. Given the positive association between the reduction of upper-alpha suppression and self-enhancement, we might expect a reliable association between independent SC and self-enhancement. This association, however, was negligible. Consistent with this finding, Kitayama and Uskul (2011) reviewed existing neuroscience work and found that SC typically predicts neural, but not behavioral measures (Kitayama & Uskul, 2011). Although puzzling at first, this empirical generalization may offer a new insight into how culture might influence psychological processes.

Our conceptual model is illustrated in Figure 13. We hypothesized that depending on the culture in which individuals are socialized, they form different construals of the self as either independent or interdependent. Those who have developed their sense of the self as independent will have undergone requisite neural changes consistent with this construal via neuroplasticity. In the present case, individuals who define themselves as independent try to hold positive views of the self, which in turn form neural mechanisms that link positive experiences to self-knowledge. The resulting positivity bias in self-referential processing contributes to self-enhancement. In Figure 13, this putative causal influence is marked by solid arrows. However, a culture's meanings and practices can be conveyed by many contemporaneous influences, such as social norms, temporary goals, feelings and desires, many of which would contribute to foster the same behavioral response (self-enhancement).

Figure 13. *A model of culture, self-construal, neural mechanisms, and behavioral outcomes. Culture shapes neural mechanisms, mediated by self-construal, longitudinally through socialization. It also shapes numerous contemporaneous situational factors. Both the neural mechanisms and contemporaneous cultural influences contribute to the behavioral outcomes.*



These putative causal pathways are represented by dotted arrows in Figure 13. This model implies that behavioral outcomes are influenced by numerous contemporaneous factors in addition to the neural mechanisms fostered by self-construal. These additional contemporaneous factors, likely due to more transient state effects, may dilute the effect of self-construal on the behavioral outcomes.

Limitations and Future Directions

First, the current evidence suggests that the reduction of the upper-alpha suppression is a reliable indicator of the amount of internally-oriented attention during self-referential processing in the current paradigm. Future work may seek to manipulate this neural response directly to see if it would result in changes in the behavioral response of self-enhancement. Second, we tested the relationship between behavioral and neural outcomes in a single study. Future work must extend this approach to domains, including holistic attention (Goto et al., 2010), causal attribution (Na & Kitayama, 2011), reactivity to norm violations (Mu et al., 2015; Salvador, Mu, et al., 2020), and cognitive dissonance (Kitayama et al., 2004). Third, the current work focused only on a comparison between Eastern and Western cultures. Future work must examine neural mechanisms underlying self-evaluative biases in other cultural contexts.

In conclusion, our work is the first to show that increased internally-oriented attention during self-referential processing is associated with self-enhancement among European Americans. Moreover, we showed that the same mechanism can explain why self-enhancement is often absent among East Asians. The current evidence reinforces the supposition that culture influences psychological responses through neuroplasticity in relevant brain networks (Kitayama & Salvador, 2017), thereby underscoring the significance of neuroscience in the investigation of culturally divergent psychological processes.

Chapter III: How the Self Influences Perceptions of Norms

Study 1[6]

Social coordination is realized through social rules that govern various settings. These rules, herein called social norms, are instrumental in regulating interpersonal relations and enabling humans to form broad social groups that go beyond immediate kin (Henrich, 2015; Norenzayan et al., 2016). Norms ensure the efficient functioning of social systems while protecting members of society against various threats (e.g., germ contamination and traffic accidents). It is not surprising then that people sometimes become highly sensitive to norm violations, thereby spontaneously taking note of them. This sensitivity to social norm violations is a crucial step in mobilizing norm-based regulation of social behaviors (Gavrilets & Richerson, 2017). At present, however, little is known about factors determining the likelihood of the spontaneous detection of norm violations.

In the current work, we adopted the N400 – an event-related potential (ERP) component – as a reliable marker of the spontaneous detection of norm violations. While N400 responds to semantic incongruity (Rabovsky et al., 2018), Mu, Kitayama, Han, and Gelfand (2015) showed that the N400 responds to norm violations. Building on the thesis that norms are utilized for social coordination, we hypothesized that norm violations would capture attention when two conditions are met. First, the person must be prepared to relate to others socially. Second, the

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[6] This study is based on: Salvador, C.E., Mu, Y., Gelfand, M.J. & Kitayama, S. (2020) When Norm Violations Are Spontaneously Detected: An Electrocortical Investigation, *Social Cognitive and Affective Neuroscience,15*(3), 319–327. https://doi.org/10.1093/scan/nsaa035

person must believe that the norms of his or her society are tight and rigid. We expected that when these two conditions are met, the N400 response to norm-violating (vs. normal) behaviors should be particularly strong. Moreover, to show that the modulation of norm-violation detection occurs without any deliberate decision making, we primed the relational goals unobtrusively with a subliminal priming procedure.

Tightness vs. Looseness Belief and Relational Goals

Recently, Gelfand and colleagues (2011) have demonstrated that people vary substantially in their belief of the norms of their society to be tight or loose (referred to as tightness/looseness belief). Some individuals are “tight” in the sense that they perceive the range of permissible behaviors to be relatively narrow. For these individuals, social norms are unequivocal, and there is little leeway to deviate from them. Accordingly, the detection of norm violations could come about easily and quickly, and thus, relatively spontaneously. In contrast, some other individuals may be “loose” in the sense that they see a much wider range of permissible behaviors. For these individuals, social norms are ill-defined, and therefore it may not be as easy to determine the violation of such norms. Thus, even when another’s action seems to clearly violate relevant norms in the eyes of “tight” individuals, the judgment may not be clear-cut for “loose” individuals. For the latter individuals, the judgment will be slower, less spontaneous, and perhaps more deliberate.

At first glance, the predicted effect of the tightness/looseness belief on norm violation detection might seem straightforward. However, this effect may not always be observed. Norms are abundant, and the applicability of the norms may vary from one situation to the next. Hence, pertinent norms may have to be judged relevant, and thus, made accessible, or “brought online,” before the perceived tightness/looseness of the norms influences the detection of norm-violating behaviors. Only when the norms are judged to be relevant, will they be attended to, consistent with prior evidence information receives more attention if it is relevant to the social perceivers' goals than if it is not (Montagrin et al., 2013; Sakaki et al., 2014). Moreover, the possibility that the beliefs about the tightness of norms have consequences on behavior only when they are relevant is consistent with age-honored theories of motivation (Kruglanski et al., 2014), which assume that beliefs are often dormant or inert in and by themselves. Such beliefs (called "expectancy") are engaged to guide actions only when they are made relevant to the needs and goals of the person (called "value"). Accordingly, we hypothesized that the tightness/looseness belief would increase the likelihood of spontaneously detecting norm violations, primarily when this belief was relevant to the demands of the immediate social situation. In other words, norm violations may be expected to capture one's attention when the person holds the goal of relating to others and believes the pertinent norms are tight.

The foregoing prediction is consistent with prior work emphasizing the function of social norms to coordinate social interactions (Gelfand et al., 2011; M. W. Morris et al., 2015). To begin, consider a case where there is no need to engage socially, such as when one studies alone in a dorm room. Under such conditions, there will be no need for social coordination, and as a consequence, social norms will prove hardly relevant to the person, regardless of whether they are tight or loose. Next, consider a case in which people have a goal to relate to others, as when two people are about to engage in a discussion. Under such a condition, the two individuals feel a need for social coordination, thereby making social norms more relevant. Moreover, under such circumstances, the need for social coordination would be greater if the norms were tight. In fact, if the norms are perceived to be loose, norm adherence will not be called for. We may thus expect that when there is a goal of socially relating to others in a context governed by tight social norms, norm adherence will become a priority to the individuals. It would follow that norm violations should capture the attention of people primarily when they have a goal of relating to others while perceiving the pertinent norms to be tight.

Of importance, research in social cognition shows that relational goals are a powerful source of motivation (Baumeister & Leary, 1995). However, this motivation does not need to be conscious or deliberate. Indeed, it often is implicit. Prior work has found that one reliable method to induce relational goals is through priming the goals unconsciously with the subliminal presentation of relational words, such as “together” and “friend” (Bargh & Chartrand, 1999; Kimel et al., 2012; Lakin & Chartrand, 2003). In one early study, Lakin and Chartrand (2003) found that after subliminal relational priming, individuals imitated their interaction partners more. This priming also increased cooperative behavior (Bargh et al., 2001; Chartrand et al., 2006). Moreover, a subsequent study showed that after this priming, Americans experienced dissonance for a choice they made for their friends even though they typically do not (Kimel et al., 2012). This subliminal priming procedure has proven reliable, does not require conscious deliberation, and therefore minimizes demand effects that could be present with explicit goal priming. Thus, we elected to use this subliminal procedure of inducing relational goals and tested the prediction that relational goals increase the sensitivity to norm violations only for those who believe relevant norms to be tight.

Present Study

To test the extent to which norm violations are spontaneously detected, we followed earlier work (Mu et al., 2015) and used an event-related potential (ERP) component called N400, a negative deflection of electro-cortical potential occurring at approximately 400ms. Since N400 signals a variety of expectancy violations, including semantic incongruities (Goto et al., 2010; Kutas & Federmeier, 2011a; J. Na & Kitayama, 2011), it may also capture a mismatch between observed behavior and the relevant social norms. Importantly, the N400 in response to norm violations is empirically distinct from the semantic incongruity N400 (Mu et al., 2015). Thus, it is likely to be modulated by various socio-cultural variables in ways that are unlikely for the semantic incongruity N400. We anticipated that the norm violation N400 would be stronger under relational priming for those who believed the norms of their society to be tight (vs. loose).

Methods

Participants

We tested European American undergraduates at the University of Michigan. They received either course credit or $20 compensation. Prior work using a similar norm violation N400 paradigm (Mu et al., 2015) found a systematic US-China difference with a total N of 50. Since we tried to capture a potentially subtler priming effect within a single culture, we sought to double the N by testing a minimum of 100 participants. Since we anticipated that some participants would have to be excluded by pre-set criteria, we collected as many participants as possible by the end of the semester. After 44 participants had been tested, we instituted a double-blind procedure. In this procedure, a research assistant randomly assigned any given participant to a priming condition by opening a computer program that was labeled with words not associated with the prime. This ensured that the experimenter was unaware of the priming condition in which the participant was tested.

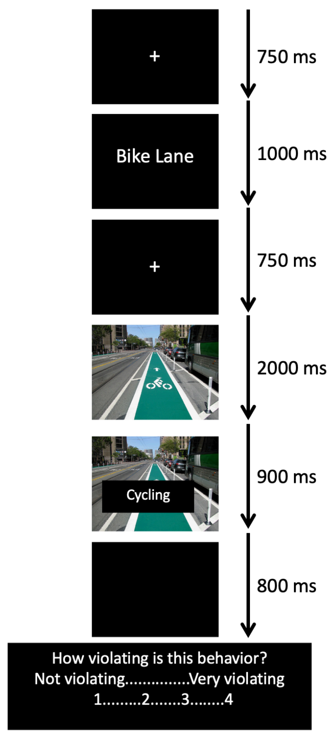
We tested 108 participants, out of which 17 were excluded before analysis for neurological medication use (9), head injuries, and (4) excessive noise in ERP data as determined with standard artifact rejection criteria (3) (Luck, 2014). Additionally, one participant who did not follow an instruction "to choose strongly disagree" while filling out post-experimental questionnaires (an attention check included) was also excluded. This resulted in a total of 91 participants, 45 females and 46 males, from 18 to 34 years of age (M = 19.11, SD = 2.11). The exclusion was no different across conditions and left 44 participants in the relational priming condition and 47 in the control priming condition. For all the participants included, valid EEG data were available for at least a half of the trials in each of the conditions.

Procedure

After providing informed consent, participants were set-up for EEG recording. They then completed a locator task, which was used to subliminally induce relational goals (Bargh & Chartrand, 1999; Kimel et al., 2012; Lakin & Chartrand, 2003). Participants were told that they would see a flash on the computer display and asked to report the location (left or right) of the flash using the arrow keys on the keyboard. The flash consisted of a 62ms presentation of a word, followed by a mask, "XQFBZRMQWGBX," for another 62 ms. With this presentation, the prime was expected to be subliminal (Kimel et al., 2012). Participants had been randomly assigned to one of two priming conditions. In the relational priming condition, all the four priming words were relational (friend, partner, together, and affiliate). In the control condition, they were not (table, neutral, room, and vertical). There was a total of 80 trials, with each of the four words presented 20 times in random order.

The locator was followed by a norm violation judgment task. As shown in Figure 14, each trial started with a fixation point (''+'') presented for 750ms at the center of the computer screen. Then, a word representing a location or situation (e.g., bike lane) was presented for 1000ms, followed by another fixation point for 750ms, after which a picture of that location or situation was shown. 2000ms afterward, a word representing a behavior (e.g., cycling) was superimposed on the picture for 900ms. Participants had been instructed to imagine someone performing the behavior in the location or situation (e.g., "cycling on the bike lane"). Then, a prompt appeared on the screen, upon which participants reported how violating the behavior would be in the situation by choosing a number from a 4-point rating scale ranging from 1 (= normal) to 4 (= very violating). Before the response prompt, there was an 800ms interval to ensure that the response would not interfere with ERPs evoked by the behavior. Immediately after the judgment, the fixation cross for the next trial appeared on the screen.

Figure 14. *Trial structure of the Norm Violation Task.*



The situation-behavior pairs were adopted from Mu et al. (2015). To preclude any potential confounds due to the behaviors tested, we used the same set of behaviors in the three Behavior type conditions. Each behavior was made either normal, weakly violating, or strongly violating by being paired with different situations. For example, "cycling" is normal in a "bike lane," but weakly violating and strongly violating in "sidewalk" and "freeway," respectively.

Each of 34 behaviors was used three times in each of the norm violation conditions. 10 of the situation-behavior pairs of each of the three conditions were randomly repeated to increase the total number of trials, which yielded a total of 132 trials. The order of the 132 trials was randomized for each participant.

After the norm violation judgment task, participants were reminded of the locator task and asked if they saw anything in each of the flashes during that portion of the task. The participants then filled out a packet of questionnaires. The packet included the 14-item Tightness/looseness in the United States scale (Gelfand et al., 2011). Participants reported their agreement with items, such as “There are many social norms that people are supposed to abide by in the US” and “People in the US almost always comply with social norms” on a 6-point scale (1 = Strongly disagree, 6 = Strongly agree). For exploratory purposes, we also included a modified version of the Singelis Self-Construal scale (Park & Kitayama, 2014). Additional scales included for exploratory purposes came from Mu et al. (2015). They are a measure of constraint in daily life, preference for territorial defense, creativity, vertical/horizontal individualism/collectivism scale, Tightness/looseness in Daily Life Scale, Rosenberg self-esteem scale, and Mattick Social anxiety scale. Participants also reported on several demographic questions.

EEG Recording and Processing

EEG was recorded with 32 channel electrodes using the BioSemi ActiveTwo System. 6 external electrodes were used for ocular correction. The data were digitized at the rate of 512 Hz and resampled at 256 Hz, and then offline re-referenced to the average of the two mastoids. The data were analyzed using MATLAB with EEGLAB plugin and ERPLAB extension. An offline butterworth filter with a lowpass of 20Hz and a high pass of 0.1Hz was applied. Then the data was segmented 200ms pre-stimulus baseline and 800ms post-feedback (1000ms in total), and baseline-corrected before the presentation of the stimulus. Before artifact detection, the data was visually inspected for bad electrodes, which were subsequently interpolated using spherical interpolation. Trials were rejected if they exceeded +/- 100mv as determined with a 200ms moving window with a 50ms step threshold, if they fluctuated more than 30mv between two sampling points, or if they had little to no activity (under .5mv) over the course of the trial. Trials with blinks occurring +/-100 ms around the onset of the stimulus behavior were removed to ensure that the behavior was appropriately attended. All other trials containing blink ocular artifacts were corrected based on a commonly used algorithm (Gratton et al., 1983).

Our primary analysis was focused on the central-parietal electrode sites (Cz, CPz, and Pz), since this is where previous studies have consistently analyzed the N400 component (Kutas & Federmeier, 2011; Na & Kitayama, 2011). Following Na & Kitayama (2011), we first visually determined the tallest peak across all conditions (439ms). The mean amplitude was extracted across the three conditions (normal, weakly violating, and strongly violating) for the N400 using a time window +/- 50ms around the average peak latency (390-490ms). The mean amplitudes for the three Behavior type conditions, computed for each participant, were used as a dependent variable in further analyses. The data was extracted the same way for frontal electrode sites (Fz and FCz), which showed a nearly identical peak latency (438ms). To keep the analysis consistent, we thus used the same time window (390-490ms). Greenhouse-Geiser corrections were used to adjust for the heterogeneity of variance when necessary. We used trial-wise data to estimate the reliability of N400, which proved reasonable, with Cronbach's alpha = .88. De-identified data, scripts, and E-Prime programs are available at: https://osf.io/w7x59/?view_only=638fe0847d8843f9bd2a2a2f020bdfa9.

Results

Subliminal Nature of The Relational Priming

After the norm violation task, participants were reminded of the locator task and asked if they saw anything during that portion of the task. Most participants reported that they saw something "behind" the mask. However, no one mentioned any of the words presented in the priming procedure even when urged to guess. To ensure that the procedure was subliminal, we also gave 52 of the participants a list of 32 words, of which they had to select the four words that they felt had been presented in the locator task. They were asked to make the best guess if they were unsure. Neither relational nor control words were picked any more often than chance, regardless of the priming conditions, $t_{relational\ words}(23) = -1.696$, $p = .103$ and $t_{control\ words}\ (23) = -.624$, $p = .539$ in the relational priming condition and, $t_{relational\ words}(27) = .273$, $p = .787$ and $t_{control\ words}\ (27) = -.902$, $p = .375$ in the control priming conditions.

Tightness/looseness Belief and Norm Violation Ratings

The overall mean of the Tightness/looseness belief scale was above the scale midpoint of 3.5 ($M = 3.70$, $SD = .65$), although the mean was significantly higher than the midpoint, $t(90) = 2.94$, $p < .005$. The Tightness/looseness belief was no different between the two priming conditions, $t(89) = 0.518$, $p = .606$. In addition, the mean for independent self-construal was significantly higher than that for interdependent self-construal ($Ms = 5.21$ and 4.82), $t(90) = 3.46$, $p < .001$, as is typical in American samples.[7] No other effect of priming approached statistical significance on the self-report scales.

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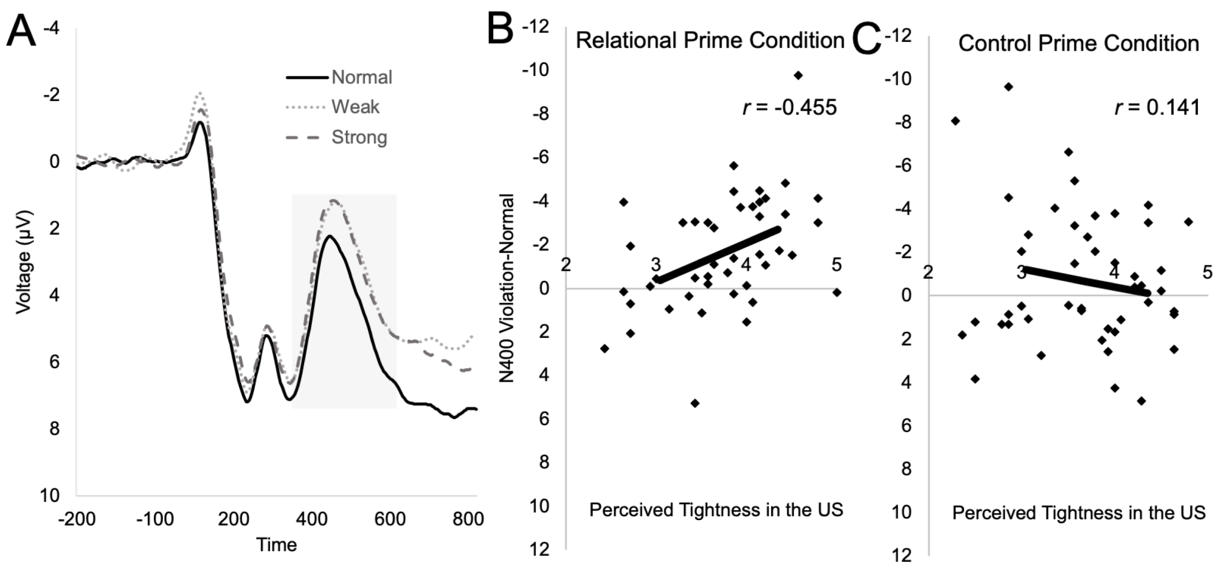
[7] The mean interdependence score tended to be higher in the relational (vs. control) priming condition ($Ms = 4.92$ and 4.72). Although the difference was statistically only marginal, $t(89) = 1.64$, $p = .052$, with a one-tailed test. The pattern is consistent with earlier evidence that priming of social relations increases interdependent orientations (Gardner et al., 1999).

Next, we examined norm violation ratings during the norm violation judgment task. Strongly violating behaviors were perceived as most violating ($M = 2.90$) and normal behaviors, as least so ($M = 1.10$), with the weakly violating behaviors falling in-between ($M = 2.07$). The main effect of Behavior type was highly significant, $F(2,87) = 27.90$, $p < 0.001$, ηp2 = 0.243. All three means were statistically different from each other. There was also a significant Behavior type by Tightness/looseness belief interaction, $F(2,87) = 7.89$, $p < 0.001$, ηp2 = 0.083. The average norm-violation rating for the strongly and weakly violating behaviors combined was significantly predicted by Tightness/looseness belief, $r(91) = .347$, $p < .001$. However, the rating for the normal behaviors was not, $r(91) = .109$, $p = .306$. This pattern was no different in the relational priming (rs = .249 and .077, for the norm violation and normal behaviors, respectively) and control priming conditions (rs = .432 and .128, for the norm violation and normal behaviors, respectively). Of note, the Behavior type x Tightness/looseness belief x Prime interaction was negligible, $F(2,87) = 1.19$, $p = 0.306$, ηp2 = 0.013. We will return to the absence of the interaction pattern we predicted on this self-report measure in Discussion.

Event Related Potentials (ERPs)

Waveforms from all 32 cortical electrodes for each condition are in Figure S15. Preliminary analyses showed no difference between the strongly and weakly violating behavior conditions (Figure 15-A). Hence, the two norm-violating behavior conditions were collapsed. Moreover, our central interest was in the extent to which people become sensitive to norm violations. Thus, the average N400 at central-parietal sites for the normal behavior condition was subtracted from the N400 in the two norm violation conditions combined to yield the relative magnitude of N400 for the norm-violation (vs. normal) behaviors. This relative N400 was analyzed with two between-subjects variables (Prime and Tightness/looseness belief) and the interaction between them. This analysis yielded a significant main effect of Prime, $F(1,87) = 5.29$, $p = .024$, $\eta p2 = 0.057$. The norm violation N400 was greater in the relational priming condition ($M = -1.61$) than in the control priming condition ($M = -.52$). Importantly, the Prime main effect was qualified by an interaction with Tightness/looseness belief, $F(1,87) = 6.86$, $p = .010$, $\eta p2 = 0.073$.

Figure 15. *A. The ERP waveform at the Cz electrode combined across conditions. The N400 is marked with a grey shadow. B and C. The magnitude of N400 as a function of T/L belief in the relational and control prime conditions.*



Tightness/looseness belief significantly predicted a greater norm violation N400 in the relational priming condition, $r(44) = -0.455$, $p = 0.002$ (Fig. 15-B). This effect, however, was negligible in the control priming condition, $r(47) = 0.141$, $p = 0.344$ (Fig. 15-C). Next, we tested the effect of priming at the high versus low levels of the Tightness/looseness belief. For those 1SD above the mean of the Tightness/looseness belief, the norm-violation N400 was significantly greater in the relational (vs. control) priming condition, $F(1,87) = 8.39$, $p = .005$,

$\eta p2 = 0.088$. For those 1SD below the mean of Tightness/looseness belief, however, the difference between the two priming conditions was negligible, $F(1,87) = .082$, $p = .776$, $\eta p2 = 0.001$.

The Tightness/looseness belief x Prime interaction was not qualified by the use of the double-blind procedure. When the use of the double-blind procedure was used as an additional independent variable, the Prime main effect was significant, $F(1, 86) = 6.31$, $p = .014$. As was the Prime by Tightness/looseness belief interaction, $F(1, 86) = 7.98$, $p = .006$. The current results did not depend on a few possible outliers apparent in Figures 15-B and C (see Supplementary Analysis 1). Moreover, the effects we report were no different when the random effects for electrodes and stimuli were included (see Supplementary Analysis 2).

Prior work (Mu et al., 2015) found a cultural difference in the norm violation N400 primarily in the frontal regions. We therefore repeated the same analyses on the frontal midline electrode sites, Fz and FCz, testing the N400 in the norm violation (vs. normal) condition as a function of both Prime and Tightness/looseness belief. The pattern was very similar in these frontal electrodes as in the main analysis (see Supplementary Analysis 3).

Correlations

Lastly, we explored whether the norm violation N400 might correlate with variables known to be linked to Tightness/looseness belief used in Mu et. al., including constraint in daily life, preference for territorial defense, creativity, and SES. Regardless of the priming condition, none of the correlations achieved statistical significance plausibly because of the narrower range of variability of the variables within a single culture.

Discussion

The current work is the first to show that norm violations are spontaneously detected when those who believe the norms of their society to be tight are primed with relational goals. The norm violation N400 was up-regulated when those who believed their societal norms to be tight were subliminally primed to relate to others. This pattern offers a few important implications for theories of social norms.

Norms and Social Coordination

We demonstrated that an electrocortical marker of norm violation detection (N400) is jointly modulated by subliminal relational priming and the Tightness/looseness belief of societal norms. This finding suggests that Tightness/looseness belief in and by itself may not be sufficient to increase the likelihood of spontaneously detecting norm violations. It may need to be made motivationally relevant, thereby providing further support to many motivational theories of social cognition and social behavior (Kruglanski et al., 2014). Specifically, when the norms are made relevant by relational goals, they are "brought online." The resulting accessibility of social norms is assumed to mediate the increased N400. Our finding is in line with a functionalist view of social norms. This view emphasizes the role of social norms in achieving effective social coordination (Gelfand et al., 2011; M. W. Morris et al., 2015). Hence, the neural processing of norm violations is spontaneous when the need for social coordination is maximized by a requirement to socially relate to others under tight norms.

Online Norm Processing

Of note, we unobtrusively primed relational goals and showed that these goals influence the norm violation N400. This finding suggests that the regulation of norms, involving both goal-dependent retrieval of norms and the norm-based evaluation of the focal behaviors, can occur subliminally, outside of conscious awareness. This finding is consistent with the current understanding of the psychological unconscious as versatile and adaptive (Bargh & Morsella, 2008). Equally important, the current demonstration validates the subliminal priming procedure (Bargh & Chartrand, 1999; Kimel et al., 2012; Lakin & Chartrand, 2003), thereby informing the debate of the replicability of social priming effects (Pashler et al., 2013; Payne et al., 2016). Nevertheless, the claim that priming words were subliminal was based on self-report of subjects failing to remember any of them after the norm violation judgment task. This claim could be challenged since we could not preclude the possibility that participants were aware of the priming words momentarily when the words were flashed. Although we found this possibility rather unlikely, future work must test the subliminal status of priming words right after the words are flashed.

It is worthy of note that the Tightness/looseness belief x Prime pattern is unique to the N400 index. When self-report of the severity of norm-violation was tested, it became more extreme as a function of the Tightness/looseness belief regardless of relational priming. Whereas the N400 is based on early processing in the order of a fraction of a second (i.e., around 400ms post-stimulus), self-report operates in the order of several seconds. Hence, in the control condition, even if the norms were not accessible early on during the processing when the behavior was first detected (thereby showing no N400 difference), it could be retrieved at a later time, when the norm congruity of the behavior was evaluated (Kahneman & Miller, 1986).

Cross-Cultural Implications

The current finding offers important cross-cultural implications. First, prior evidence shows that Asians including Chinese and Japanese are more likely to perceive the norms of their society to be tight than North Americans do (Gelfand et al., 2011). Second, Asians are more interdependent than Americans and, therefore, Asians may be more likely than Americans to hold relational goals (Markus & Kitayama, 1991). In combination, these two factors (the belief of norms to be tight and active relational goals) may lend themselves to a stronger norm-violation N400 (Mu et al., 2015). Our work then may be instrumental in "unpacking" the complex effect of culture by offering an important clue for active dimensions of culture that are responsible for the group difference that has been observed.

Limitations and Future Directions

We wish to acknowledge some limitations of the current work. First, our work focused exclusively on N400, without any effort to link it to behaviors designed to cope with norm-violating behaviors. Future work must test whether the current neural indicator would predict future behavioral responses (e.g., punishment) to the norm violators. Second, in the current study, participants had an explicit goal of judging whether the behavior is norm-violating. Hence, the detection of norm violations demonstrated in the current work may turn out to be contingent on this processing goal. Future work must test boundary conditions for the spontaneous detection of norms, by using a processing goal that does not involve norm-violation detection (e.g., a judgment of whether the behavior typically occurs outside or inside). Moreover, how specific the reported effects may be to norm violations must be further investigated. Fourth, our work focused primarily on conventional norms. As such, our findings may or may not generalize to violations of moral values and imperatives. Future work must explore neural responses to moral (vs. conventional) violations.

Finally, it would be important to extend the current paradigm to the priming of other goals – most importantly, goals of independence. At first glance, goals for independence might seem to suppress social norms (resulting in a less pronounced norm violation N400) since this suppression could be an effective means to promote freedom from social norms. However, as argued by Erich Fromm (1941), the psychoanalyst, such goals may paradoxically make the existing norms more salient (thereby augmenting the N400 in the context of the current experimental paradigm). More specifically, under certain conditions, some facets of independence (e.g., freedom and separation from others) could induce a fear of anomie, lawlessness, or what Fromm called the hopelessness. If so, the priming of independence might motivate some individuals to "escape from freedom" (Fromm, 1994), thereby increasing their norm sensitivity under such conditions. Only future work can tell whether this hypothesis might have any merit in the socio-cultural neuroscience of social norms.

Study 2[8]

How will people respond to external threats such as imminent wars, potential germ infection, and future earthquakes? Some people may be alarmed by the threat. These people may then become highly responsive to social norms, insofar as abiding by the norms is often crucial in coping with the external threat (Gelfand et al., 2011; Murray & Schaller, 2016). However, it is also conceivable that other people feel protected from such threats, reducing their level of alarm and their subsequent responsiveness to social norms. So far, little is known about individual differences predisposing these contrasting responses to external threats.

In the current work, we drew on recent evidence that a construal of the self as belonging to and embedded in significant social relations, called the interdependent self-construal (SC) (Markus & Kitayama, 1991), affords a sense of protection against external threats (Eisenberger

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[8] This study is based on: Salvador, C.E., Kraus, B.T. Ackerman, J.M., Gelfand, M.J. & Kitayama, S. (2020) Interdependent Self-Construal Predicts Reduced Sensitivity to Norms Under Pathogen Threat: An Electrocortical Investigation, *Biological Psychology*. https://doi.org/10.1016/j.biopsycho.2020.107970.

et al., 2007; C. Wang et al., 2014). Based on the evidence that interdependent SC can buffer the sense of threat, we predicted that interdependent SC would moderate people's responsiveness to social norms under threat. While the available evidence suggests that people respond more strongly to norm violations under threat, the effect of threat may be attenuated for those high in this SC, insofar as the sense of social connection associated with this SC buffers the sense of threat.

Interdependent SC and External Threat

Interdependent SC refers to a view of the self as belonging to and being embedded in significant social relations. The dimension is distinguished from independent SC, which refers to a contrasting view of the self as separate from social relations (Markus & Kitayama, 1991). Compared to their lower SC counterparts, those high in the interdependent SC are more likely to define themselves in terms of their social position and role in their social relations. As a consequence, the need to belong to their primary groups (i.e., family, school, firms, and local communities) is more central to their identity.

Existing evidence suggests that interdependent SC comes with a sense of protection in the face of threat. Theoretically, close social relations are perceived as "warm" (H. H. Kelley, 1950; Williams & Bargh, 2008), consistent with a premise in attachment theory that close social relations can serve as a "secure base" (Bowlby, 1990). We may then expect that people high in interdependent SC will perceive social relations as warmer and thus more protective. Consistent with this prediction, recent neuroimaging studies find that the presence of close others can mitigate neural responses to physical pain (Coan et al., 2006). Further, Eisenberger and colleagues (2007) showed that physiological responses to physical pain are not as strong among those who feel they have social support (Eisenberger et al., 2007). The reduced response to threat may be greater for those who are interdependent and thus closely attached and supported by their relations. In support of this, a similar reduction of pain response was observed when people are induced to feel interdependent (C. Wang et al., 2014). Moreover, people high in interdependent SC are more resilient when they are socially excluded compared to people low in interdependent SC (Gardner et al., 2005; Over & Uskul, 2016; Ren et al., 2013; Uskul & Over, 2014).[9] Together, the growing body of evidence suggests that interdependence may be a potent buffer for the experience of threat.

Moderation of Threat Effects by Interdependent SC

If interdependent SC buffers the experience of threat, it should attenuate the psychological effects of external threats. One of the most extensively studied effects of external threats relates to social norms (Murray & Schaller, 2016). For example, Gelfand and colleagues (2011) show that a higher historical level of external threats predicts tightness of norms across both many modern nations (Gelfand et al., 2011) and pre-industrial societies (Jackson et al., 2020). A similar effect may occur at the individual level. Murray and Schaller (2012) find that when exposed to cues of external threat, individuals judge normative transgressions to be less justifiable (Murray & Schaller, 2012). They also value conformity more strongly and agree with majority opinions more (Murray et al., 2011). Also consistent is a finding that people who are sensitized to germ threats hold more negative attitudes toward immigrants (who do not assimilate to local norms), compared to those who are not as sensitized to such threats (Karinen et al., 2019) Hence, when there is an imminent external threat, responsiveness to social norms

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[9] It is of note that Over and Uskul (2014) specified social exclusion by others whom the individual knows. This study therefore provides a particularly compelling demonstration that interdependence buffers a threat of social exclusion supposedly because there are others in the group who are still accepting the person even when some members of the group have excluded him or her.

should increase. Importantly, however, interdependent SC is likely to buffer the sense of threat, and as a consequence, the heightened sensitivity to social norms under threat may be attenuated among those high in interdependent SC. Thus, the impact of the external threat would be most pronounced among those low in interdependent SC.

What effect will interdependent SC have on responsiveness to norm violations when there are no external threats? The extant evidence suggests that in the absence of threat, interdependent SC may increase (rather than decrease) this responsiveness. For example, a recent study shows that when interdependence is primed, people become more responsive to norm violations of others (Salvador, Mu, et al., 2020). This finding is consistent with an earlier review of cultural differences within the Asch-conformity paradigm, which shows that the conformity rate is significantly higher in countries that are higher in interdependent (vs. independent) SC (Bond & Smith, 1996).Moreover, when independent vs. interdependent SC is measured at the individual level, a similar trend is observed in an experimental paradigm designed to assess the effect of social influence on memory (Petterson & Paterson, 2012). Interdependent (vs. independent) individuals were more influenced by others. Altogether, interdependent SC is likely to predict an increased degree of norm abidance or norm sensitivity in the absence of any external threats. It is only when such threats are imminent that this SC may serve as a buffer to the threats, thereby decreasing the degree of norm abidance or norm sensitivity.

Present Study

In the current study, we tested whether the sensitivity to norm violations would be moderated by both an imminent threat and interdependent SC. For this purpose, we adopted a threat of pathogen contamination (Hill et al., 2015; Mortensen et al., 2010). Pathogen threat is typically invisible, yet potentially deadly, and has been one of the most impactful dangers across human history (Ackerman et al., 2018). Thus, it is suitable as a domain of interest in an initial inquiry into the effect of threat on responses to norm-violations. Participants were primed or not primed with a pathogen threat and then exposed to the norm-violations of another person while their electroencephalogram was being monitored. Importantly, we directly tested mechanisms of the effect of threat on the responsiveness to norm violations by adopting electrocortical indicators of this responsiveness: N400 and suppression of upper α-band power.

N400 is a marked negative going deflection of electrocortical response, typically observed in centro-parietal regions of the brain approximately 400ms post-stimulus (Kutas & Federmeier, 2011; Rabovsky et al., 2018). It indexes the detection of semantic expectation violations in the processing of sentences (Kutas & Hillyard, 1980), words (Hanslmayr et al., 2007; Na & Kitayama, 2011) and pictures (Goto et al., 2010). As may be expected, this component also responds to norm violations (Mu et al., 2015; Salvador, Mu, et al., 2020). Another component that may be involved in the response to norm violations is the suppression of parietal upper α-band power. The α frequency band primarily reflects inhibitory neuron activity (Klimesch, 2012; Pfurtscheller et al., 1996). The α power assessed at parietal regions often increases when tasks require inwardly oriented attention, such as self-reflection and mind-wandering (Benedek et al., 2014). Conversely, the parietal α is typically decreased (or "suppressed") when tasks require outwardly oriented attention, such as vigilance to an external stimulus. This decrease of spectral power as a function of the demands of external processing is quite pronounced for the upper half of the α band (10.5-13 Hz) (Klimesch, 2012; W. J. Ray & Cole, 1985). In contrast, the lower half of the α band (8-10.5 Hz, called lower α) is more diffused topographically and its functions are more general (Klimesch et al., 2007). Altogether, we anticipated that enhanced vigilance to others' norm-violating (vs. normal) behaviors would entail systematic suppression of upper α-band power.

Our analysis suggests that interdependent SC would have a contrasting effect on the responsiveness to norms and norm violations assessed by both N400 and upper α-band power suppression, depending on the presence of an external threat. In the absence of such a threat, this SC will predict increased responsiveness. But in the presence of the threat, interdependence will predict decreased responsiveness. To assess interdependent SC, we used a well-validated measure of SC (a modified version of the Singelis SC scale, Park & Kitayama, 2014). Since prior work shows that effects of interdependent SC are sometimes mirrored by contrasting effects of independent SC (Goto et al., 2010; Kitayama et al., 2020; Na & Kitayama, 2011; Park & Kitayama, 2014), we also explored whether the predicted effect of interdependent SC might also be mirrored by independent SC and, if so, it might be more clearly observed by a difference score between the two (interdependent SC - independent SC).

Methods

Participants

The current study was conducted in the fall of 2017, well before the COVID-19 pandemic (the winter of 2020). Sixty-nine undergraduates at the University of Michigan participated in the study. All participants were right-handed. Moreover, they self-identified as European American, Caucasian, or White. Participants received either course credit or $15 compensation for their participation. Given the paucity of prior work using threat priming within an ERP paradigm, a priori power analysis was not possible. We thus drew on prior EEG studies comparing two groups, either within a norm violation paradigm (Mu et al., 2015) or with N400 as a key dependent variable within different paradigms (Goto et al., 2010; Na & Kitayama, 2011). These studies use up to 20 participants per cell. In the current work, we tried to increase the N at least by 50% in each cell by testing as many participants as possible until the end of the term.

Of the 69 participants, 10 were excluded before analyses due to medication use (4), head injuries (2), not meeting ethnicity criteria (1) and excessively noisy ERP data (3) as determined by standard artifact rejection criteria (Luck, 2014). With these criteria, all participants included in the analysis (N=59, 38 females, varying from 18 to 30 years of age, $M = 21.38$, $SD = 2.44$) had at least 50% of usable trials in each Behavior type. More than 86% of the Behavior type conditions had more than 90% of trials included, with the average percent of inclusion of approximately 95% of trials across the participants. The participants provided their written informed consent in accordance with the Declaration of Helsinki. The study protocol was approved by the Institutional Review Board of the University of Michigan.

Data Availability

Materials, scripts for data-analysis, de-identified behavioral and EEG data of the present study are available at: https://osf.io/ga96k/?view_only=f2c3741cd2eb4ae0986af39b23b81f57.

Procedure

Upon arrival at the lab, participants filled out pre-screening questions on medication use, history of seizure disorders, head injury, ethnicity, and handedness. After the EEG was set up, participants were asked to evaluate a slideshow that was described as “educational materials for another study.” They were instructed to pay close attention to the slideshow and prepare themselves to answer several questions afterward. The participants were randomly assigned to either a threat or control priming condition. In the threat priming condition, the slideshow, entitled “The Growing Problem of Disease in America: A Sick Future Ahead,” illustrated the danger of germ contamination (Figure S16-A). In the control priming condition, the slideshow, entitled “A Day at Home: Organizing your Desk,” illustrated how an office would look (Figure S16-B). The current threat manipulation was successfully used in prior studies (Hill et al., 2015; Mortensen et al., 2010).

The slideshow rating task was followed by a norm violation judgment task, which consisted of a total 204 experimental trials (Figure 14), preceded by 3 practice trials. Each trial started with a fixation point (‘‘+’’) (750ms), followed by a word representing the situation (e.g., bike lane) (1000ms). Following another fixation point (750ms), a picture of the situation was shown. After 2000ms, a word representing a behavior (e.g., cycling) was superimposed on the picture for 900ms. The disappearance of the behavior was followed by a blank screen for 800ms, after which a prompt to judge the behavior appeared. This period was inserted to minimize any motor artifacts. The participants judged how violating the behavior was for the situation by using a 4-point rating scale ranging from (1 = normal, 4 = very violating). After the response, the next trial started immediately with the presentation of a fixation point. The period between the presentation of the behavior and the disappearance of the behavior along with the picture constitutes the time window of interest for the electro-cortical data.

In the norm violation judgment task, situation-behavior pairs and pictures were adopted from Salvador et al. (2020). There were 34 behaviors, each of which (e.g., cycling) was made normal (e.g., bike lane), weakly norm-violating (e.g., sidewalk), or strongly norm-violating (e.g., highway), depending on the situations it was paired with, yielding 102 unique behavior-situation pairs. Two rounds of these 102 stimuli were used, resulting in 204 total trials. The order of the stimuli was randomized in each round for each participant.

After the norm violation judgment task, the participants filled out a packet of questionnaires. The packet included a modified version of the Singelis Self-Construal scale (Park & Kitayama, 2014), composed of a 10-item Independent self-construal subscale ($\alpha = 0.804$, "I do my own thing regardless of what others think") and a 10-item Interdependent SC subscale ($\alpha = 0.664$, "I will sacrifice my self-interest for the benefit of the group I am in."). Participants rated themselves on a 7-point rating scale (1 = strongly disagree, 7 = strongly agree). Our focus was on Interdependent SC. Interdependent SC was centered prior to running the reported models.[10] In addition, we performed a subsidiary analysis testing independent SC, as well as the difference between the two SCs (interdependence - independence).

EEG Recording and Processing

EEG was recorded from 32 scalp channels using a BioSemi ActiveTwo System. Four bipolar EOG electrodes were used to monitor eye movements and an electrode was placed on both of the left and right mastoids. During the set-up of electrodes, impedances were verified to be within +/- 20KΩ. The data were digitized at 512Hz, then offline resampled at 256Hz and referenced to the average of the two mastoids. Within MATLAB, the EEGLAB plugin and ERPLAB extension were used for data analysis. An offline bandpass filter with a lowpass of 30Hz and a high pass of 0.1Hz was applied. Then the data was segmented 200ms pre-stimulus baseline and 900ms post-response (1100ms in total). Ocular artifacts were corrected based on a commonly used algorithm (Gratton et al., 1983). Trials were then rejected if they exceeded +/-

[10] In addition, the packet included perceived vulnerability to disease (Duncan et al., 2009), fear of negative evaluation (Leary, 1983), need to belong (Baumeister & Leary, 1995), neuroticism (Kitayama et al., 2018), PANAS (Watson et al., 1988), and other measures from creativity and cultural superiority (Mu et al., 2015), and the 14-item Tightness/looseness belief scale(Gelfand et al., 2011). Some of them were included for other purposes. The remaining scales were included for exploratory purposes and are not discussed in the current paper. Regardless, the current findings held even when these variables were statistically controlled.

150μV as determined with a 400ms moving window using a 100ms stepwise peak-to-peak threshold, if they fluctuate more than 30μV between two sampling points, or if they had little to no activity (less than +/- .5μV) over the course of the trial (Luck, 2014).

Measurement of N400

The EEG was time-locked to the presentation of each stimulus behavior and baseline corrected to 200ms prior to the critical stimulus. A visual inspection of the post-behavior EEG identifies a clear negative-going deflection approximately 440ms after the onset of the behavior in the central sites, for which we selected the electrode Cz for further analyses. The spatiotemporal location corresponds closely to prior work on N400 (Kutas & Federmeier, 2011; Na & Kitayama, 2011). First, the average peak latency across all conditions was visually determined (440ms). The mean amplitude was extracted using a time window +/- 50ms around the average peak latency (390-490ms). As in prior work, the mean amplitude for all trials for each participant was then used as a dependent variable in further analyses.

Measurement of Upper α-Band Suppression

To measure the upper α-band power, several steps were taken. To perform a time-frequency analysis (TFA) utilizing a moving window approach, it is necessary to use a data segment larger than the time-period of interest. Here, we elected to mirror the original data epochs (M. X. Cohen, 2014) in order to have enough data for our analysis. That is, the original data epoch was duplicated, reversed along the x-axis (time), and attached to the end of the original epoch. In addition to retaining more data for analysis, the mirroring allowed us to avoid edge artifacts in the TFA (M. X. Cohen, 2014) , while also reducing the influence of DC (or "direct current") drifts (baseline variation of low-frequency waves) in the data. This has the added benefit of minimizing the issues that can occur in regression-based eye corrections (Croft

& Barry, 1998). This process was repeated in order to create an EEG data segment from -4043 to 4742ms. Next, we ran a TFA using complex Morlet wavelets (M. X. Cohen, 2014). The wavelets were 3 cycles wide at .5Hz and were gradually shrunk to 36 cycles wide at 30Hz. We extracted 473 log-spaced frequencies between .5 and 30Hz utilizing zero-padding to a factor of 8 and estimated 400 timepoints between -700 and 1400ms.

For each trial, the baseline was defined as the 200ms window prior to the onset of the stimulus. To calculate the event-related spectral perturbation (ERSP), we took the average of the upper alpha (10.5 – 13Hz) frequency range from 400ms and 900ms post-stimulus onset, where the suppression was evident. Consistent with prior work (Klimesch et al., 2007), this effect was most pronounced at the midline parietal sites, thus we selected Pz for further analyses during the 400-900ms time window of interest.

Analytic Plan

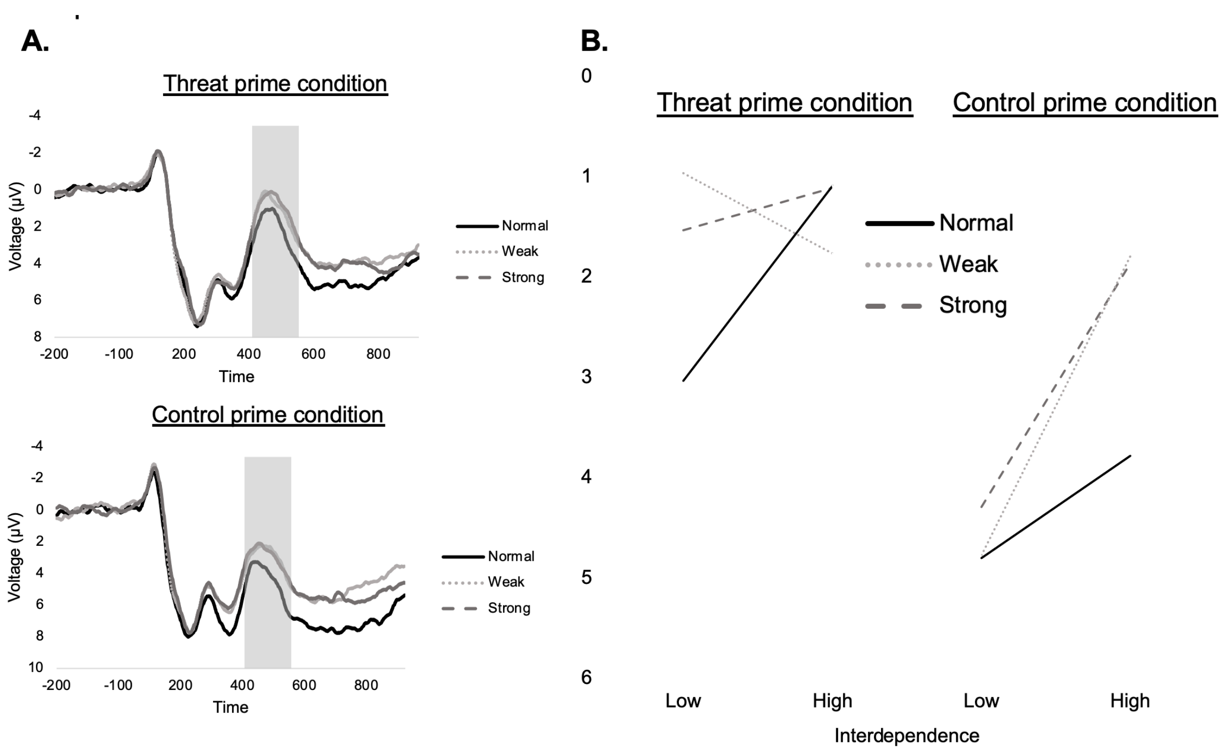
We analysed data from the set of 102 stimuli, which were repeated twice, resulting in two rounds of the same stimulus set. To guard against the possibility that the repetition of identical norm violations could invite habituation (Zajonc, 1968), we first ran each round separately. When the results for the second round were no different from those of the first round, the two rounds were combined. Further, prior evidence with neural measures shows that the two degrees of norm violation (strong vs. weak) do not differ from each other (Mu et al., 2015; Salvador, Mu, et al., 2020). To ensure that this applies to the current work (which includes both N400 and upper alpha suppression), preliminary analysis was performed to compare the two conditions. Our main set of analyses used interdependent SC scores. In addition, however, we also tested both independent SC and the difference between the two (interdependence - independence).

Results

N400

Figure 16-A shows waveforms at Cz in both threat and control priming conditions. The time window for the N400 is highlighted in grey. Our prediction implies that the effect of norm violation on the N400 would be moderated by both Prime and Interdependent SC. We first performed a preliminary analysis focusing on the strong vs. weak norm-violating behaviors. This variable showed no main effects nor interactions with other variables, *p*s > .133. We thus collapsed the two norm-violation conditions. Further, another preliminary analysis examining each of the two rounds showed nearly identical patterns. We thus performed a 2x2x2 mixed ANOVA (Behavior type x Prime x Interdependent SC) on the magnitude of the N400 that were combined across the two rounds.

Figure 16. *A. Wave forms at Cz in the threat prime and control prime conditions. B. N400 mean amplitude for norm-violating and normal behaviors in the two prime conditions at +1 and -1 SD of interdependent self-construal.*



This analysis showed the main effect of Behavior type, $F(1, 55) = 9.93$, $p = .003$, $\eta_p^2 = .153$, showing that the N400 is significantly greater for norm-violating behaviors than for normal behaviors. Moreover, the 3-way interaction involving Behavior type, Prime, and SC proved significant, $F(1, 55) = 10.74$, $p = .002$, $\eta_p^2 = .163$.[11] This interaction is illustrated in Figure 16-B. To more closely examine the nature of this interaction, separate 2x2 mixed ANOVAs (Behavior type x Interdependent SC) were performed on each of the two priming conditions.

First, in the threat priming condition, the main effect of Behavior type was marginally significant, $F(1, 29) = 3.18$, $p = .085$, $\eta_p^2 = .099$, showing that the N400 was somewhat greater in magnitude for norm-violating behaviors than for normal behaviors. The effect of interdependent SC, apparent in Figure 1-B (the right panel), did not achieve statistical significance, $F(1, 29) = .195$, $p = .662$, $\eta_p^2 = .007$. However, the interaction between Behavior type and Interdependent SC was statistically significant, $F(1, 29) = 5.86$, $p = .025$, $\eta_p^2 = .161$. For those 1SD below the mean for Interdependent SC, the N400 was significantly higher for norm-violating behaviors than for normal behaviors, $F(1, 29) = 9.75$, $p = .004$, $\eta_p^2 = .252$. However, this effect disappeared, with the N400 being no greater for norm-violating behaviors than for normal behaviors, for those 1SD above the mean in Interdependent SC, $F(1, 29) = .303$, $p = .586$, $\eta_p^2 = .010$.

Second, in the control priming condition, the main effect of Behavior type was statistically significant, $F(1, 26) = 7.37$, $p = .012$, $\eta_p^2 = .221$. The N400 magnitude was greater for norm-violating behaviors than for normal behaviors. The effect of interdependent SC, apparent in Figure 1-B (left panel), did not reach statistical significance, $F(1, 26) = 1.64$, $p =$

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[11] When Round (1st vs. 2nd) was included as an additional independent variable, the interaction between Round, Behavior type, Prime and SC was not significant, $F(1, 55) = 0.18$, $p = .893$, $\eta_p^2 = .000$.

.211, $\eta_p^2 = .059$. Importantly, the Behavior type x Interdependent SC interaction was significant, $F(1, 26) = 5.20$, $p = .031$, $\eta_p^2 = .167$. For those 1SD above the mean for Interdependent SC, the N400 was significantly greater for norm-violating behaviors than for normal behaviors, $F(1, 26) = 13.75$, $p = .001$, $\eta_p^2 = .346$. This effect disappeared for those 1SD below the mean in Interdependent SC, $F(1, 26) = .219$, $p = .644$, $\eta_p^2 = .008$. For these individuals, the N400 was no greater for norm-violating behaviors than for normal behaviors.

Upper Alpha Suppression

The results of the time-frequency analysis over both rounds across all conditions are plotted in Figure 17-A. The focal upper α-band is marked by a red box in the time-frequency chart. A decrease of upper α-band power (indicated by blue shading) is evident, starting around 400ms after the onset of the target behavior and continuing throughout the time period of interest. As in the prior analysis we first focused on the two norm violation conditions. This analysis showed that the degree of norm violation had no main effects nor interactions with other variables, *p*s > .120. Hence, these two conditions were averaged and we performed a 2x2x2 mixed ANOVA (Behavior type x Prime x Interdependent SC) on upper α suppression. For the first round of stimulus presentation, upper α suppression was greater for norm-violating than normal behaviors as shown by a main effect of Behavior type, $F(1,55) = 9.25$, $p = .004$, $\eta_p^2 = .144$. Moreover, the 3-way interaction involving Behavior type, Prime, and SC proved significant, $F(1, 55) = 6.11$, $p = .017$, $\eta_p^2 = .100$. When we examined the second round of stimulus presentation, the main effect of Behavior type was significant, $F(1, 55) = 4.51$, $p = .038$, $\eta_p^2 = .076$. Importantly, however, the 3-way interaction involving Behavior type, Prime, and SC was not, $F(1, 55) = .148$, $p = .702$, $\eta_p^2 = .003$. We return to this in the discussion.

The 3-way interaction that proved significant for the first round is illustrated in Figure 17-B. To more closely examine the nature of this interaction, a separate 2x2 ANOVA (Behavior type x Interdependent SC) was performed on each of the two priming conditions. First, in the threat priming condition, the main effect of Behavior type was significant, $F(1, 29) = 7.98$, $p = .008$, $\eta_p^2 = .216$. There was greater upper α suppression for norm-violating behaviors than for normal behaviors. The effect of Interdependent SC was statistically negligible, $F(1, 29) = .357$, $p = .56$, $\eta_p^2 = .012$. However, the interaction between Behavior type and Interdependent SC was statistically significant, $F(1, 29) = 4.32$, $p = .047$, $\eta_p^2 = .130$. For those 1SD below the mean for Interdependent SC, upper α suppression was significantly higher for norm-violating behaviors than for normal behaviors, $F(1, 29) = 13.18$, $p = .001$, $\eta_p^2 = .312$. This effect disappeared for those 1SD above the mean in Interdependent SC, $F(1, 29) = .096$, $p = .759$, $\eta_p^2 = .003$. Upper α suppression was no greater for norm-violating behaviors than for normal behaviors.

Second, in the control priming condition, the main effect of Behavior type was not significant, $F(1, 26) = 2.29$, $p = .142$, $\eta_p^2 = .081$. The effect of Interdependent SC in Figure 17-B (left panel) did not achieve statistical significance, $F(1, 26) = 1.27$, $p = .270$, $\eta_p^2 = .047$. Neither did the Behavior type x Interdependent SC interaction, $F(1, 26) = 2.01$, $p = .169$, $\eta_p^2 = .072$.

Perceived Severity of Norm-Violations

A preliminary analysis performed on the strong vs. weak norm-violating behaviors, showed a significant main effect of the extent of norm violation, $F(2, 54) = 663.73$, $p < .001$, $\eta_p^2 = .925$. Thus, in this analysis, we did not collapse the two norm violation conditions. In an ANOVA performed on the perceived severity of norm violation for each of the two rounds separately, only the main effect of Behavior type was significant, $F(2, 53) = 750.49$, $p < .001$, $\eta_p^2 = .934$ and $F(2, 53) = 623.44$, $p < .001$, $\eta_p^2 = .920$ for the first and second rounds, respectively.

Across the two rounds, the normal, weakly violating and strongly violating behaviors were all rated as significantly different from each other (*M*s = 1.09, 2.10 and 2.90), *ps* < .001. The remaining effects did not reach statistical significance, *p*s > .089.

Effects of Independent SC

Subsequently, we performed the same analysis after replacing interdependent SC with independent SC. We also tested the difference between interdependent and independent SC (interdependence - independence). Unlike some prior work suggesting that the effect of interdependent SC is mirrored in the effect of independent SC, we found no effect of independent SC.

As for N400, when independent SC was used instead of interdependent SC, the 3-way interaction involving Behavior type, Prime, and SC was not significant, $F(1, 55) = 1.77$, $p = .189$, $\eta_p^2 = .031$. When the difference between the two SCs was used the Behavior type, Prime, and SC interaction was significant, $F(1, 55) = 7.14$, $p = .010$, $\eta_p^2 = .115$. On upper α suppression, when independent SC was used instead of interdependent SC, the 3-way interaction involving Behavior type, Prime, and SC was not significant, $F(1, 55) = 1.054$, $p = .309$, $\eta_p^2 = .019$. When the difference between the two SCs was used the Behavior type, Prime, and SC interaction was significant, $F(1, 55) = 4.14$, $p = .047$, $\eta_p^2 = .070$. Lastly, on the perceived severity measure, we found no effect of independent SC as in the analysis with interdependent SC reported above.

Relationship Among the Three Indicators of the Response to Norm Violations

Table 5. *Correlations between (1) the norm violation N400, (2) upper α suppression for norm-violating (vs. normal) behaviors, and (3) perceived norm-violation for norm-violating (vs. normal) behaviors.*

	N400	Upper α suppression

Upper α suppression	0.176	1
Perceived severity of violation	0.026	-0.105

As the last step of our analysis, we examined the correlations among the three indices of the response to norm violations: norm-violation N400, upper α suppression for norm-violating (vs. normal) behaviors, and perceived norm-violation for norm-violating (vs. normal) behaviors. As shown in Table 5, the correlations were all quite small and statistically non-significant.

Discussion

The present work shows that people respond to norm violations very differently depending on both pathogen threat priming and interdependent SC. In the threat priming condition, the effect of norm violation was observed only for those low in interdependent SC. For these individuals, both N400 and upper α suppression were stronger for norm-violating behaviors than normal behaviors. But for those high in interdependent SC, these effects disappeared. This pattern supports the hypothesis that interdependent SC has an analgesic effect when there is an imminent threat. In contrast, in the control prime condition, the effect of norm violation was observed only for those high in interdependent SC. For these individuals, N400 was stronger for norm-violating behaviors than for normal behaviors. This is consistent with the idea that under ordinary circumstances, people high in interdependent SC are more sensitive to social norms. Notably, the heightened response to norm violations for those high in interdependent SC in the control condition was observed for N400 (an index of the detection of norm violations), but not the upper α suppression measure (an index of vigilant attention to norm violations). Perhaps, under ordinary circumstances, even when people are sensitized to norm violations due to their interdependent SC, there is no strong need to monitor norm violations and thus to be vigilant.

It is noteworthy that the effect we observed for interdependent SC was unique to this SC. Unlike some available studies that show the effect of interdependent SC is mirrored by independent SC (Goto et al., 2010; Kitayama et al., 2020; Na & Kitayama, 2011; Park & Kitayama, 2014), we found no effect of independent SC. It might be the case that some functions of interdependent SC, such as promoting social harmony, can be achieved through reduced propensities toward independence. In such situations, the effect of interdependent SC would be mirrored by a contrasting effect of independent SC. However, the function of interdependent SC that is relevant to the present work was to yield a sense of security or protection when a threat was imminent. It might not be possible to achieve this effect by reducing the level of independence. Future work must elaborate on this line of analysis and determine the precise conditions in which the two SCs have mirroring or unique effects.

Mechanisms Underlying N400 and Upper α-Suppression

Remember in the current procedure, the same set of 102 stimuli were presented twice in separate rounds. The predicted interaction between Prime and Interdependent SC was robust across the two rounds for N400 (which indexes the detection of norm violations). However, it was robust only for the first round for upper α-suppression (which indicates vigilance for them). While unpredicted, this discrepancy may reveal distinct mechanisms underlying the detection (N400) and the vigilance (upper α-suppression) to norm violations.

To detect a norm violation, one must retrieve a relevant norm, keep the norm active in working memory, and compare the target behavior against the norm (Kahneman & Miller, 1986). If the target behavior does not match the norm, then N400 will ensue. The finding that the N400 effect is strong in the second round suggests that the norm accessibility is fairly stable across the two rounds. If the accessibility is made high (or low), it remains high (or low) throughout. When a violation is detected, people may allocate attention to it (as indicated by the upper α-suppression). This attention is a precautionary measure taken against any danger the behaviors could be posing, which may be only salient when there is cause for alarm, such as in the threat condition. At first glance, the disappearance of the vigilance response in the second round might seem puzzling as the N400 measure shows that the effect of the present priming manipulation persisted over the two rounds. Upon closer scrutiny, however, this effect might reveal a hitherto unappreciated mechanism that could be of substantial significance for adaptation and survival.

Imagine that you have encountered a novel stimulus, say a person who is acting "strangely." This encounter may be alarming. Then, imagine that nothing adverse has happened afterward. You may classify the behavior as "safe." The "safety-tag" attached to the person may enable you to approach the same person more proactively, or perhaps in a less guarded fashion when you see him or her next time. A "safety-tag" mechanism like this could be responsible for the mere exposure effect, wherein repeated exposure to novel stimuli results in increased liking (Zajonc, 1968). In the present context, when a norm-violating behavior is presented for the first time under threat, it generates an alarm response (indicated by the upper α suppression) for those low in interdependent SC. However, by design, in the present procedure, nothing adverse occurs upon the presentation of the behavior. As a consequence, the behavior may be tagged as safe. When the behavior is presented for the second time, it will still generate N400 since the mismatch between the behavior and the relevant norm remains. However, the "safety tag" attached to it may override any precautionary alarm responses, including the upper α suppression. This potential mechanism must be tested more closely in future work.

Why Did Self-Report Show No Effects of Either Threat or Interdependent SC?

Given the consistency of our findings for the two disparate neural measures of the response to norm violations under threat, it is noteworthy that the self-report measure of the severity of norm violation showed no comparable evidence. To understand the theoretical significance of the dissociation between the neural measures and the self-report measure, we must recognize some uniqueness of the psychological reactions to threat.

The threat network of the brain is likely to involve the amygdala (AMG), the anterior insula (aINS), and the anterior cingulate cortex (ACC), among others. The pathogen threat manipulation may activate this network (Kitayama & Tompson, 2015). Evidence shows that monitoring of errors and conflicts (including norm violations) implicate the ACC (Carter & van Veen, 2007; Swick & Turken, 2002). Further, vigilance is a function of perceptual processing that is modulated strongly by the AMG activity. Accordingly, when the threat is primed, both ACC and AMG are activated (along with aINS). The increased activity of ACC and AMG would enhance the ability to both detect norm violations (N400) and to become vigilant to the violation (upper α suppression). However, neither ACC nor AMG is directly related to the cognitive appraisal of norm violations. Hence, there is an ample reason why there is a substantial dissociation between neural responses and self-report. Indeed, cognitive dissonance as a state of self-threat is barely accessible to self-report (Nisbett & Wilson, 1977), even though it comes with a distinct pattern of activation of its neural mechanisms involving aINS and ACC (Kitayama & Tompson, 2015). Given these findings, it might now be more meaningful to ask when the two might coincide and if they do, why.

Limitations and Conclusion

Some limitations of the current work must be acknowledged. First, our work leaves open the question of whether the current evidence would generalize across a wider array of threats. For example, natural disasters, such as earthquakes and tsunamis, and social adversities such as wars and joblessness. It is possible that threat in general leads to tightening of norms, as implied by some existing analyses (Gelfand et al., 2011). Moreover, interdependence may defray the impact of all such threats. At the same time, the threat of pathogen contamination may be unique in numerous ways (Ackerman et al., 2018; Sng et al., 2018). Indeed, other threats such as warfare and resource scarcity may also be unique in theoretically meaningful ways. Future work must address whether the current results would extend to other types of threats.

Second, in the current work, we did not specify whether the norm violator was an ingroup vs. outgroup member. Prior work shows that external threats, such as pathogen threats, typically entail ingroup favoritism, outgroup derogation, or both (T. Ji et al., 2019). It is not clear whether the responses to norm violations studied here might be linked directly to either ingroup favoritism or outgroup derogation. Nevertheless, it might prove useful to explore the effect of group membership within the current paradigm.

Third, whereas EEG offers high temporal resolution, it lacks spatial resolution (Luck, 2014). Future work may utilize functional magnetic resonance imaging to better understand the neural substrates involved in different facets of norm tightening, including vigilance, monitoring, and punishment (Buckholtz & Marois, 2012). Fourth, our work drew only on a U.S. college student sample. It is of theoretical interest to test whether our findings would generalize to other cultures, in which the sense of community is thought to be chronically higher and culturally more elaborated (Markus & Kitayama, 1991). It is possible that in these societies, complacency responses might be likely even for those low in interdependent SC since the high levels of interdependence of society at large may be sufficient to provide an analgesic effect on an impending threat. Lastly, our EEG measure of sustained attention is based on extensive prior work (Klimesch, 2012). However, in future work, these findings must be supplemented with eye tracking and other behavioral indicators of vigilance.

These limitations notwithstanding, our work shows that interdependent SC may have important consequences on the perception and coping with external threats. As such, it may offer unique implications for the coronavirus (COVID-19) pandemic in 2020. Major outbreaks of the virus are being reported in social gatherings of a large number of people. Moreover, evidence shows that societies that normatively encourage social openness exhibit faster spread of the disease during the pandemic (Salvador, Berg, et al., 2020). The sense of community or interdependence, plausibly enhanced in these groups, might have fostered complacency, as the threat of infection became increasingly evident. Individuals may have become looser in norm enforcement, thereby substantially increasing the chances of pathogen infection. This public health implication of the current theorizing may deserve a careful assessment in the future.

Study 3[12]

Over the last several months, a novel strain of coronavirus (SARS-CoV-2) has spread across the globe causing the COVID-19 pandemic. While there is substantial cross-national variation in the damage incurred by the virus, little is known about the factors that contribute to this variation. It is commonly accepted, however, that the virus transmits through social contact.

[12] This study is based on: Salvador, C.E., Berg, M.K., Yu, Q., San Martin, A. & Kitayama, S. (2020) Relational Mobility Predicts Faster Spread of COVID-19: A 39 Country Study, *Psychological Science.* https://doi.org/10.1177/0956797620958118.

Hence, viral transmission could increase as social contact becomes more frequent and variable. We thus investigated whether country-wise vulnerability to COVID-19 might vary systematically based on social ecologies that encourage or discourage social contact.

Our focus is on relational mobility (RM), the extent to which it is easy to form new relationships and terminate current ones in any given society (Yuki & Schug, 2020). In societies low in RM, interdependence with close others is valued (Markus & Kitayama, 1991). Relationships are typically ascribed by social roles and restricted to close others (Adams, 2005). Conversely, in societies high in RM, social relationships tend to be freely chosen, and more expansive. People can form new relationships and leave former ones at will. They thus tend to be socially open (Schug et al., 2010). The resulting social ecologies would increase the opportunity for interaction with a greater number of individuals outside each person's primary social groups (e.g., close inner circle of friends). Thus, high RM may put people at particularly high risk for contracting an infectious disease like COVID-19.

We tested whether country-wise RM scores (Thomson et al., 2018) would positively predict the growth of cases and deaths due to COVID-19. The growth (the rate of increase) is unlikely to be affected by reporting biases and testing availability, as long as the latter factors are constant. It would therefore be important to examine a short initial period of growth. At the same time, it is necessary to test a sufficiently long period to obtain reliable estimates of the growth rate. To simultaneously meet these two competing demands, we analyzed the first 30 days of country-wise outbreaks in the main analysis. This analytic strategy also enabled us to capture the COVID-19 spread prior to lockdowns.

Methods

Data

Main variables. We retrieved data on daily confirmed COVID-19 cases and deaths by country from a public repository updated daily by the Johns Hopkins University Center for Systems Science and Engineering (https://github.com/CSSEGISandData/COVID-19). Our current results are based on data up until July 21, 2020. RM scores were obtained from Thomson et al. (2018), who measured RM by assessing the extent to which people perceive others in their local communities are socially open and, thus, seek new friendships while exiting unsatisfactory relationships. They administered a 12-item scale of RM to a large number of adults, recruited with Facebook ads, in 39 countries, and found systematic cross-cultural variation. A series of analyses with a wide range of culture-level indicators of behavioral outcomes shows the validity of the RM score. For example, RM predicts the national levels of general trust, self-disclosure, intimacy, and social support (Thomson et al., 2018).

We followed prior work (Berg et al., 2020), and included countries if they had reported at least 15 days of data, starting with the day of the first 100 confirmed cases as ‘day 1’. For deaths, we included countries with at least 15 days of data, starting with the first day of at least 1 reported death as ‘day 1.’ All 39 countries met this criterion.

The 39 countries included are listed in Table S2, which also shows the dates for the first 100 confirmed cases, the first confirmed death, and the date of national lockdown if it was instituted, for each of the countries. In many cases, the lockdown occurred during this period. Even in those cases, it occurred more than halfway through the period. Since it takes a certain amount of time (usually several weeks, based on an estimate for the 1918 influenza pandemic by Bootsma & Ferguson, 2007) for any lockdown to have an effect, it would seem reasonable to ignore any effect of state-imposed lockdowns on the current analysis. This point is arguably valid in a robustness check with the first 15 days of data.

Demographics. Following prior work (Berg et al., 2020), several demographic variables were included as covariates. Total population was added because larger groups of people will have more cases and deaths. Median age of the total population (in years) was included since older adults are more susceptible to disease. Population density (in persons per square kilometer) was used because it is likely to foster greater social contact, resulting in greater chances of infection. Net migration (persons entering country minus persons exiting country, per 1000 people) was included so as to control for population movement. These four statistics were compiled from the United Nations Department of Economic and Social Affairs World Population Prospects 2019 (United Nations, Department of Economic and Social Affairs, Population Division, 2018). Gross domestic product (at purchasing power parity) per capita (GDP per capita in thousands), tourism rates and percent urban were included to control for economic development, the influx of foreigners and how urban the country is (The World Bank, 2018).

Cultural dimensions. Three cultural dimensions were tested as potential confounding variables. First, Hofstede's index of individualism (Hofstede, 1980) was used because its conceptual equivalent (independent self-construal) is positively correlated with RM (San Martin et al., 2019; Thomson et al., 2018), consistent with the notion that freedom to choose is an important facet of independent self-construal (Markus & Kitayama, 1991). Scores are based on responses to a series of questions asked to employees of a large IT company across countries. Scores were available for 35 of the 39 countries. Second, the efficiency in governmental operations might promote more effective coping with COVID-19. We used the World Bank's Government Efficiency Index -- an index that shows the public sector's performance in managing and regulating the political economy (retrievable at: https://bit.ly/34lXAT9). The index varies from 1 (very inefficient) to 5 (highly efficient). Scores were available for 34 of the

39 countries. Third, recent research suggests that the tightness (vs. looseness) of social norms could be an adaptation to threats, including pathogen threats (Gelfand et al., 2011). Tightness might then lower the growth rate of cases and deaths. The index, adopted from Gelfand et al. (2011), is an arithmetic mean of responses to a 6-item questionnaire assessing the perceived rigidity of social norms in one's own country. Scores were available for 23 of the 39 countries tested.

BCG. Berg et al. (2020) tested 139 countries and found that those with universal Bacillus Calmette-Guérin (BCG) vaccination policies show a reduced rate of the growth of both COVID-related confirmed cases and deaths (Berg et al., 2020). We thus used BCG policy status (with or without BCG policy) as another covariate. Data was available for 37 out of the 39 countries.

Robustness Checks

Underreporting of cases. Countries may vary in underreporting due to, for example, governmental information suppression. To account for this, we adopted an underreporting index devised by Russell and colleagues (Russell et al., 2020). These researchers first computed a case fatality ratio (CFR) in each country that is adjusted for delay between admission to the hospital and death. Then they computed the ratio of the best empirical estimate of CFR (1.4%) to the adjusted CFR for each country. If this ratio is smaller than one, it indicates underreporting of cases. Some countries, such as Italy, Spain, and Morocco, show substantial underreporting (underreporting index < 10%), whereas some others, such as Norway, Israel, and South Korea, show very low underreporting (underreporting index > 50%). We used country-wise underreporting scores on April 15, 2020, downloaded from https://github.com/thimotei/CFR_calculation. This index was available for 29 of the 39 countries.

This index can be defined as a measure of inaccuracy of the report of cases. In one analysis, we used it as a weight, with the data from countries with higher values of this index weighed more than the data from those with lower values. The index can also indicate under-estimation of the number of cases reported. Thus, in another analysis, we also used it as an additional covariate. These analyses were performed only for the number of confirmed cases.

Testing availability. We also adopted the number of COVID-19 tests per case. This data was obtained from: https://ourworldindata.org/grapher/the-number-of-tests-for-each-confirmed-case-since-5th-death. In countries such as France and Mexico, the tests per case ratio was low, suggesting that testing was not readily available. Conversely, in countries like New Zealand, Australia and Taiwan, this ratio was high, implying higher degrees of testing availability. Data was available for 29 out of the 39 countries. As with the reporting index, we conducted two analyses with these scores. First, we weighed countries with more testing more heavily presumably because more testing would lead to more accurate counts of cases. Second, we included it as a covariate since less testing can also lead to an underestimation of cases reported. These analyses were performed only for the number of confirmed cases.

15/60 days of country-wise outbreaks. In the main analyses, we focused on the initial 30-day period of country-wise outbreaks. To ensure the robustness of the pattern, we carried out two analyses that used a half (15 days) or twice as many days (60 days) as in our standard analysis.

Interpolation of RM data with cultural distance scores. In a recent study, Muthukrishna and colleagues (2020) offered an index of cultural distance between each of the pairs of 80 countries (Muthukrishna et al., 2020). The distance index is based on geometric distance across many attitudinal items culled from the World Value Survey. The 80 countries tested by Muthukrishna et al. (2020) included 34 of the 39 countries for which RM scores were available. By averaging the RM scores for the 34 countries after weighting each RM score with the inverse of the cultural distance score of each of the countries, we interpolated the RM score for each of the 46 (= 80-34) countries. For example, consider one of the 80 countries tested by Muthukrishna et al. (2020) that did not have an RM score (designated as RM_j). This country has a cultural distance score (designated as D_{ij}, where i = 1 to M) with each of the M countries with RM scores (designated as RM_i). The RM score for this country was computed by the following formula:

$$RM_j = \frac{\sum_{i=1}^{m} RM_i * \frac{1}{D_{ij}}}{\sum_{i=1}^{m} \frac{1}{D_{ij}}}$$

In this instance, M = 34. The RM scores imputed for the 46 countries were used to repeat the same set of analyses for the 85 (= 39 + 46) countries.

To assess the validity of this procedure, we repeated the same procedure for the 34 countries for which the RM scores were available. In this case, to interpolated the RM score for a target country by averaging the RM scores for the remaining 33 countries (i.e., all countries for which RM scores were available minus the target country) after weighting each score with the inverse of the cultural distance between the target country and each of the 33 countries. In this instance, *M* = 33. The correlation between actual RM scores and the interpolated RM scores was .596, $p < .001$.

Statistical Analysis

All analyses were conducted on up to 30 days of data from each country. Linear mixed effect models with restricted maximum likelihood estimation were used to analyze both the number of cases and deaths. We natural log-transformed both cases and deaths since the growth of cases and deaths is known to be exponential in an early period of a pandemic. Day was centered so that main effects could be interpreted as differences at the mean day of the growth curve. Total population was natural log-transformed to reduce skewness. All demographic and cultural variables were z-scored. We estimated both a random intercept and random slope across days to allow for the heterogeneity of growth curves across countries. We included another random effect that accounts for countries being nested in Geographic regions defined by the World Bank (The World Bank, 2019), because these nations are not independent and have some shared cultural and political history.

We tested three models. Model 1 included Day, RM, the Day x RM interaction. To control for population size, both Population size and its interaction with Day were also included. Model 2 added all the demographic variables to Model 1. All demographic variables were available for all 39 countries, with the exception of the Tourism measure for Taiwan. Model 3 included only those covariates that had an interaction with Day at $p < .10$ in Model 2. We report the statistics from Model 3 in the text. All other statistics can be found in relevant tables. Regarding the remaining covariates (e.g., cultural values, BCG policy status, underreporting, and testing availability), data were often missing for some countries. Thus, to retain the maximal number of countries, they were tested one at a time in a separate analysis. When a full model failed to converge, we dropped the intercept-slope covariance of the random effects (Country and Geographic region). This is arguably the most conservative strategy, as the covariance terms would be automatically dropped once one of the two terms defining the covariances was dropped (Bates et al., 2018). When the model still did not converge, we dropped the Geographic region as a nesting factor although this happened only in for a few robustness checks. Correlations among the cultural and demographic variables are given in Figure S17.

Results

Main Analysis

Confirmed cases. Results are summarized in Table 6-A. The main effect of Day was significant, b = .121, p = .006, showing an increase in COVID-19 cases over time. Importantly, it was qualified by a significant Day by RM interaction, b = .112, p = .002. Fig.17-A shows the growth of confirmed cases in the natural log scale. Countries higher in RM showed a faster growth of confirmed cases over time compared to countries low in RM. The main effect of RM was also significant, b = 1.80, p = .010. This main effect, however, is a necessary consequence of the steeper slope in the high (vs. low) RM countries. Hence, in and by itself, it does not carry any theoretical significance. The beta coefficients indicating the growth rate are plotted in Fig. 17-B, which shows that the relationship between the growth rate and RM is robust and unlikely to be due to any outliers. Among the demographic variables, total population (designated as Population), migration and tourism had an impact on the growth rate. Countries with larger populations had a faster rate of the growth of confirmed cases, as indicated by the Day x Population interaction, b = .021, p = .003. Moreover, countries with more migration and tourism had a faster rate of the growth of confirmed cases, as indicated by the Day x Migration and Day x Tourism interaction, b = .014, p = .017 and b = .024, p = .001, respectively. The remaining covariates had no significant effect on the growth rate of confirmed cases.

Table 6. *Regression coefficients predicting the number of confirmed cases (A) and deaths (B) over the first 30 days of country-wise outbreaks. Models vary in the covariates included. Model 1 includes only total population (called Population). Model 2 includes all demographic covariates. Model 3 includes only those that prove at least marginally significant in Model 2. The results are based on all 39 countries, except in Model 2, which is based on 38 countries because of a missing value for Tourism in one of the countries (Taiwan).*

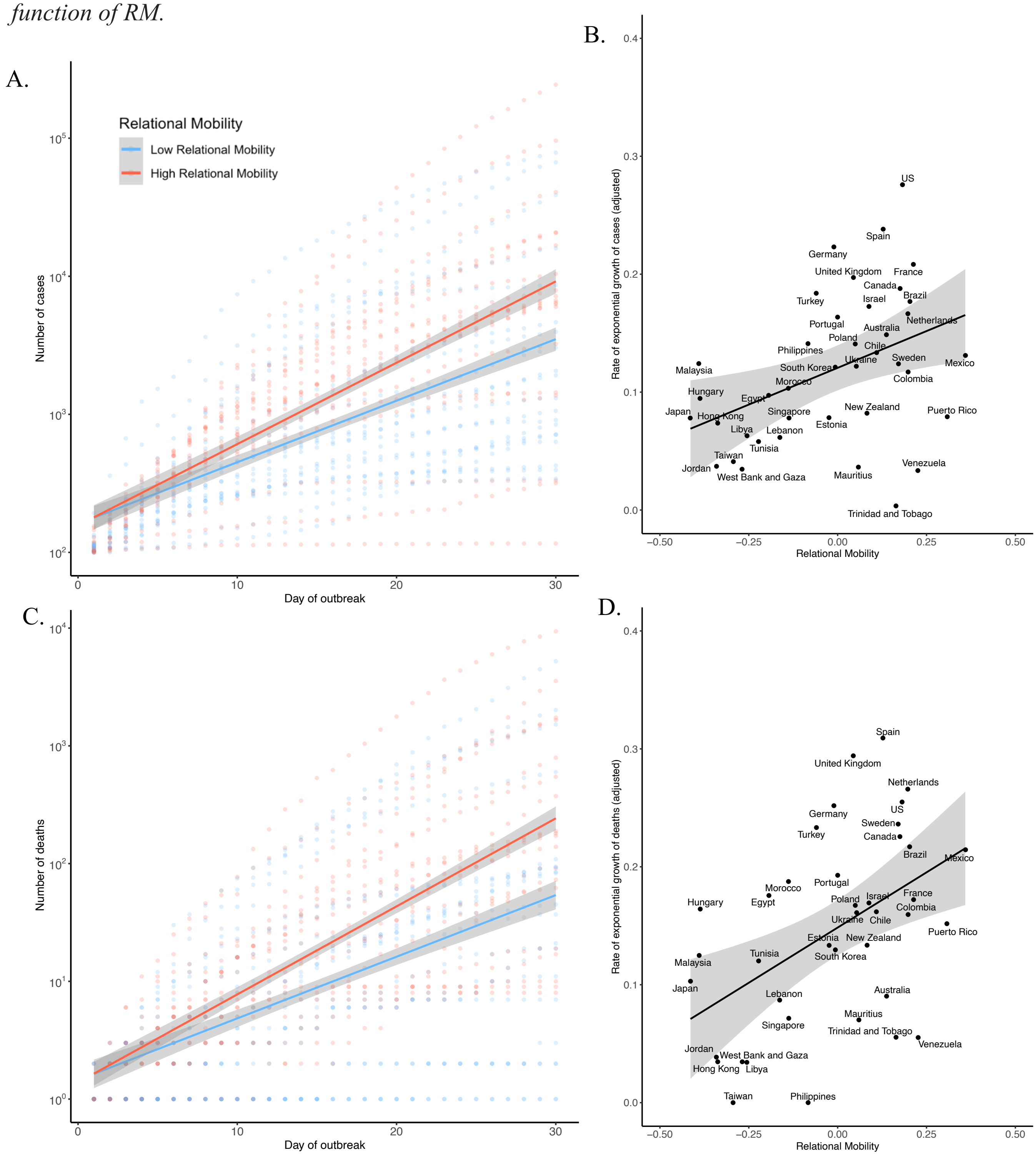
	Model 1			Model 2			Model 3		
A. Predictor	b	t	p	b	t	p	b	t	p
Intercept	7.023	20.394	<.001	6.924	45.445	0.002	6.916	38.220	<.001

Day	0.131	6.109	0.005	0.120	17.055	0.011	0.121	12.830	0.006
Relational Mobility	2.312	3.268	0.002	1.446	2.095	0.055	1.798	2.791	0.010
Population	0.647	4.777	<.001	0.351	2.493	0.019	0.356	2.744	0.011
Migration				0.263	2.090	0.046	0.248	2.171	0.038
GDP				0.103	0.433	0.668			
Population Density				-0.360	-2.161	0.039	-0.251	-2.139	0.040
Tourism				0.322	2.218	0.035	0.339	2.521	0.017
Percent Urban				0.033	0.231	0.819			
Median Age				0.115	0.658	0.518			
Day x Relational Mobility	0.131	3.610	0.001	0.082	2.514	0.026	0.112	3.513	0.002
Day x Population	0.039	5.411	<.001	0.022	3.233	0.003	0.021	3.333	0.003
Day x Migration				0.013	2.197	0.037	0.014	2.532	0.017
Day x GDP				0.016	1.398	0.173			
Day x Population Density				-0.014	-1.732	0.094	-0.004	-0.726	0.473
Day x Tourism				0.022	3.197	0.003	0.024	3.586	0.001
Day x Percent Urban				-0.003	-0.375	0.710			
Day x Median Age				0.001	0.157	0.877			
R^2 fixed effects		0.615			0.767			0.751	
R^2 fixed and random effects		0.978			0.973			0.972	

	Model 1			Model 2			Model 3		
B. Predictor	b	t	p	b	t	p	b	t	p
Intercept	2.618	7.230	0.002	2.665	8.513	0.018	2.618	7.230	0.002
Day	0.149	6.743	0.002	0.149	8.592	0.002	0.149	6.743	0.002
Relational Mobility	2.073	1.860	0.073	1.689	1.392	0.189	2.073	1.860	0.073
Population	0.472	2.320	0.027	0.361	1.455	0.158	0.472	2.320	0.027
Migration				0.225	1.037	0.309			
GDP				0.234	0.569	0.574			
Population Density				-0.361	-1.254	0.220			
Tourism				0.119	0.475	0.638			

Percent Urban				0.112	0.459	0.650			
Median Age				0.220	0.721	0.481			
Day x Relational Mobility	0.144	2.727	0.010	0.103	1.889	0.070	0.144	2.727	0.010
Day x Population	0.031	3.172	0.004	0.024	2.223	0.036	0.031	3.172	0.004
Day x Migration				0.013	1.411	0.170			
Day x GDP				0.016	0.933	0.358			
Day x Population Density				-0.020	-1.638	0.113			
Day x Tourism				0.011	1.026	0.314			
Day x Percent Urban				0.001	0.142	0.888			
Day x Median Age				0.018	1.335	0.192			
R^2 fixed effects		0.499			0.577			0.499	
R^2 fixed and random effects		0.969			0.970			0.969	

Figure 17. *The rate of growth of confirmed cases and deaths of COVID-19 during the first 30 days of country-wise outbreaks. A. Growth curves on a log scale for confirmed cases. The solid red (or blue) line designates the growth estimated for the country one SD above (or below) the grand mean of RM. Blurred red (or blue) lines show individual countries that are higher (or lower) than the RM grand mean. B. Country-wise growth rates of confirmed cases as a function of RM. C. Growth curves on a log scale for deaths. D. Country-wise growth rates of deaths as a function of RM.*



RM accounted for a sizable amount of variance in the number of confirmed cases. We hypothesize that RM fosters a higher rate of the increase by Day (as captured by the Day x RM interaction) and, by so doing, increases the number of cases by the end of the study period. Hence, the total amount of variance explained by RM is the sum of the variance explained by the Day x RM interaction and the RM main effect (obtained by subtracting the variance explained by a model including Day only from a model including Day, RM, and Day x RM). This combined variance was 8.4%.

Deaths. Results are summarized in Table 6-B. The main effect of Day was significant, $b = .149$, $p = .002$, showing an increase in the number of deaths across time. The Day x RM interaction was also significant, $b = .144$, $p = .010$. Deaths increased over time, and were greater for countries high in RM (Figure 17-C). This effect was statistically significant in both Models 1 and 3 although it was marginal in Model 2. As shown in Figure 17-D, it is not due to any outliers. As in the analysis of confirmed cases, the Day x Population interaction was significant, $b = .031$, $p = .004$, showing that countries with larger populations had a higher growth rate of deaths. Other demographic variables had no effect. RM accounted for 7.5% of the variance in the number of deaths.

Controlling for Other Cultural Variables

Individualism. In an analysis performed on 35 of the 39 countries, after controlling for individualism, we found a significant Day x RM interaction for cases, $b = .084$, $p = .010$ (Table S3-A). This interaction was marginal for deaths, $b = .101$, $p = .063$ (Table S3-B).

Government efficiency. In an analysis performed on 34 of the 39 countries, after controlling for government efficiency, the Day x RM interaction remained significant for both cases and deaths respectively, $b = .116$, $p = .001$ and, $b = .115$, $p = .032$ (see Tables S4-A and B).

Tightness. In an analysis performed on 23 of the 39 countries, after controlling for Tightness, the Day x RM interaction was significant for cases and non-significant for deaths, b = .100, p = .014 and b = .096, p = .112, respectively (Table S5-A and B). The weaker Day x RM interaction may be due to diminished sample size (= 23).

BCG. In an analysis performed on 37 of the 39 countries, after controlling for BCG policy status, the Day x RM interaction was significant for cases, b = .088, p = .004 (Table S6-A). This effect was no longer significant for deaths, b = .083, p = .160 (Table S6-B).

Robustness Checks

Underreporting of cases. In an analysis performed on confirmed cases on 29 out of the 39 countries, with the Russell et al. (2020) underreporting index as a weighting factor, the Day x RM interaction remained significant, b = .095, p = .004 (Table S7-A). When the underreporting index was used as an additional covariate, the Day x RM interaction remained significant, b = .080, p = .025 (Table S7-B)

Testing availability. In an analysis performed on cases for 29 out of the 39 countries, with the test availability index as a weighting factor, the Day x RM interaction remained significant, b = .085, p = .015 (Table S8-A). When it was used as an additional covariate, the Day x RM interaction remained significant, b = .076, p = .026 (Table S8-B).

The first 20 cases. In an analysis performed on 38 out of the 39 countries, with the 20 (rather than 100) cases as the cutoff, the Day x RM interaction remained significant for cases, b = .131, p = .010 (Table S9).

The first-15 days of country-wise outbreaks. When the data from the first 15 (rather than 30) days were analyzed, the Day x RM interaction remained significant for cases, b = .118, *p* = .029 (Table S10-A). This interaction was no longer significant for deaths, *b* = .134, *p* = .172, plausibly due to the reduced amount (one half) of data included in this analysis (Table S10-B).

The first-60 days of country-wise outbreaks. When the data from the first 60 (rather than 30) days were analyzed, the Day x RM interaction remained significant for cases, *b* = .039, *p* = .038 (Table S11-A) and deaths, *b* = .086, *p* = .001 (Table S11-B).

Interpolation of RM data with cultural distance scores. Lastly, we examined whether the same results were present if we increased the number of countries from 39 to 85 by using the interpolated RM scores for 46 countries for which the RM scores were unavailable (Figure S18). As shown in Table S12, the Day x RM interaction was significant for both cases and deaths, *b* = .090, *p* = .007 and *b* = .113, *p* = .022, respectively.

Discussion

Our findings show that each country's social openness (called relational mobility, RM) positively predicts the growth rate of both confirmed cases and deaths of COVID-19 during an early period of country-wise outbreaks. The results for cases were robust across a number of analyses that controlled for underreporting, testing availability, demographic variables, and cultural traits such as individualism, tightness, and government efficiency. Although a comparable effect for deaths was less robust when the inclusion of covariates necessitated a reduction of the number of countries that could be included, it was significant in the main analysis that included all the 39 countries. The RM effect was sizable. RM accounted for approximately 8% of variance for both cases and deaths. To illustrate, the U.S. is among the highest in RM. If it had been low in RM, comparable to Japan (one of the lowest in RM), the deaths at the end of the 30-day study period would have been 8.2% (281) of the actual number reported (3417).

The COVID-19 pandemic has proven extremely difficult to contain. Without any vaccines available, the only viable defense against the virus is to keep sufficient physical distance from others, particularly, strangers. Our data suggests that this practice of social distancing could prove indispensable in countries high in RM. In such countries, individuals might seek new friends and acquaintances outside of their primary groups (Thomson et al., 2018); they might be more outgoing (H. Kim et al., 2018); and they might not easily suppress emotions in face-to-face encounters (Kraus & Kitayama, 2019). These psychological propensities could make social ecologies particularly vulnerable to infectious disease.

Some limitations must be noted. First, we focused only on an early period of outbreaks to minimize various confounds. Second, country is admittedly a crude unit of analysis. Third, our sample size was limited by the availability of RM scores. Nevertheless, our data is the first to show a substantial effect of socio-cultural ecologies on the peril of infectious disease.

In closing, since RM is an important expression of the values of independence, egalitarianism, and freedom of movement and choice (Markus & Kitayama, 1991), the present findings may be posing a fundamental challenge to all countries aspiring to promote these values. Expertise of social and behavioral sciences (Van Bavel et al., 2020) may therefore be strongly called for to devise strategies to fight against infectious disease without compromising the core values of democracy.

Chapter IV: The Latin American Self

Study 1[13]

Latin America and the Caribbean is the most populous region in the Americas, with over 641 million people (The World Bank, 2018). Despite encompassing a large portion of the globe, the region is underrepresented in social and cultural psychological research (Arnett, 2008; Henrich et al., 2010). Scholars often describe Latin Americans as collectivistic or interdependent (Greenfield et al., 2003; Kitayama & Salvador, 2017; Lisansky, 1981; Triandis, 1983; Triandis et al., 1984) . However, it remains unclear how Latin Americans might differ from other interdependent groups, particularly East Asians, the group that has been studied most often in the cultural psychology literature (Kitayama & Salvador, 2017; Markus & Kitayama, 1991) . In the present study, we propose that Latin America has nurtured expressive interdependence, a form of interdependence that sanctions emotional expression as a means for promoting social connections with others. To examine this hypothesis, we tested three cultural groups (Colombians, European Americans, and Japanese), with a comprehensive set of psychological tasks designed to assess different facets of interdependence (Kitayama et al., 2009). We anticipated that Colombians and Japanese would both be more interdependent than European

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[13] This study is based on: Salvador, C.E., Idovro Carlier, S., Ishii, K., Torres Castillo, C., Nanakdewa, K., Savani, K., San Martin, A. & Kitayama, S. (in revision) Expressive Interdependence in Latin America. https://psyarxiv.com/pw4yk/.

Americans. However, we also expected that the two interdependent groups would show distinct profiles: Colombians would be emotionally expressive, whereas Japanese would be less so.

Sources of Interdependent Cultural Ethos in Latin America

The interdependent ethos of Latin America today (Fuligni et al., 1999; Sabogal et al., 1987; Triandis, 1983) may be traced back to several historical roots. Before Columbus arrived at the shore of the Paria Peninsula in present-day Venezuela, Latin America was inhabited by a large number of indigenous groups, a number of which were hunters and gatherers. Other groups, such as the Mayas and the Incas, engaged in agriculture and built notable civilizations. These civilizations achieved technological advances in domains such as metallurgy, irrigation and textiles (Bethell, 1984). They placed a strong emphasis on collectivism, including loyalty to the primary groups, such as the family and the tribe (Pike, 1978). At the turn of the 15th century, these civilizations were uprooted by colonizers from Spain and Portugal.

The Europeans brought with them guns and steel that gave them distinct military advantages. Further, Europeans exposed Latin American natives to novel germs that they had never been exposed to. Widespread infection and death caused devastating damages to the indigenous populations, and paved the way toward eventual colonization of the entire region (J. Diamond, 1999). Of note, the two nations that conquered Latin America (Portugal and Spain) are the two of the most collectivistic countries in Europe (Hofstede, 1980), and have received substantial influences from the Middle East and Africa due to close geographic proximity. The colonizers also brought with them their languages and the Catholic religion. To date, more than 80% of the population in Latin America was raised Catholic (Pew Research Center, 2014). Compared to Protestantism, Catholicism focuses more on the group over individuals (Sanchez-

Burks, 2002). In combination, the European influences on Latin America tend to focus more on collectivism as opposed to individualism.

In addition to European religious and cultural influences, there have always been pervasive African influences in Latin America. During the 16th through 19th century, enslaved Africans were brought in much larger numbers to Latin America than to the United States and Canada. The collectivistic nature of African cultures (Adams, 2005; Tchombé et al., 2013) may have reinforced the interdependent ethos of Latin cultures. Since the European settlers were outnumbered by the indigenous and African people, the settlers sought to prevent rebellion by actively promoting unity across diverse ethnicities. In contrast to the United States, where various ethnic groups were largely kept separate, there was an emphasis on "mestizaje" or interracial and intercultural mixing in Latin Americans as a means to build a nation state (Martínez-Echazábal, 1998). As a consequence, today, Latin American countries have a shared national identity, official language, and overarching religion. Despite this unity at one level, the region is extremely heterogeneous, with influences from indigenous traditions, African influences, and European colonial influences.

Expressive Interdependence of Latin Culture

The brief discussion above shows that Latin America today has four important, extremely heterogeneous sources, i.e., the indigenous culture that existed prior to European colonization and continues to exist today, the culture of Spain and Portugal, the culture of Catholicism, and African cultural influences (which themselves are heterogeneous). These influences result in a unique juxtaposition of both diversity and commonality. One common thread across these four traditions stems from a strong emphasis on primary groups, such as family and kin-based groups, and an associated ethos of interdependence. Aside from this commonality, however, within the same locales, the four divergent traditions reside simultaneously. Thus, multiple languages, conventions, values and beliefs co-exist. Over the course of the last several hundred years then, there must have been a strong demand to overcome the diverse cultural, linguistic, and historical backgrounds in a collective effort to create interdependent, or collectivistic communities. This historical process may have culminated in a dynamic pattern of personal, interpersonal, and social processes, a pattern that may be shared across many Latin American cultures (Adams & Markus, 2004).

The need to create interdependent communities without common languages, conventions, and norms posed a challenge. However, there exists one powerful code of communication that does not require them. As a species, humans share a common emotional code. Drawing on a recent analysis by Niedenthal and colleagues (Niedenthal et al., 2019), we propose that over the past several centuries, Latin American cultures mastered the use of emotions as a means to communicate and promote mutual understanding among people with no shared explicit language.

One basis for this proposal comes from an index of historical heterogeneity of countries of the world (Putterman & Weil, 2010). The researchers first identified distinct ethnic groups in the year 1500 before the massive trend toward global migration started. Then, they quantified the historical diversity of 172 countries today by counting the number of source groups that contributed to them. This index takes on higher scores in nations that have high numbers of immigrants, such as the United States, Canada, and Australia. As may be expected from the analysis above, Latin American countries are also relatively high, indeed, much higher than, for example, most Asian countries.

Building on this work, Rychlowska and colleagues proposed that in countries with high levels of ethnic heterogeneity, a strong social norm to express emotions as they are felt emerged

(Niedenthal et al., 2019; Rychlowska et al., 2015; A. Wood et al., 2016). These scholars argue that in the absence of either common cultural knowledge or a common language, people utilize emotional signals to carry out social interactions. In one study, they found that across 32 countries, the historical cultural heterogeneity index significantly predicted the degree of endorsement of an emotion display rule of “expressing what is felt”. More recently, these scholars found that the historical heterogeneity index also explains differences in the self-reported expressivity of emotions (e.g., smiles and laughter) across a variety of countries and within the United States (Niedenthal et al., 2018). This same team found that the same index of historical cultural heterogeneity predicts the clarity of facial emotional expressions (A. Wood et al., 2016). Importantly, in all these studies, the historical index of cultural heterogeneity had an effect above and beyond an index of contemporary ethnic diversity of different countries. As may be predicted by their high historical heterogeneity, the clarity of facial expressions and the propensity to express smiles and laughter in Latin countries was quite high.

Based on this emerging work, we hypothesize that Latin Americans are interdependent, but they achieve interdependence by using emotional signals. Consistent with this analysis, several observers have proposed that one way emotional resonance is achieved in Latin culture is through the emotional disposition of *simpatía* (being likeable, pleasant and kind when interacting with others) (Holloway et al., 2009; Ramírez-Esparza et al., 2008; Savani et al., 2013; Triandis et al., 1984). Also consistent is a recent proposal that the Latino form of collectivism is convivial in that it focuses on joy and positive emotional expression in the context of social relationships (Campos & Kim, 2017; Ruby et al., 2012; Savani et al., 2013). This form of collectivism stands in contrast to the more emotionally restrained form of interdependence prevalent in East Asian cultures (Kraus & Kitayama, 2019; Murata et al., 2013; Tsai et al., 2016).

Varieties of Interdependence: Emotion-Expression vs. Emotion-Suppression

The hypothesis that Latin cultures are emotionally interdependent may substantially extend the horizon of the cultural psychological literature. Over the last few decades, this work has largely focused on comparisons between East Asians and European Americans (Heine, 2015; Kitayama et al., 2009; Markus & Kitayama, 1991). At present, it remains mostly unknown how Latin Americans would fit into this framework. In the current work, we propose that Latin America is similar to East Asia in that both regions have a commitment to interdependence. In this regard, the two regions can be contrasted against the independent ethos of European American culture. However, we propose that East Asians and Latin Americans are highly distinct in the specific strategies each region historically cultivated to achieve interdependence.

In testing these possibilities, we focus on implicit measures of interdependence. These measures are based on experimental tasks designed to assess various non-self-reflective psychological tendencies that constitute interdependence (vs. independence). These measures differ from self-reflective (and thus explicit) attitude and value questionnaires that are more typically involved in cross-cultural research (Hofstede, 1980; Schwartz, 1992; Triandis & Gelfand, 1998). The explicit measures are more susceptible to various biases such as social desirability, acquiescence, and reference-group artifacts (Heine et al., 2002; Peng et al., 1997). Moreover, many elements of culture are tacit rather than explicit. These tacit elements may be hard to assess with the explicit measures. Using the implicit measures, researchers have shown that East Asians are more interdependent, whereas European Americans are more independent (Kitayama et al., 2009).

The hypothesis that there are multiple forms of interdependence implies that different cultural groups or regions (say, Latin cultures and East Asian cultures) are both similar (since they share a common set of features of interdependence) and yet distinct (since each culture carries a distinctive set of features of interdependence). In other words, among the many features that are linked to interdependence, some are associated strongly with interdependence across cultures. These features may be called the core features of interdependence. Some other features, however, may be less pancultural. Instead, they may be more contingent on the social-ecological, historical, and economic factors of a given context (Kitayama & Uskul, 2011; San Martin et al., 2018; Talhelm et al., 2014). Such features may be called the subsidiary features. The core features make the varying cultures similarly interdependent, whereas the subsidiary features make them distinctive and unique.

Core features of interdependence (vs. independence). Which features would qualify as the core or as a subsidiary must eventually be decided both theoretically and empirically. In carrying out the current work, we adopted a working hypothesis that there are two core features of interdependence: holistic cognition and the social happiness (San Martin et al., 2018).

Holistic cognition implies a psychological tendency to attend to the context while processing a focal figure (Nisbett et al., 2001). If people are embedded in interdependent social relations, they will be cognitively attuned to others. This demand for processing a broader range of information in addition to the one that is most relevant to their personal goals and desires will make their cognition more holistic (Varnum et al., 2010). Research in culture and cognition over the last few decades has provided evidence for the predicted link between interdependence and holistic cognition. As compared to European Americans (considered independent), East Asians (considered interdependent) are highly holistic in social cognition (e.g., causal attribution) (Kitayama et al., 2009; M. W. Morris & Peng, 1994), spontaneous trait inference (Na & Kitayama, 2011), spatial attention (Kitayama et al., 2003, 2009; Masuda & Nisbett, 2001), judgements about focal objects (Goto et al., 2010) and dialectical (vs. linear) decision-making (L.-J. Ji et al., 2001). Although much of existing evidence comes nearly exclusively from the European American vs. East Asian comparisons, recent work has begun to show that the holistic cognitive tendencies extend to other interdependent cultures, including Arab regions (San Martin et al., 2018) and Latin America (de Oliveira & Nisbett, 2017).

Another feature of interdependence that may be tentatively assumed to be inherent in, and thus, a core of interdependence is the emphasis on social (vs. personal) predictors of happiness (San Martin et al., 2018). Interdependent people are more motivated to seek collective or communal goals than independent people (Kitayama & Park, 2014; Oishi, 2000). Hence, people high in interdependence may feel happier when they achieve the social (vs. personal) goals. Consistent with this expectation, Kitayama and colleagues (2006) tested self-reported intensity of various emotions across many social situations. They found that for Japanese (an interdependent group), happiness was predicted more strongly by socially engaging emotions (e.g., feelings of closeness to others) than by socially disengaging emotions (e.g., self-esteem). San Martin et al. (2018) observed this same pattern for Arabs. In contrast, this pattern was reversed for European Americans (an independent group), whose happiness is predicted more so by disengaging emotions than engaging emotions (Kitayama, Mesquita, et al., 2006; Kitayama et al., 2009). To the extent that social relations are tantamount to happiness, it would seem plausible that happiness in Latin culture is also contingent on social engagement rather than disengagement. Such a pattern would lend support to the working hypothesis that the social (vs. personal) predictor of happiness is one core feature of interdependence. However, at present, there is no empirical evidence substantiating the assumption in Latin regions. Our work is the first to explore this possibility.

Subsidiary features of interdependence (vs. independence). Unlike the core features, some other features of interdependence (vs. independence) are thought to be contingent on specific social ecologies and histories of different cultural groups and thus deemed subsidiary. Prior cross-cultural work on East Asians and European Americans shows that interdependence is linked to emotion suppression (vs. expression) (Kraus & Kitayama, 2019), which could explain why East Asians value low-arousal emotions more (Tsai et al., 2006). In East Asian societies, the expression of innermost feelings is seen as antagonistic to social harmony, and therefore, emotion suppression is highly valued (Kitayama & Salvador, 2017).

Latin cultures could be as interdependent as East Asian cultures. At the same time, as noted earlier, Latin cultures are high in historical heterogeneity and likely value emotional expressivity, possibly to the same extent or even more than European American cultures. When combined with the ethos of interdependence in Latin America, emotional expressivity can serve the function of forming and maintaining social relations. Conversely, for European Americans, emotional expressivity may primarily be a means for independence, that is, for displaying and validating one's innermost feelings (Chentsova-Dutton & Tsai, 2010). In this regard, although both Latin Americans and European Americans may be emotionally expressive, the predominant goal of emotional expression may turn out to be different.

Prior evidence provides some initial evidence for the foregoing analysis. Tsai and colleagues (2006) theorized that the desire for high arousal emotions is linked to the expression of personal influence, whereas the desire for low arousal emotions is conducive to social harmony. Consistent with this theorizing, they observed that European Americans are more likely to report that they want to feel high (vs. low) arousal positive emotions, but East Asians are more likely to report that they want to feel low (vs. high) arousal positive emotions (Tsai et al., 2006). Of importance, Ruby and colleagues (2012) extended this finding to show that Latin Americans (Mexicans) are more similar to European Americans than to East Asians, reporting a greater desire to feel high- (rather than low-) arousal positive emotions (Ruby et al., 2012). The Ruby et al. finding might seem puzzling if the goal for high arousal emotions were assumed to be universal across cultures. Nevertheless, our analysis implies that, unlike European Americans, Latin Americans prefer to experience positive high arousal emotions to form and maintain social relations. If so, they may show a greater tendency to express emotions that are socially engaging rather than disengaging. In this particular regard, Latin Americans may be more similar to East Asians than to European Americans, even though unlike East Asians, Latin Americans and European Americans share a strong desire to experience high (rather than low) arousal emotions.

In addition to suppression (vs. expression) of emotions, in the current literature, self-enhancement (a tendency to overestimate the value of the self) and self-effacement (a tendency to underestimate this value) are seen as an aspect of independence and interdependence, respectively (Heine et al., 1999; Kitayama et al., 1997). It is commonly assumed that independence requires a high value given to the personal self. Hence, the self is typically enhanced, with unrealistically positive appraisals. In contrast, interdependence is thought to require modesty, humility and thus self-effacement (a tendency not to overestimate the self) (Heine et al., 1999; Kitayama et al., 1997). However, these self-related motivational propensities may be best seen as culture-dependent strategies of achieving independence or interdependence.

Specifically, self-enhancement may be a means to reinforce the independence in European American cultures. This psychological tendency, however, could be linked to interdependence in societies where in-group protection is valued as a way to achieve interdependence. In such societies, self-assertion -- an isomorphic psychological tendency -- may be recognized as a signature of the commitment to the ingroup (San Martin et al., 2018). Consistent with this reasoning, San Martin et al. (2018) observed in a cultural region that has traditionally undergone intense tribal competitions (the Arab region), people are highly interdependent in the measures of both holistic attention and social happiness (the two features considered core). However, Arabs were highly self-assertive. San Martin et al. (2018) marshalled two pieces of evidence. First, they showed that Arabs portray the self as “bigger” than others (an effect called the symbolic self-inflation, Kitayama et al., 2009). Second, San Martin et al. (2018) also showed that Arabs reportedly experience more socially disengaging (vs. engaging) emotions. The researchers interpreted the latter finding to indicate self-assertion, insofar as the socially disengaging emotions (e.g., pride and self-esteem) are also more self-assertive than socially engaging emotions (friendly feelings and feelings of respect). The validity of this interpretation hinged on the auxiliary assumption that Arabs interpret socially disengaging emotions, not as showing the independence of the self (as assumed by Kitayama et al., 2006), but rather as signaling the self’s strength, prowess, worth, and the like.

How about Latin Americans? Savani et al. (2013) had both European Americans and Mexicans remember situations in which they felt good or bad. The participants then reported specific emotions they felt. The researchers found that both groups reported disengaging emotions more than engaging emotions, although this effect was more pronounced for European Americans than for Mexicans. Following San Martin et al. (2018), we may interpret the pattern as demonstrating that both groups exhibit a self-assertive tendency. Nevertheless, as noted above, we also anticipate that Colombians would “express” socially engaging emotions more than disengaging emotions. If this prediction should be borne out, it would raise an interesting paradox: How come that Colombians “experience” disengaging (self-assertive) emotions more than engaging emotions (as shown by Savani et al., 2013) while "expressing" engaging emotions more than disengaging emotions (as we predicted above)? Instead of confronting with this puzzle outright, our approach was to test whether we could replicate the Savani et al (2013) finding. As important, we tried to obtain independent confirmation of Latin Americans' self-assertive tendencies with the symbolic self-inflation task.

Present Study

The goal of the present work was to test whether we could identify an expressive form of interdependence in Latin America -- the form that is different from the emotion-suppressing form of interdependence among East Asians. For this purpose, we drew comparisons among three cultures, i.e., Colombia (predicted to show an emotion-expressive ethos of interdependence), Japanese (predicted to show the emotion-suppressive ethos of interdependence), and European Americans (predicted to show independent cultural ethos). We had two specific aims.

First, we tested the prediction that both Colombians and Japanese would be more interdependent or less independent, compared to European Americans. For this purpose, we used several tasks designed to assess the putatively core features of interdependence, including holistic cognition and correlates of happiness. Building on prior evidence (de Oliveira & Nisbett, 2017), we expected that Colombians would be holistic in cognition, similar to Japanese. In addition, we explored whether Colombians' happiness would be predicted by social engagement rather than disengagement, similar to happiness in Japan, but unlike happiness in European American culture.

Second, our analysis implies that the three cultural groups would show nuanced patterns in the domain of emotional experience and expression. First, following Ruby et al. (2012), we predicted that the relative value placed on high (vs. low) arousal emotions would be higher for both European Americans and Colombians than for Japanese. Second, however, we also anticipated that, once emotional expression and the dimension of engagement vs. disengagement was considered, Colombians and Japanese would prove to be similar to one another. Both of these two groups of individuals would express social engaging emotions more than disengaging emotions. In contrast, this tendency should be absent for European Americans.

In addition, we explored two issues. To begin, we tested the extent to which Colombians are self-assertive or self-effacing. In particular, we tested whether we could find self-assertion among Colombians with the symbolic self-inflation task. As noted, this task measures self-assertion without the confounding with social disengagement as in the emotion measure used in the prior work by Savani et al. (2013). Further, we also tested within-culture correlations among various features of interdependence. Prior work suggests that cultures vary systematically on the independent vs. interdependent axis, but attributes that constitute these higher-order cultural dimensions do not cohere at the individual level in the traditional psychometric sense (Kitayama et al., 2009; Na et al., 2019).

Methods

Participants

We recruited 204 European Americans (98 men), 175 Colombians (69 men), and 178 Japanese (69 men). They were all college undergraduates recruited during the Fall of 2019 at the University of Michigan (USA), Universidad de La Sabana (Colombia), and Nagoya University (Japan). In all three locations, we set a target N of 200 or as many as possible until the end of the term. This target sample size was set because an a priori power analysis was unadvisable. Some of these tasks have yet to be implemented in all cultures. Thus, we felt it prudent to at least double the sample sizes in prior cross-cultural work (e.g., Kitayama et al., 2009). All three groups were significantly different from each other in age, $F(2, 540) = 50.95$, $p < .001$, $\eta^2p = .159$. The European American sample was on average the youngest ($M = 18.69$, $SD = 0.99$), followed by the Japanese sample ($M = 20.04$, $SD = 1.24$) and the Colombian sample ($M = 20.60$, $SD = 2.92$). The study, overseen by the Institutional Review Board of the University of Michigan, met ethics requirements of all the three countries in accordance with the Declaration of Helsinki.

Materials

All materials were originally developed in English. They were translated into Japanese and Spanish. Back-translation was used to ensure the equivalence of meaning. We administered 8 tasks, which yielded 10 measures.[14] These measures could be classified into three general sets: two core features of interdependence (i.e., holistic cognition and correlates of happiness) and two subsidiary features of interdependence (i.e., emotional expression and self-assertion).

Interdependence 1. Holistic cognition. We adopted three tasks to assess holistic cognition. To assess ***holistic social attribution***, we used the attribution questionnaire from Kitayama et al., (2009). Participants were given four scenarios, each of which described a target person who behaved in a socially desirable or undesirable fashion. After participants read each of the scenarios, they rated the extent to which the behavior reflected the protagonist's dispositional

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[14] Five additional tasks were interspersed across the tasks of primary interest. All these tasks were pre-tests to develop materials for future studies. One task asked participants the believability of certain statements. Two tasks included new items designed to assess people's lay theories of happiness. The remaining two tasks were new experimental tasks on emotion.

attributes (e.g., attitudes and personality) and the social context (e.g., norms and atmosphere) by indicating their agreement on a 7-point scale (1 = strongly disagree, 7 = strongly agree). The main dependent variable was the difference between the contextual vs. dispositional attribution, with positive scores indicating more holistic (i.e., less dispositional) attribution and thus serving as a putative measure of interdependence (vs. independence).

To examine focused vs. holistic attention in a non-social domain, we administered the **framed line task (FLT)** (Kitayama et al., 2003). This task assesses how much people are influenced by contextual information. People who are less influenced by the context are considered more analytic, whereas those who pay more attention to the context are described as more holistic. The task was presented in a booklet, which contained a cover page with instructions that the experimenter went through. Participants first saw a square with a vertical line embedded in it for 5 seconds. Then, they flipped the page and saw another square that was bigger, smaller or the same size without a line. Their task was to draw a line inside the new square that was either identical to the line they had seen in the previous page (absolute version of the task), or keeping the same proportion with the line and square from the previous page (relative version of the task). They had 5 seconds to draw the line. In total, participants completed three practice trials for each version of the task (absolute and relative), followed by six critical trials. The order of the tasks was counterbalanced. The main dependent variable was the absolute value of the error (in mm) in the critical trials. Lower error in the relative compared to absolute tasks indicates more holistic (vs. analytic) thinking. Prior to analyses, participants were excluded if they told the experimenter they did not understand the task at the end (i.e., said they did the relative task when they were supposed to do the absolute version). This resulted in 2 fewer participants in the US and Colombia respectively. In Colombia, 3 additional participants were excluded because the photocopies of the booklets were faulty (i.e., had the trials in the incorrect order).

Whereas the first two tasks focus on the range of contextual information that is attended, the next task examines the extent to which reasoning is more cyclical. We adopted the **trend reversal task** (L.-J. Ji et al., 2001)**.** People with holistic cognitive styles are thought to be open to opposing forces and thus more likely to acknowledge cyclical trends. Participants were presented with four different scenarios that described the current state of affairs. For example, they were told that Steve and Jeff are both seniors at the same university. They have been very close friends for all four years during college. Then, they were asked how likely it would be for a change to occur (e.g., How likely is it that they will stop being friends after graduation?). Thus, a higher percent likelihood of change would indicate more holistic thinking.

Interdependence 2. Correlates of happiness. Independent (vs. interdependent) people tend to associate happiness with social disengagement (vs. engagement). To assess this association, the Implicit Social Orientation Questionnaire (ISOQ) was used. Participants were asked to recall 10 mundane social situations (e.g., the last time they thought about their appearances). After reporting how long ago the event occurred to them, they reported how much they experienced twelve different emotions in each situation on a 6-point scale (1 = not at all and 6 = very strongly). The emotions were both positive and negative, socially disengaging and engaging. In addition, there were also some general positive and negative emotions. The correlates of happiness measure captures the degree to which socially disengaging (i.e., self-esteem) vs. engaging (i.e., feelings of closeness to others) positive emotions would predict general positive emotions (e.g., calm, happy, elation) across the 10 situations for each participant (Kitayama et al., 2009; San Martin et al., 2018). To compute this measure, we regressed the average general positive emotions on the average disengaging positive and engaging positive emotions on for each participant. The unstandardized beta for disengaging emotions was subtracted from the unstandardized beta for engaging emotions to obtain a single index of interdependence vs. independence.

Emotion. To assess emotion, we used two tasks. First, we adopted the **ideal and actual affect questionnaire** from Tsai and colleagues (Tsai et al., 2006). Participants rated how much they would ideally like to feel a series of emotions that varied in both valence and arousal (1 = never to 5 = all the time). Then they rated how much they actually felt each of the emotions in a typical week using the same scale. Following prior work, we computed the average high arousal positive emotions (e.g., excited and enthusiastic) and low arousal positive emotions (e.g., calm and serene) people ideally and actually felt (Tsai et al., 2006).

Second, we also assessed the degree to which people would express engaging (vs. disengaging) emotions. Participants considered four situations that varied in valence and rated how strongly they would express the twelve emotions from the ISOQ using a 6-point scale (1 = not at all and 6 = very strongly) when discussing the situation with their friends and family members. Participants had been instructed that emotional expression would include both bodily gestures and facial expressions to show how they feel. We first determined the perceived valence of each situation by subtracting the expression scores for the general negative feelings (unhappy) from the expression score of the three general positive emotions (elated, happy and calm). For situations that were positively valenced, we averaged positive socially disengaging (e.g., pride and self-esteem) and engaging (e.g., friendly feelings and feelings of closeness to others) emotions, whereas for negatively valenced situations, negative socially disengaging (e.g. anger and frustration) and engaging (e.g. guilt and shame) emotions were averaged. The main dependent variable was the average expression of socially engaging (vs. disengaging) emotions.

Self-enhancement/assertion vs. effacement. As in San Martin et al. (2018), we adopted two tasks. First, we assessed **symbolic self-inflation**. People who think of the self as important may represent the self as larger in an abstract image of their social network. As in Kitayama et al., (2009), participants were asked to draw their social network by using circles to depict themselves and their friends. As part of the network, people were asked to depict the relationship between people by drawing lines to connect the circles. Participants were given 5 minutes for the task and told to make the network as complex as they wished. The main dependent variable was the diameter of the self, compared to the average diameter of the friend circles. A larger diameter in the self (vs. friend) circle indicates higher levels of self-assertion.

Second, we measured the intensity of experiencing socially disengaging (vs. engaging) emotions with the ISOQ. In the ISOQ, participants recalled 10 mundane social situations (e.g., the last time they thought about their appearances) and reported the intensity of experiencing twelve emotions in each situation on a 6-point scale (1 = not at all and 6 = very strongly). We first determined the valence of the situation as with the emotional expression ISOQ. Then, we created an average of the socially engaging and socially disengaging emotions according to the valence of the situation. The composites for each situation were then averaged to yield the average tendency to experience disengaging and engaging emotions. Prior work has demonstrated that individuals who are more self-assertive (vs. effacing) experience more socially disengaging vs. engaging emotions. With the assumption (adopted from San Martin et al., 2018) that the experience of socially disengaging emotions signals the self's prowess, strength, and worth, we used the current emotion measure as a second measure of self-assertion.

Explicit Measure of Self-Construal

In order to examine explicit beliefs about how independent (e.g., I am comfortable with being singled out for praise or rewards) and interdependent (e.g., It is important for me to maintain harmony within my group) the self is, we used the **Singelis self-construal scale** (Singelis, 1994). The scale is composed of a total of 23 items, which participants rate their level of endorsement with a 5-point scale (1 = strongly disagree, 5 = strongly agree). Reliabilities were computed for the interdependent and independent subscales separately for each cultural group. Reliabilities for interdependent and independent self-construal were adequate for Colombians ($\alpha = .542$ and .536), European Americans ($\alpha = .628$ and .676), and Japanese ($\alpha = .696$ and .565). Lastly, we included several demographic variables to assess: age, gender, the region, religion, cultural background and social status.

Procedure

In all sites, participants were tested in their native language in small groups of 2-8 people. Upon arrival at the lab, participants were told that the study was about cognitive, emotional and motivational factors that influence individual self-perceptions. Participants began with the two paper and pencil tasks, (1) the Framed-Line task and (2) the Sociogram task. The remaining questionnaires were administered with Qualtrics online. The questionnaire started with the implicit tasks, including the trend reversal task, attribution task, ISOQ, and emotion expression ISOQ. Finally, the questionnaire ended with the two self-report questionnaires (Ideal Affect and Self-construal) and demographics. As noted earlier, some additional tasks were interspersed as pre-tests for future studies. After all tasks, participants were debriefed and compensated. Data and syntax for the present study will be made available upon publication.

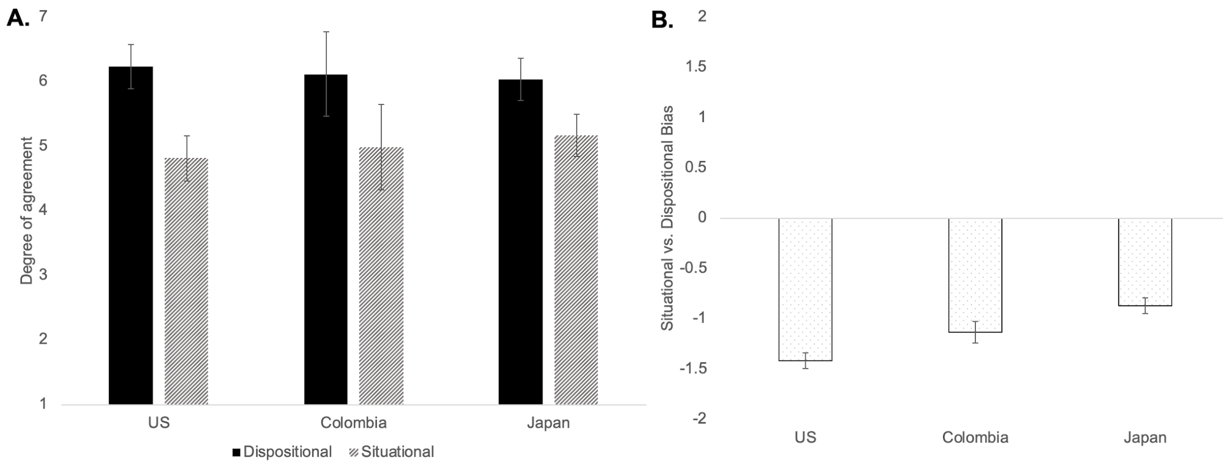
Results

The results are organized by two key types of measures, (i) putatively core features of interdependence (holistic cognition and social happiness), (ii) subsidiary features including emotional expressivity measures (ideal and actual affect and expression of engaging vs. disengaging emotions), and self-assertion (symbolic self-inflation and experience of self-assertive emotions). We also report an explicit measure of self-construal. In all these analyses, gender was included initially. Unless otherwise noted, gender did not show any significant effect and thus was subsequently dropped. All comparisons we report are pairwise comparisons.

Core features of Interdependence

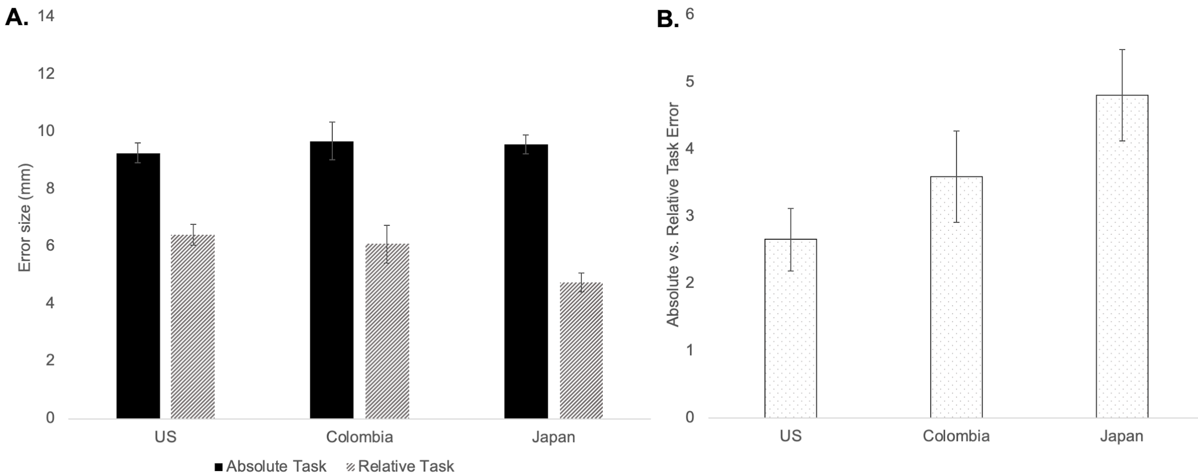
Holistic social attribution. Figure 18-A shows that the mean dispositional and situational attribution scores in the three cultures. In all three cultures, there is dispositional bias. However, this bias varied in magnitude across the countries, as indicated by the Culture x Attribution interaction, $F(2, 551) = 10.48$, $p < .001$, $\eta^2 p = .037$. When the dispositional attribution score was subtracted from the situational attribution score to yield an index of situational vs. dispositional bias, this score was highest among European Americans and the lowest among Japanese, with Colombians falling in-between (Figure 18-B). The difference between European Americans and Colombians was significant, $p = .019$. So was the difference between Colombians and Japanese, $p = .036$.

Figure 18. *A. The degree of agreement that an event was determined by dispositional and situational factors for European Americans, Colombians and Japanese. Error bars represent standard error of the mean. B. Situational vs. dispositional for each cultural group. More positive numbers indicate a more holistic social attribution. Situational attribution was significantly less among European Americans than Colombians and Japanese. Moreover, it was stronger among Japanese than Colombians.*



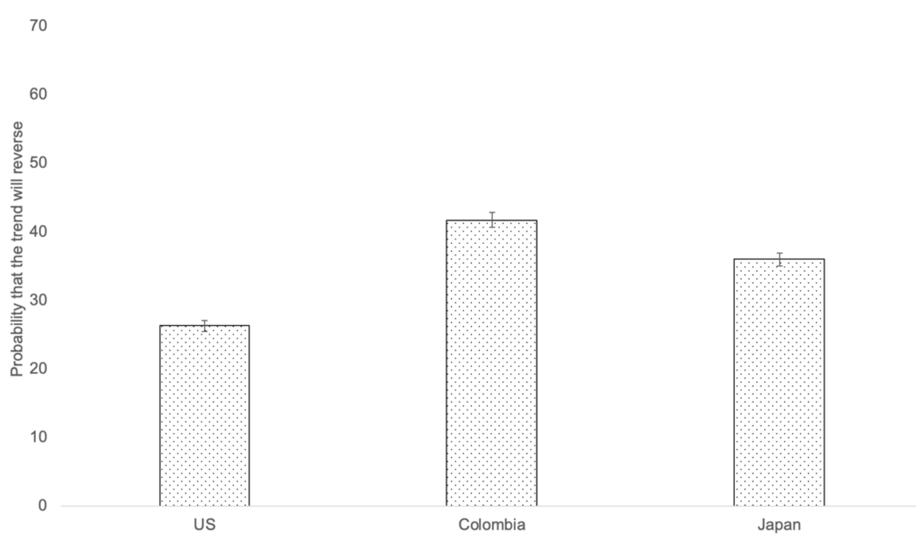
Framed-line task. Figure 19-A shows that the mean errors for the absolute and relative tasks in the three cultures. In all three cultures, the error was greater in the absolute task than in the relative task. However, the magnitude of the error in the absolute (vs. relative) task varied across cultures, as indicated by the Culture x Task interaction, $F(2, 543) = 2.25$, $p = .015$, $\eta^2 p = .015$. When the relative task error was subtracted from the absolute task error to yield an index of holistic attention, this score was significantly greater among Japanese compared to European Americans, $p = .004$. Colombians fell in-between and were no different from either European Americans or Japanese, $p = .114$ and $p = .211$, respectively.

Figure 19. *A. The average error for the absolute and relative versions of the frame line task for Americans, Colombians and Japanese. All groups showed a holistic tendency and had more error in the absolute than relative version of the task. Error bars represent standard error of the mean. B. The holistic tendency (more error in the absolute than relative task) was significantly more pronounced in Japanese than Americans. Colombians fell in-between both groups.*



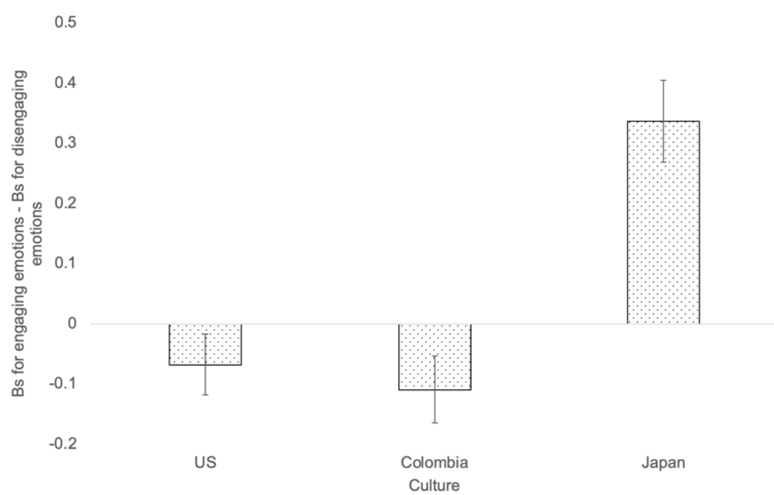
Trend reversal task. Figure 20 shows that the mean percent likelihood of change (another index of holistic cognition) in the three cultures. There was a significant main effect of Culture, $F(2, 553) = 73.19$, $p < .001$, $\eta^2p = .209$. The estimated likelihood of change was significantly higher for Colombians than for Japanese, $p < .001$. It was significantly lower for European Americans than for either Colombians or Japanese, $p < .001$ and $p < .001$, respectively.

Figure 20. *The probability (out of 100) that a trend will reverse for European Americans, Colombians and Japanese. Colombians reported that the trend was most likely to change, followed by Japanese and European Americans. Error bars represent the standard error of the mean.*



Correlates of happiness. Figure 21 shows the degree to which happiness is predicted by engaging (vs. disengaging) positive emotions (e.g., pride vs. friendly feelings). As predicted, the main effect of Culture was significant, $F(2, 545) = 17.54$, $p < .001$, $\eta^2 p = .060$. Among Japanese, happiness was predicted more by engaging (vs. disengaging) emotions, as indicated by the positive score in Figure 4, *95% CI* = [.221, .453]. European Americans showed the opposite trend, indicating that their happiness is predicted more by disengaging than by engaging emotions, although this pattern did not differ from zero, *95% CI* = [-.226, .009]. Curiously, Colombians were no different from European Americans, $p = .615$. Their happiness index was no different from zero either, *95% CI* = [-.176, .040].

Figure 21. *Social predictor of happiness among European Americans, Colombians and Japanese. The unstandardized betas from a regression predicting general positive emotions with socially socially engaging (e.g., friendly feelings towards others) vs. disengaging (e.g., pride) positive emotions are plotted. Colombians and European Americans showed a tendency towards personal happiness, whereas Japanese showed a tendency towards social happiness. Error bars represent the standard error of the mean.*

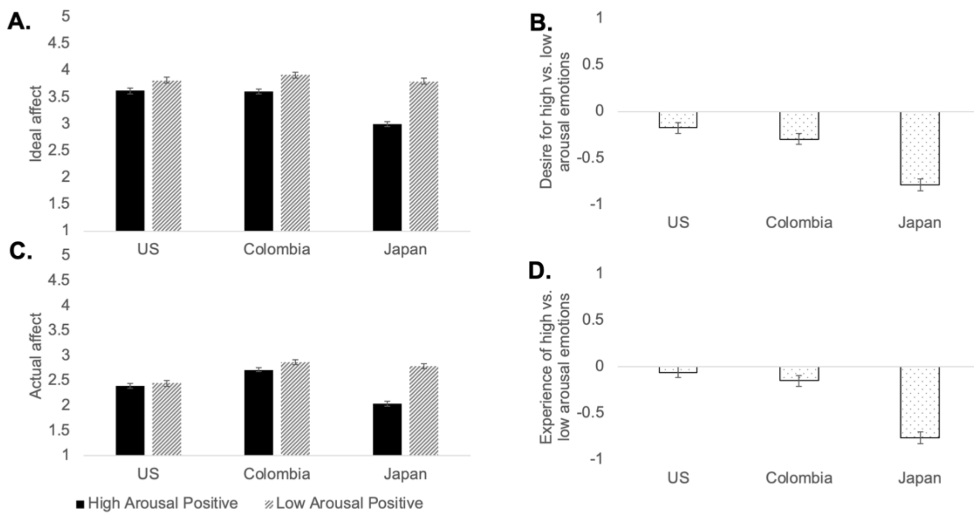


Emotion

Ideal and actual affect. Figure 22-A shows the mean ideal affect rating for the high (vs. low) arousal positive emotions in the three cultures. We found main effects of both Culture and

Emotion-type, $F(2, 539) = 19.63$, $p < .001$, $\eta^2p = .068$ and $F(1, 539) = 173.85$, $p < .001$, $\eta^2p = .244$, respectively. We also found a significant interaction between Culture and Emotion-type, $F(2, 539) = 32.27$, $p < .001$, $\eta^2p = .107$. There were no cultural differences in the desire to experience low arousal positive emotions.

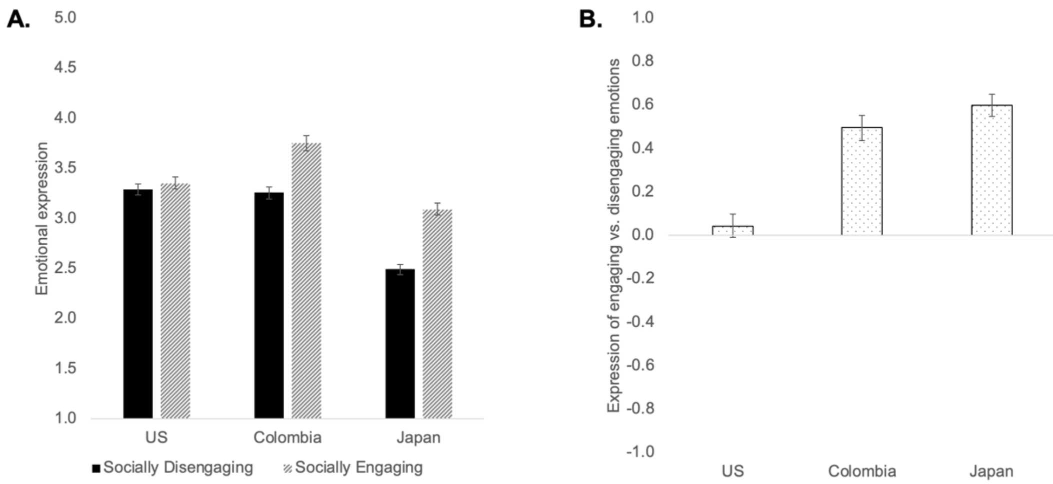
Figure 22. *A. The extent to which European Americans, Colombians and Japanese desire to feel high arousal and low arousal emotions (i.e., ideal affect). B. The overall desire to feel high vs. low arousal positive emotions. Error bars represent the standard error of the mean. C. The experience high and low arousal positive emotions in a typical week for European Americans, Colombians and Japanese. D. The difference between the experience of high and low arousal positive emotions in a typical week.*



As shown in Figure 22-B, Colombians and European Americans wanted to feel high arousal positive emotions more than Japanese, although the former two groups did not differ from each other, $p = .972$. Next, we tested cultural differences in actual affect (Figure 22-C). We found main effects of both Culture and Emotion-type, $F(2, 540) = 26.82$, $p < .001$, $\eta^2p = .090$ and $F(1, 540) = 112.89$, $p < .001$, $\eta^2p = .173$, respectively. We also found a significant interaction between Culture and Emotion-type, $F(2, 540) = 52.92$, $p < .001$, $\eta^2p = .164$. Colombians and Japanese experienced low arousal positive emotions to the same extent, $p = .324$, and significantly more than high arousal positive emotions, $ps < .007$ (Figure 22-D). On the other hand, European Americans reported feeling high arousal and low arousal positive emotions to the same extent, *ps* = .237. All groups were significantly different from each other in the experience of high arousal positive emotions, *ps* < .001. Colombians reported feeling high arousal emotions the most, followed by European Americans and Japanese.

Emotional expression. Figure 23-A shows the reported propensity to express socially engaging and disengaging emotions in the three cultures. The main effects of both Culture and Emotion type were significant, $F(2, 548) = 44.101$, $p < .001$, $\eta^2 p = .139$ and, $F(2, 548) = 147.07$, $p < .001$, $\eta^2 p = .212$. So was the interaction between the two, $F(2, 548) = 28.60$, $p < .001$, $\eta^2 p = .095$. As important, the reported degree of emotional expression was significantly greater for European Americans and Colombians than for Japanese, *ps* < .001. Colombians and European Americans are equally expressive of socially disengaging emotions, $p = .607$. However, Colombians were significantly more expressive of socially engaging emotions than European Americans and Japanese, *p*s < .001. Figure 23-B shows the relative expressivity for socially engaging (vs. disengaging) emotions. Colombians and Japanese were similarly more expressive of socially engaging (vs. disengaging) emotions, *95% CI* = [-.711, -.489] and *95% CI* = [-.610, -.383], respectively. In contrast, European Americans exhibited no stronger expression of socially engaging (vs. disengaging) emotions, *95% CI* = [-.149, .059].

Figure 23. *A. The reported intensity of emotional expression for socially engaging and disengaging emotions for European Americans, Colombians and Japanese. Error bars represent the standard error of the mean. B. The average expression of socially engaging vs. disengaging*

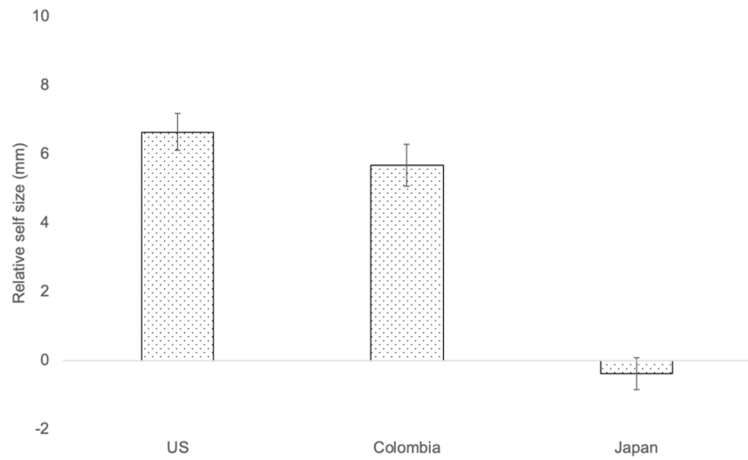


emotions.

Self-Assertion

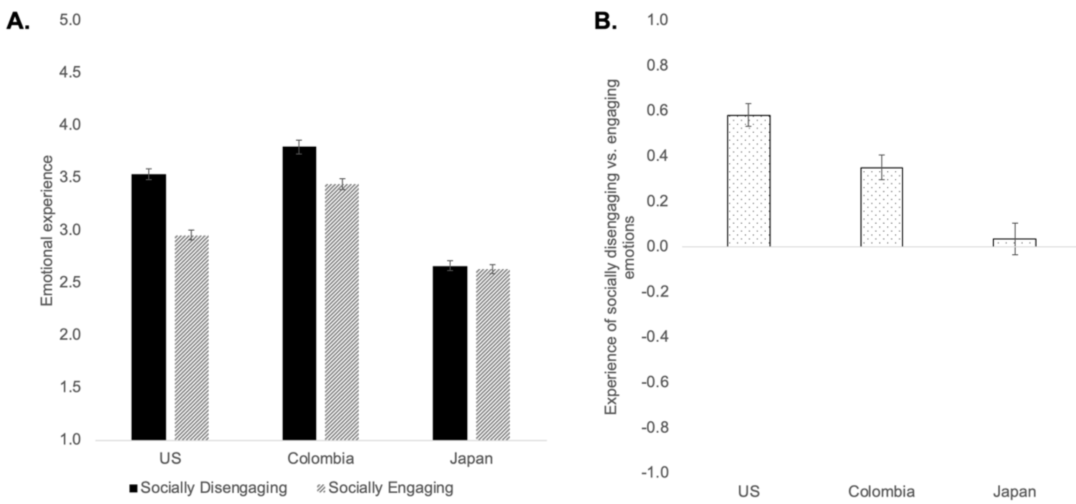
Symbolic self-inflation. Figure 24 shows the relative size of the self vs. others circles. The main effect of Culture was significant, $F(2, 544) = 50.40$, $p < .001$, $\eta^2 p = .156$. Both Colombians and European Americans exhibited robust symbolic self-inflation and did not differ from each other. In contrast, Japanese significantly differed from both groups and did not show any self-inflation, *95% CI* = [-1.45, 0.68].

Figure 24. *Symbolic self-inflation (i.e., the relative size of the self vs. other circles) in Colombia, US and Japan. Self-inflation is present to the same degree in Colombia and the United States, but absent in Japan. Vertical bars represent the standard error of the mean.*



Experience of self-assertive (i.e., socially disengaging) emotions. Figure 25-A shows the reported intensity of experiencing self-assertive (i.e., socially disengaging) and non-assertive (i.e., socially engaging) emotions. The effects of both Culture and Emotion-type were significant, $F(2, 550) = 109.02$, $p < .001$, $\eta^2p = .284$ and $F(2, 550) = 155.62$, $p < .001$, $\eta^2p = .221$. So was the interaction between the two, $F(2, 550) = 38.43$, $p < .001$, $\eta^2p = .123$. Colombians reported experiencing socially engaging emotions more than both other groups, $p < .001$. However, the reported intensity was significantly greater for self-assertive (vs. non-assertive) emotions for both European Americans and Colombians, $ps < .001$ (Figure 25-B). This effect was absent for Japanese, *95%CI* = [-.053, .126].

Figure 25. *A. The experience of socially disengaging and engaging emotions across 10 different situations for European Americans, Colombians and Japanese. Colombians reported experiencing socially engaging emotions more than all other cultural groups. Error bars show the standard error of the mean. B. The difference between the experience of socially disengaging vs. engaging emotions. European Americans show self-assertion (i.e., experience of disengaging vs. engaging emotions) the most followed by Colombians Japanese. Japanese did not show a difference in their experience of these emotions.*



Self-construal

In order to examine whether self-reported self-construal showed a similar pattern to the implicit measures, we assessed cultural differences in the two subscales. Table 7 shows the mean scores for independent and interdependent self-construal respectively, for each cultural group. For the Independence subscale, there was a significant main effect of Culture, $F(2, 539) = 27.29$, $p < .001$, $\eta^2 p = .092$.

Table 7. *Singelis self-construal scale.*

	European Americans	Colombians	Japanese
Independent SC	3.43_a	3.70_b	3.33_a
Interdependent SC	3.50_a	3.33_b	3.25_b

Note. Means in a row with different subscripts differ at $p < 0.05$

Colombians reported being significantly more independent than Japanese and Americans, who did not differ from each other, $p = .063$. As for Interdependent self-construal, there was also a significant effect of Culture, $F(2, 540) = 15.32$, $p < .001$, $\eta^2 p = .054$. European Americans reported being significantly more interdependent than Colombians and Japanese, who did not differ from each other, $p = .102$.

Correlations Among Attributes of Independence and Interdependence

Tables 8-A, B, and C show the correlations among the attributes of independence and interdependence in each of the three cultures. For the most part, the correlations were negligible. The overall mean correlations were 0.024, 0.033, and 0.022, for European Americans, Colombians, and Japanese, respectively, thereby confirming earlier evidence that even though the dimensions of independence vs. interdependence differentiate among different cultures, they do not form cohere clearly at the individual level in the traditional psychometric sense (Kitayama et al., 2009; Na et al., 2010, 2019).

Table 8. *Correlations among the ten implicit measures.*

Measure	1	2	3	4	5	6	7	8	9
			A. European Americans						
Holistic C-1 (1)									
Holistic C-2 (2)	-0.02								
Holistic C-3 (3)	0.07	0.01							
Predict-Happy (4)	-0.08	0.08	-0.14						
Emotion-1 (5)	-0.02	0	-0.11	-0.06					
Emotion-2 (6)	0.04	-0.01	0.05	-0.03	0.35				
Emotion-3(7)	0.04	-0.04	0.02	-0.03	0.04	0.11			
Assertion-1 (8)	-0.05	-0.01	-0.05	0.08	0.12	0.09	0.15		
Assertion-2 (9)	-0.06	-0.07	-0.07	-0.1	0.07	0.16	-0.03	0.13	
Self construal (10)	0	0.07	0.03	-0.09	0.22	-0.01	0.19	0.13	-0.06
			B. Colombians						
Holistic C-1 (1)									
Holistic C-2 (2)	-0.04								
Holistic C-3 (3)	0.04	-0.02							
Predict-Happy (4)	-0.03	0.12	0.06						

Emotion-1 (5)	-0.07	0.03	0.07	0.1					
Emotion-2 (6)	-0.05	-0.07	0.02	0.05	0.38				
Emotion-3(7)	-0.02	0.1	-0.2	0.04	-0.07	0.02			
Assertion-1 (8)	0.01	0.06	-0.02	0.29	0.03	0.02	0.25		
Assertion-2 (9)	-0.12	0.07	0.13	0.04	0.06	0.08	0.01	0.09	
Self-construal (10)	0.06	0.05	0.02	-0.04	0.03	-0.01	-0.14	0.01	0.04
C. Japanese									
Holistic C-1 (1)									
Holistic C-2 (2)	0.01								
Holistic C-3 (3)	-0.13	0							
Predict-Happy (4)	0.01	-0.05	-0.02						
Emotion-1 (5)	0.02	-0.01	0.08	0.1					
Emotion-2 (6)	0.03	-0.11	-0.02	0.03	0.32				
Emotion-3(7)	0.05	0.01	-0.06	-0.11	0.06	0.01			
Assertion-1 (8)	-0.08	0.08	-0.04	-0.12	-0.09	0	0.37		
Assertion-2 (9)	0.07	0.07	-0.05	-0.01	0.14	0.04	-0.02	-0.04	
Self-construal (10)	-0.16	-0.02	0	0.1	0.16	0.13	0.19	-0.01	0.04

Note. Holistic C-1: Dispositional (vs. situational) bias, Holistic C-2: Analytic (vs. holistic) attention (FLT), Holistic C-3: Likelihood of trend reversal, Predict-Happy: Personal (vs. social) correlates of happiness, Emotion-1: Desire for high (vs. low) arousal emotions,Emotion-2: Actual experience of high (vs. low) arousal emotions, Emotion-3: Expression of socially disengaging (vs. engaging) emotions, Assertion-1: Experience of socially disengaging (vs. engaging) emotions, Assertion-2: Symbolic self-inflation and Self-construal: independence (vs. interdependence).

Discussion

Independence and Interdependence in Three Cultures

In the present study, we documented the first comprehensive evidence for expressive interdependence in a Latin American culture. This form of interdependence is characterized by the expression of socially engaging emotions in order to forge social relations with others. More specifically, we first predicted that Colombians are interdependent, similar to Japanese in the two features that were considered core, i.e., holistic cognition and social happiness. As summarized in Table 9, this first prediction received support in all the three measures of holistic cognition (situational vs. dispositional attribution, holistic attention, and trend reversal).

Table 9. *Summary of the findings in the present work: Interdependence of Colombians is indicated by holistic cognition and expression of socially engaging emotions. Their propensity toward emotional expression is indicated by the relatively strong preference for and experience of, high-arousal emotions, as well as an intense expression of emotions. Colombians exhibited strong self-assertive tendencies.*

	European Americans	Colombians	Japanese	Colombians are more similar to:
Presumptive core of interdependence: We expected both Colombians and Japanese to be higher than European Americans.				
Holistic cognition	Low	High	High	Japanese
Social Happiness	Low	Low	High	European Americans
Emotional expression: We expected both Colombians and European Americans to prefer high-arousal emotions, but both Colombians and Japanese to express engaging vs. disengaging emotions.				
Desire for high arousal emotions	High	High	Low	European Americans
Actual experience of high arousal emotions	High	High	Low	European Americans
Strength of emotional expression	High	High	Low	European Americans
Expression of engaging vs. disengaging emotions	Low	High	High	Japanese
Self-assertion: We explored how high or low Colombians might be in this dimension.				
Symbolic self-inflation	High	High	Low	European Americans
Experience of self-assertive emotions	High	High	Low	European Americans

Compared to European Americans, both Colombians and Japanese were significantly more holistic in all the three cognitive domains. In the second of the two putatively core features of interdependence, i.e., the social predictor of happiness, the prediction did not receive support. Replicating prior findings, happiness for Japanese was predicted more by socially engaging than by socially disengaging emotions, while the opposite was true for European Americans.

For Colombians, the pattern was similar to the European American pattern: Happiness was predicted more by socially disengaging emotions than by socially engaging emotions. We will return to this unexpected finding later.

Second, based on Ruby et al. (2012), we anticipated that Latin Americans would value high arousal emotions, similar to European Americans, but dissimilar to Japanese. Unlike early work, all three groups preferred low arousal emotions more than high arousal emotions. However, the relative desire to feel high (vs. low) arousal emotions varied as in more recent work (Tsai et al., 2016). As predicted, the preference for high arousal emotions was higher for both Colombians and European Americans than for Japanese. The same pattern emerged for the actual experience of high arousal emotions. Moreover, the intensity of expressing emotions was significantly higher overall for both Colombians and European Americans than for Japanese. Importantly, as predicted, when the emotions were divided by social engagement, a contrasting pattern emerged. That is, Colombians and Japanese expressed socially engaging emotions more than socially disengaging emotions. European Americans expressed emotions to the same degree, regardless of their level of social engagement.

Third, our subsidiary aim was to test whether Colombians are more similar to European Americans or Japanese on the dimension of self-assertion vs. effacement. Here, the pattern was very clear for the symbolic self-inflation measure. Both Colombians and European Americans depicted a larger circle for the self than for others in their social network, thereby demonstrating a strong self-assertive tendency. This effect was absent for Japanese. As for the measure of socially disengaging (vs. engaging) emotions, both European Americans and Colombians reportedly experienced more socially disengaging (vs. engaging) emotions, suggesting that these two groups have a tendency toward self-assertion. This effect, however, was absent for Japanese.

Interestingly, among the two groups that showed self-assertion, this effect was significantly weaker for Colombians than for European Americans, thereby replicating the pattern observed in Savani et al. (2013). Since in this measure self-assertion is confounded with social disengagement, the weaker self-assertive effect apparent in Colombian data might be a result of relatively stronger experience of socially engaging emotions for Colombians, which is consistent with our hypothesis that Colombians are interdependent. We will return to this issue.

Colombian Happiness: Why Is It Linked to Social Disengagement?

Colombians are holistic in cognitive domains -- as much as Japanese are, and more so than European Americans. Moreover, they tend to express socially engaging emotions more, very much like Japanese, but unlike European Americans. Based on these findings, we conclude that Colombians are highly interdependent -- as least as much so as Japanese are. However, if Colombians were interdependent, should we also expect their happiness to be predicted by social engagement (vs. disengagement)? Contrary to our a priori prediction, Colombian happiness was predicted more by socially disengaging (vs. engaging) emotions.

This unexpected finding might be pointing to subtler aspects of culture that are not captured by our current instrument. Specifically, some interdependent cultures, including Latin American cultures, might recognize that one's personal achievement could be a form of contribution to his or her group. Imagine a Colombian college student who is graduating with high honors. He feels very proud of what he has accomplished. But this pride, a seemingly highly disengaging positive emotion, may conceal his understanding that his achievement is also an accomplishment of his parents and the community members who supported him. In that way, the socially disengaging component of the graduation is inherently meshed with another, much more engaging component. Consistent with this observation, Latin American scholar Christian

(1970) noted that in Latin America "individualism must contribute to the wellbeing of the group instead of creating an isolated man" (Christian (Jr), 1970, pg. 386). Thus, individual achievement is valued insofar as it is seen as a significant contribution to the collective good, which may be in sharp contrast to East Asian agrarian traditions, which tend to regard personal achievement as a "nail that sticks out." Both of these forms of happiness may be interdependent when contrasted against a form supposedly dominant in European American culture, in which happiness is tied relatively exclusively to one's personal accomplishments separate from their implications for social others (Kitayama et al., 2000; Kitayama & Markus, 2000; Uchida & Kitayama, 2009). These more nuanced distinctions about the experience of happiness must be addressed in future work.

Expressive Interdependence of Colombians

The most important contribution of the current work is to demonstrate that a preference for high arousal emotions and high levels of expressivity can coexist with interdependent psychological tendencies. Compared to Japanese, Colombians are similar to European Americans in their relatively strong preference for high-arousal emotions. Moreover, both of these two groups also expressed emotions more strongly than Japanese. This pattern is consistent with the hypothesis that expression of emotions plays a significant role in both Latin culture and Western culture, presumably because both tend to be high in historical heterogeneity (Niedenthal et al., 2019).

Despite this similarity, however, there is an important difference between the two groups. Specifically, we hypothesized that the desire to express and experience strong emotions is in service of interdependence for Latin Americans, unlike European Americans. Consistent with this hypothesis, Latin Americans (but not European Americans) reportedly expressed socially engaging emotions more than socially disengaging emotions. Indeed, when emotional expression was assessed, Colombians were more expressive of engaging (vs. disengaging) emotions, similar to Japanese, but different from European Americans, who were equally expressive of both engaging and disengaging emotions. These findings are particularly notable because all participants were told that they would be expressing the emotions in a social situation, around their family and friends. Thus, even in a social context where presumably social engagement is called on the most, European Americans express socially engaging emotions less than Colombians. The pattern suggests that the emotionality of Colombians has a function of promoting interdependence (i.e., social engagement) and in that respect it is very different from the emotionality of European Americans.

Consistent with these conclusions, Ondish et al. (2019) argue that Latins prefer evocative language because it is particularly effective in achieving resonance with the listener (Ondish et al., 2019). Further, it has been shown that Latinos are preferred as interaction partners compared to European Americans, because they are similarly outgoing but exhibit a higher number of positive interpersonal traits (e.g., gracious, considerate and friendly) (Holloway et al., 2009). In short, in Latin culture, high arousal emotions need not be disruptive to social harmony. To the contrary, the conviviality produced by them is instrumental in achieving interdependence and social connections with others.

Self-Assertiveness of Latin Culture

Our subsidiary aim was to explore where Colombians might be located on the dimension of self-assertion vs. effacement. Replicating prior work, we found that European Americans show a significant symbolic self-inflation effect, whereas this effect was negligible for Japanese. Of importance, Colombians were no different from European Americans. Thus, Colombians appear highly self-assertive, and in this regard, they are similar to Arabs (San Martin et al., 2018). Future work may test whether the self-assertion shown here for Colombians is in fact in service of interdependence (rather than independence).

In addition, we also found both European Americans and Colombians reportedly experience socially disengaging emotions more than socially engaging emotions. This effect was quite clear for Colombians although the magnitude of the effect was somewhat weaker for them than for European Americans, thereby replicating an early study by Savani et al. (2013). Importantly, the effect was completely absent for Japanese. In interpreting a similar finding for Arabs, San Martin et al. (2018) suggested that socially disengaging emotions such as pride and self-esteem indicate the self's prowess, worth, and strength. With this auxiliary assumption, the current finding may be interpreted as providing additional evidence that Colombians are self-assertive, consistent with the results from the symbolic self-inflation task that independently confirm this possibility.

The Colombian Paradox?

Colombians reportedly "express" socially engaging emotions more than self-assertive (or disengaging) emotions, yet reportedly "experience" self-assertive (or disengaging) emotions more than engaging emotions. Why is it that Colombians express social engagement while at the same time experience high levels of self-assertion (or disengagement)?

One important clue in addressing this paradox lies in San Martin et al. (2018). Following their analysis, we assume that self-assertion in Latin culture (as in Arab culture) signifies a commitment to one's ingroup identity. In interdependent cultures, self-assertion is a way to affirm loyalty by highlighting the personal and psychological resources that can be brought to bear to maintain honor and protect others in the ingroup. It may therefore be an integral part of the Latin form of interdependence. How about the function/meaning of social engagement? Social engagement implies interpersonal connections with others in an ingroup. It therefore involves an effort to cultivate and maintain close, smooth, harmonious, and perhaps joyous social relations. In short, in this cultural context, the primary function of self-assertive or socially disengaging emotions may be to affirm ingroup identity, whereas the primary function of socially engaging emotions may be to cultivate interpersonal social relations, respectively.

From this vantage point, two implications would follow. First, the primary function of socially engaging emotions is to cultivate social relations. These emotions may therefore have to be "expressed" clearly and actively to meet this functional need. This may explain why Colombians "expressed" socially engaging emotions more than disengaging emotions. Second, the primary function of self-assertive/socially disengaging emotions is to affirm ingroup loyalty. In all likelihood, the commitment to ingroup identity is fully internalized and thus is experienced "deep at heart." Thus, there may be little need to express it at least under ordinary circumstances. This might explain why Colombians "experienced" self-assertive/socially disengaging emotions more than socially engaging emotions.

Family Resemblance between Latin Interdependence and European American Independence

Altogether, our Colombian data is consistent with the hypothesis that Colombians are interdependent. Nevertheless, Table 4 also makes it clear that Colombians are more similar to European Americans than Japanese, especially in the subsidiary features of interdependence. Unlike Japanese, both Colombians and European Americans preferred high-arousal emotions and exhibited strong self-assertive tendencies. There are two important points to make.

First, as noted above, the motivation for seemingly identical behaviors of both emotional expression and self-assertion may be different between European Americans and Colombians. To begin with, Colombians value strong emotions since these emotions are more communicative and instrumental in forming convivial social relations (Campos & Kim, 2017; Ondish et al., 2019; Ruby et al., 2012; Triandis et al., 1984). European Americans also value strong emotions, but do so because these emotions are more self-expressive, revealing innermost feelings and the motivational drives that come with such feelings (Tsai et al., 2007). Moreover, both Colombians and European Americans show self-assertive tendencies. However as is likely in the case of emotion, the motivation for these overt tendencies may again be distinct. San Martin et al. (2018) already showed that self-assertiveness of Arabs is contingent on interdependence, unlike the seemingly identical effect of European Americans, which is contingent on independence. They reasoned that whereas self-assertiveness is a form of self-expression for European Americans, it is a form of resourcefulness for the protection of ingroup for Arabs. Given the geographic proximity of Arab regions and the Latin region in Europe, self-assertiveness of Latin Americans and Arabs may well be anchored to interdependence.

Second, it also remains the case that substantial similarities do exist at the level of overt behavior (e.g., preference for high-arousal emotions and self-assertive tendencies) between Colombians and European Americans. These similarities require an analysis of their own. As argued by some scholars, most recently by Tomasello (2019), interdependence may have been the fundamental survival strategy for humans over the course of evolution (Tomasello, 2019). This observation would apply even to Western European civilization, the one grounded in the modern notion of independence, from which contemporary European American culture is derived (Kitayama & Uskul, 2011). In this civilization, the idea of independence is used as the foundation for forming social relations through market economy as in Adam Smith, through social contracts both formal and informal as in Jean Jacques Rousseau (B. Morris, 1991), or by the Catholic Church to dilute tribal power by banning cousin marriages (Schulz et al., 2019). Nevertheless, this idea of independence is relatively young, only several hundred years old.

The relative depth of history may suggest that Western European independent culture emerged with substantial influences from interdependent cultures, including the Latin interdependent culture. Latin American cultures in turn have their roots in Europe (i.e., Spain and Portugal), which is closely linked to Arab and African culture. This civilization can be traced back to several millennia. The modern West might have adopted the behavioral patterns of emotional expressivity and self-assertion from these cultures and changed their meanings in such a way that they now served the newly emerging ethos of independence rather than the traditionally more dominant ethos of interdependence. This historical transformation might explain why Latin Americans and European Americans are highly similar at the behavioral level and yet remarkably distinct at the symbolic level. Meanwhile, East Asian civilization, which Japan is part of, developed on the opposite end of the Eurasian continent. This might explain why Japanese patterns are so distinct from the patterns observed in both European Americans and Colombians.

Problems of the Explicit Measure of Self-Construal

The implicit measures showed that European Americans are the least interdependent (or most independent). Relative to European Americans, both Japanese and Colombians are more interdependent (or less independent). However, the Singelis scale of independence and interdependence shows an utterly different ordering of the three cultures. In terms of independence, Colombians are the highest, with the remaining two groups (European Americans and Japanese) equally less so. In terms of interdependence, European Americans are the most interdependent, with the remaining two groups (Colombians and Japanese) equally less so. A similarly anomalous pattern was observed in a three cultural comparison involving European Americans, Western Europeans, and Japanese by Kitayama and colleagues (2009).

It is possible that explicit measures, including this one, require reference groups in arriving at self-appraisals. In cross-cultural comparisons, reference groups are completely confounded. For example, Colombians compare themselves with other Colombians in assessing their independence or interdependence (Heine et al., 2002). It is also possible that explicit appraisals of the self may be easily affected by social desirability. For example, part of the reason why European Americans rate themselves as interdependent could be because this trait is relatively missing and, for that reason, is considered valuable in the culture (Peng et al., 1997). Neither of these factors are likely to be relevant in the case of implicit measures. Most important, however, we should be mindful that culture is often embodied and embrained (Kitayama & Salvador, 2017). That is, over the course of development, practices, conventional ways of action, and routine modes of thought or feelings are ingrained into psychological and neural pathways that are automatized (Kitayama & Salvador, 2017; Kitayama & Uskul, 2011). These pathways may enable the person to participate in the culture's practices and conventions. Note, however, that these pathways may well function automatically and perhaps subconsciously, outside of conscious awareness. The explicit measures may draw only on that part of culture that happens to be accessible to conscious reflection at a particular time and place. Thus, they miss much of the cultural activities that are embrained, automatized and thus supposedly largely unconscious. In contrast, our implicit measures may tap on these later activities. For this reason, the implicit measures may be more likely to show systematic cultural variations than the explicit measures. Future work must examine the conditions under which explicit and implicit measures coincide.

Cultural Prototypes and Individual Idiosyncrasies

As in prior work, we demonstrated that cultural prototypes do emerge quite systematically, especially when implicit measures of independence and interdependence are used. However, the correlations among these measures are negligible. Thus, the construct of independence or interdependence does not seem coherent in the traditional psychometric sense (i.e., Cronbach's alpha higher than .6). Importantly, however, the cultural patterns are always highly systematic and, therefore, the constructs appear valid at the cultural level even though they are not at the individual level.

Although puzzling at first glance, this result can happen if each person samples a subset of cultural elements of independence or interdependence and becomes a representative of the culture by acquiring that subset (Kitayama, Mesquita, et al., 2006). For example, a woman in Colombia, Mariana, could become a cultural representative by being emotionally expressive. She may or may not acquire other attributes of culture, such as holistic cognition. In contrast, a Colombian man, Pedro, could also be an equally good representative by being cognitively attuned to social context and thus holistic. He might not necessarily be emotionally expressive. Given this individual difference, the correlation between emotional expressivity and holistic cognition can be close to zero. However, when the individuals are averaged, a characteristic cultural pattern (holistic cognition combined with emotional expressivity) should emerge (Kitayama et al., 2009; Na et al., 2010). In fact, Na et al. (2019) showed that the idiosyncratic individual profiles of cultural traits are longitudinally stable, thereby providing stable cultural fingerprints that are unique and yet share varying degrees of family resemblance with the cultural prototypes.

This line of empirical work may contribute to the current effort to refine psychometric models for the measurement of various psychological constructs (Nesselroade & Molenaar, 2016). So far, the prevailing assumption in psychometrics is that any given construct must ideally be defined by a set of attributes that load on the construct equally well across all individuals and groups (called measurement invariance) (Chen, 2008; Flake et al., 2017). However, our data shows that the weight (or "loading" in the factor-analysis sense) given to various manifestations of the construct (e.g., holistic attention and emotional expression for expressive interdependence above) could be variable across different individuals, thereby calling for a systematic effort to explicitly take this individual idiosyncrasy into account in the psychometric measurement models (Nesselroade & Molenaar, 2016).

Limitations and Future Directions

Several limitations of our work must be noted. First, like most studies in social and cultural psychology, we tested college undergraduates. This choice of sample eliminates numerous confounding variables. However, it also invites an important question of whether the current findings would be applicable to non-student adults. Second, our work shows clear cross-cultural variations on the dimension of independence vs. interdependence. However, it falls short of testing any other facets of psychological processes that could be relevant. For example, tightness vs. looseness of social norms might also vary across cultures, with important consequences on cognitive and emotional processes (Gelfand et al., 2011; Salvador, Mu, et al., 2020). Little is currently known how the dimension of tightness vs. looseness might interact with the dimension of independence vs. interdependence to influence psychological processes. Third, our work shows that expressive interdependence (a combination of emotional expressivity and interdependence) is quite prominent in Colombian culture. However, it remains to be seen whether this pattern could be found in other Latin American countries. Nor is it known whether it might extend to other regions. For example, Arabs might be as expressive of socially engaging emotions as Latin Americans. Only future empirical work can tell. Of importance, along with its predecessors (Kitayama et al., 2009; San Martin et al., 2018), our work drew on prior studies comparing European Americans and East Asians. Thus, as we globalize cultural psychology, more effort will be needed to develop tasks that are better calibrated to reflect cultural ethos in other regions. In particular, effort is warranted in future work to separate the emotion dimension of social disengagement from that of self-assertion.

Despite these limitations, the current work has pushed the literature one clear step forward by identifying a new cultural profile, expressive interdependence, in Latin America. This profile is distinct from self-effacing interdependence in East Asia and independence among European Americans. Along with recent work focused on Arab regions (San Martin et al., 2018), our work has begun to reveal the varieties of interdependence across the globe. Through further empirical effort along this line, we may hope to draw a fuller picture of cultural evolution, namely, how ecology, demography, geography, and the like interacted to yield various forms of interdependent cultures throughout the last several millennia (Gelfand et al., 2011; Niedenthal et al., 2019; Talhelm et al., 2014). Moreover, such an analysis will provide a basis for understanding the emergence of Western individualism over the last several hundred years (Kitayama, Ishii, et al., 2006; Schulz et al., 2019). This evolution of culture may well be supported by important biological changes realized through genetic and epigenetic mechanisms (Henrich, 2015; Kitayama et al., 2020). We thus believe that the systematic inquiry into the cultural evolution over the last 10,000 years may help us realize an integrative theory of the human mind and, by so doing, enrich the current views of what it means to be a human.

Chapter V: Conclusion

The field of cultural psychology has documented substantial variation across groups in how they view the self (Markus & Kitayama, 1991). European Americans tend to see the self as autonomous or independent from others, whereas East Asians and other non-Western European Cultures share the view of the self as interdependent, or embedded in close social relationships. These distinct construals of the self impact cognition, emotion and motivation (Markus & Kitayama, 1991). Here, I extended this literature by examining how self-construal impacts two additional psychological tendencies: self-referential thought (Chapter II) and sensitivity to social norms (Chapter III). In addition, I tested whether the interdependence is linked with the same psychological tendencies across cultures. In Chapter IV, I tested the hypothesis that Latin American Interdependence is different from its' East Asian counterpart in the domain of emotional expression and self-enhancement. Together these lines of work provide new insights and approaches to understand the mutual constitution of culture and the self.

Self-related thought

Examining self-related thought is a crucial to understand how the self is constructed. In Chapter II, I provide evidence for that a neural oscillation known as alpha is an important neural correlate of self-related thinking. In Study 1, I started by validating this measure by seeing whether alpha was preferentially involved in self-related thought. Across two studies, we found that alpha was significantly greater when people were asked to imagine an event for the self as opposed to someone else (Salvador et al., in preparation). Importantly, this effect was specific to alpha and didn't extend to another neural oscillation, such as theta. This data suggests that alpha is one neural correlate of self-related thought.

Based on the evidence that alpha is involved in self-related thinking, we next examined whether there were individual and cultural differences in how much people spontaneously thought about the self (Study 2). We examined resting state differences because prior work has shown that intrinsic activity during resting state implicitly "assigns" self-relevance to most things (Northoff, 2016). Importantly, self-relevance may be assigned more easily for those who focus on the personal self to a greater degree, such as those with a more independent (vs. interdependent) view of the self. Consistent with this hypothesis, we found that resting state alpha was greater for more independent people, suggesting they may spontaneously engage in self-related thought to a greater degree (Kraus et al., revise & resubmit). This was particularly pronounced for independent self-construal, not interdependent self-construal suggesting increased alpha may be more characteristic of the personal (vs. relational) self.

In Study 3, we used this neural correlate of self-related thinking to test the hypothesis that cultural differences in self-enhancement are driven by a cultural difference in the engagement of self-related thought in response to several outcomes. Specifically, we expected that European Americans, or those individuals who self-enhance, would spontaneously link a self-serving events to their self-concept and elaborate on them. Conversely, we expected East Asians would not, consistent with the idea that they are more self-critical. We found that European Americans (or people high in independent self-construal) showed greater alpha in response to the self's successes (vs. failures), suggesting enhanced internal attention to those events. Importantly, consistent with the idea that this neural response is linked to self-enhancement, we found that it predicted self-report measures of self-enhancement, such as a situation being perceived as more impactful to self-esteem. Conversely, Taiwanese showed no such effect. Instead, for judgements of both self and others, they exhibited a negativity bias, consistent with prior work in person perception. Together, these three studies show that alpha may be a promising approach to study self-referential thought and its' associated cultural variation (Salvador et al., revise & resubmit).

Sensitivity to Social Norms

The study of social norms has been a central to the field of social psychology (Ajzen & Fishbein, 1977). However, little is known about the conditions under which people become sensitive to them. Here, I show how the view of the self as interdependent (vs. independent) can dynamically influence sensitivity to norms (Study 1 and 2). Drawing on prior work that interdependence and stronger norms are related across countries (Gelfand et al., 2011), we tested the hypothesis that interdependence is linked to enhanced sensitivity to norms. In Study 1, we randomly assigned some people to a relational goal and others to a control condition and asked them to view a series of norm violations as their EEG was recorded. We found that those in the relational goal condition showed a heightened sensitivity to norms, as indexed by a greater N400 (a neural index of incongruity) in response to norm violations as opposed to normal behaviors. This is consistent with the idea that these individuals may be attune to the social context and ready to adjust to the norms more readily. Importantly, this effect was more moderated by how tight or loose participants perceived the context to be. The relational goal prime only increased attunement to norms when they believed that the social context was tight, or strict. This finding suggests that under non-threatening conditions interdependence is linked to increased sensitivity to norms (Salvador, Mu, et al., 2020).

While we observed one condition when interdependence increases attunement to norms in Study 1, it is possible that there are circumstances when it shows the opposite effect.

Interdependence signifies the embeddedness of the self in significant social relationships, overtime the feeling of embeddedness can increase feelings of perceived protection (Bowlby, 1990; C. Wang et al., 2014). This perceived protection, could make interdependence act as a psychological buffer in the presence of threat (H. S. Kim et al., 2016). To test this idea, in Study 2, we randomly assigned participants to a pathogen threat and control condition. This was followed by the same norm violation task in Study 1. Consistent with Study 1, we found that in the control condition, interdependent people were more sensitive to norms. Importantly, this effect reversed in the threat condition. In the threat condition, independent people became sensitive to norms, whereas interdependent people became less sensitive. This suggests that interdependence predicts less sensitivity to norms in conditions of threat, presumably because interdependence reduces feelings of threat (Salvador, Kraus, et al., 2020)

Understanding social norms is important not only for theories in social and cultural psychology, but to understand changes in times of crisis. In the current COVID-19 pandemic, a particular set of norms that matter are relational norms. In some societies, people perceive that relational norms are flexible, they have many opportunities to talk to strangers and interact with a variable range of others. Conversely, other societies perceive fewer opportunities to interact with others. This tendency is known as relational mobility (Thomson et al., 2018). Since COVID-19 transmits through social contact, we predicted that relational mobility would predict a faster spread of COVID-19. We tested this hypothesis in Study 3, where we combined country-level relational mobility scores (Thomson et al., 2018) with COVID-19 daily counts of cases and deaths to analyze whether relational mobility predicted a faster initial growth rate of COVID-19. We found support for this analysis for both cases and death even after conducting a series of robustness checks controlling for relevant cultural and demographic variables (Salvador, Berg, et al., 2020). This work shows the importance of cultural norms in understanding infectious disease trajectories.

Interdependence Outside of East Asia

Much of the work in Cultural psychology, including some of my work, has focused on comparisons between East Asians and European Americans. This work has shown that compared to European Americans, East Asians are more holistic in cognition (Nisbett et al., 2001), less emotionally expressive (de Oliveira & Nisbett, 2017; Kraus & Kitayama, 2019), less self-enhancing (Heine et al., 1999; Kitayama et al., 1997) and prefer low arousal emotional states (Tsai et al., 2006). While East Asian interdependence may be linked to these psychological tendencies, it is an empirical question whether these tendencies are linked to interdependence in other groups.

In Chapter IV, I tested the hypothesis that the Latin American form of interdependence differs from its' East Asian counterpart. Similar to Japanese, we found that Colombians, a Latin American sample, were more holistic in cognition than European Americans. This feature has also been found in Arabs, suggesting it may be a more common feature linked to interdependence across cultures (San Martin et al., 2018). However, the features of emotion and self-enhancement distinguished between the interdependent groups. Unlike Japanese, Colombians were more expressive of emotions, to a similar extent as European Americans. However, consistent with the hypothesis that Colombians are generally more interdependent than European Americans , they were more expressive of socially engaging (or interdependent) as opposed to disengaging (or independent) emotions. Second, they experienced low arousal emotions similar to Japanese, and high arousal emotions to a similar degree to European Americans and more so than Japanese. Finally, unlike Japanese and similar to European

Americans, they were self-enhancing. These findings suggest that interdependence can take on a different form depending on the cultural context. Unlike the Japanese form of interdependence that is self-effacing and characterized by downregulating emotional arousal, the Latin American form of interdependence is emotionally expressive (Salvador, Idovro Carlier, et al., 2020). These findings suggest that interdependence is culturally variable. Depending on aspects of the ecology and history of the place, the way in which interdependence is achieved substantially varies.

Implications and Conclusions

The idea that the view of the self as independent and interdependent powerfully shapes psychology is well documented in the literature. Here, I expand this literature in three ways. First, I propose a neural correlate of self-related thought, alpha (Chapter II, Study 1). This neural correlate, varies based on how independent (vs. interdependent) people see the self (Chapter II, Study 2). Moreover, it can help explain why cultures vary in self-enhancement (Chapter II, Study 3). This line of work proposes a new approach to understanding self-related thought. This insight is crucial since self-referential thought is the foundation of autobiographical memory and the instantiation of the continuous thought we know to be the self. Moreover, engagement in self-referential thinking is difficult to ask about explicitly as people lack self-awareness about many things about themselves. This characteristic of the self makes the neuroscience approach all the more important because it is relatively implicit. However, the neuroscience approach is important in the study of the self not only because of the methodological implications, but because of the theoretical implications.

First, we found that the neural marker varies as a function of independence and interdependence. This lends insight into how these views of the self are instantiated in the brain and illustrates how deep the influence of culture goes (Kitayama & Salvador, 2017). By using alpha to examine cultural variation in self-enhancement, we were also able to understand the underlying mechanisms for this classic bias. This is important because it gives some clues as to why self-criticism is not as common as self-enhancement in the literature. We suggest that self-criticism is likely an extension of the negativity bias in person perception. This is because the only case when there was less alpha suppression was when European Americans encountered success information in reference to the self. Otherwise, the levels of alpha were no different. This suggests that for Taiwanese, the responses to events about the self may be an extension of their responses to events occurring for others. In our task, this meant that they were relatively critical of both.

Second, I propose that the view of the self as independent (vs. interdependent) powerfully influences sensitivity to norms. In non-threatening conditions, it makes people more attune to norms if they think their cultural context has strict norms (Chapter III, Study 1). However, when threat is activated, interdependence predicts reduced sensitivity to norms, presumably because this construal provides social connection which can buffer the negative feelings linked with the threat (Chapter III, Study 2). Finally, I show how the study of cultural norms is important and consequential, since countries that value choice in their relationships with strangers have a faster spread of COVID-19 (Chapter III, Study 3).

This second line of work provides evidence for understanding the conditions under which people are motivated to be attune to norms. Moreover, it shows how these distinct motivations and cultural tendencies can be consequential and predict a faster spread of infectious disease. Theoretically, this highlights two key functions social norms have. First, social norms promote social coordination as they are the organizing features of human societies. This suggests that when the motivation to engage with someone is activated, sensitivity to norms will increase, as showed in Study 1. However, coordination is not the only function. Norms also serve the function of psychological protection. If the coordination is effective, then when people encounter a threat they will be less alarmed. Thus, under threatening conditions, interdependence will lead to reduced sensitivity to norms. Together, this work begins to shed light on the importance of motivation in responses to norm violations.

Third, the evidence discussed above along with much of the work in cultural psychology, assumes that independence and interdependence are the same across cultures. In Chapter IV, I challenge this assumption comparing East Asian to Latin American interdependence. Despite both groups being more holistic than European Americans, they varied substantially in the domains of emotion and self-enhancement. East Asians generally suppressed emotions and were self-critical, whereas Latin Americans expressed emotions and were self-enhancing. Importantly, the types of emotions that were expressed distinguished Latin Americans from European Americans. Consistent with the hypothesis that Latin Americans are interdependent, this group was particularly expressive of interdependent (vs. independent) emotions. We conclude by suggesting that unlike the East Asian form of interdependence, the Latin American counterpart is emotionally expressive and self-enhancing. This insight is important, because it suggests a substantial revision to theories of interdependence. In the future, efforts such as this one can broaden the scope of cultural psychology to be more inclusive of the global population.

As the field of psychology progresses it is crucial to understand cultural variation. This will help us build a more inclusive science. Just as important, we need to study culture to revise our theories so they can be more broadly applicable. In my dissertation, I have provided three additional insights by examining variation in self-related thought, sensitivity to norms and interdependence. Together, I hope this work provides a small step in the direction of globalizing the field of psychology.

Appendices

Appendix I: Chapter II: Study 2 Supplement

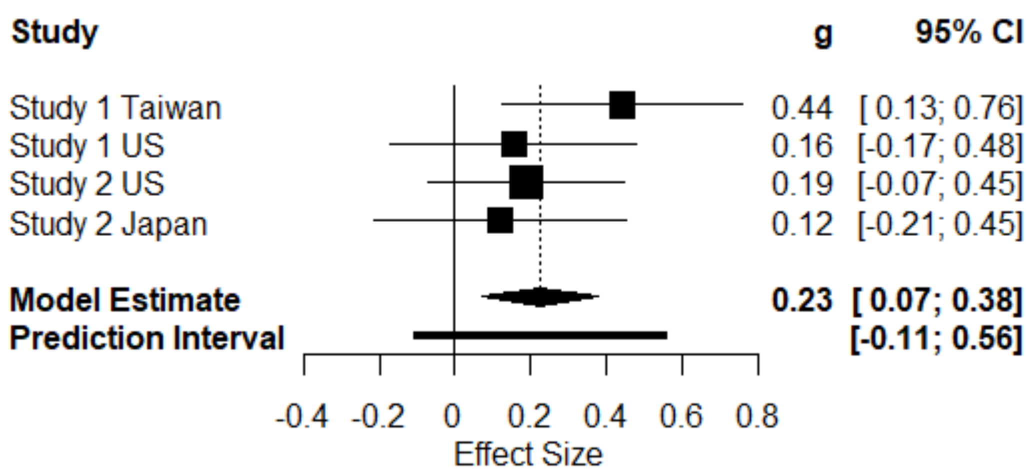
Method

To extract total spectral power, a FFT was performed. The power from this FFT was log transformed and the average power was calculated for the alpha range (8-13 Hz). This total power estimate was used as the dependent variable in the multilevel models outlined in section 2.1.6 in the main manuscript. A meta-analysis was then performed on the estimates from these multilevel models for each sample for SC, Independence, and Interdependence scores.

Results

In the eyes closed condition, the weighted mean effect size (ES) for overall SC scores showed a significant positive effect with total alpha power, *ES* = .226, 95% CI: [.073-.378], z = 2.9, p = .004 (see Figure S1). The distribution of the effect sizes in these samples did not show strong evidence for heterogeneity, $Q(3) = 2.44$, p = .486, I^2 = 0%. We also tested whether the estimated effect sizes systematically differed by Culture (US/East Asian), Country (US/Taiwan/Japan), or EEG Amplifier (Neuroscan/BioSemi). None of these subgroups significantly differed in effect size (all *p*s > .1).

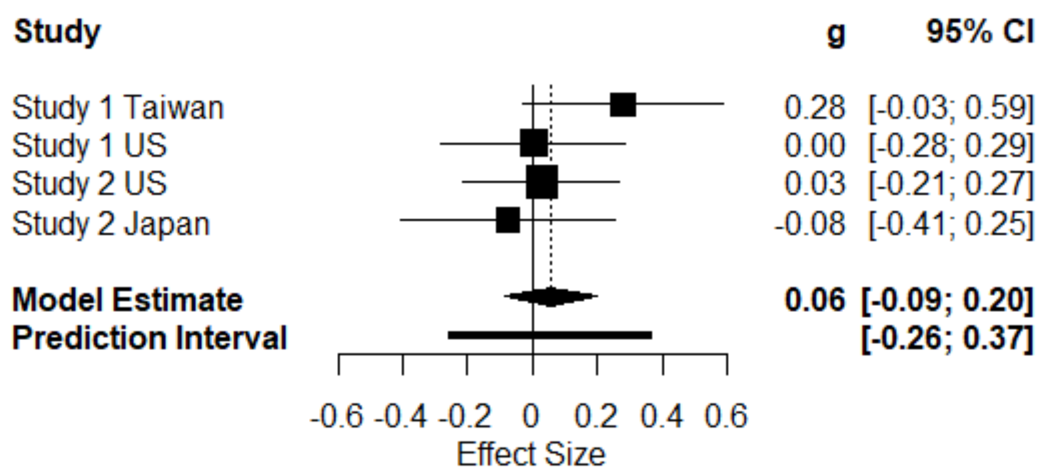
Figure S 1. *Meta-analysis for Total Spectral Power and SC in the Eyes Closed Condition.*



Note. A forest plot of the effect sizes for the relationship between SC and total alpha power in the eyes closed condition is shown for all 4 samples reported. The square size indicates the relative weight of a study in the analysis and the lines indicate the range of the confidence interval.

In the eyes open condition, the weighted mean effect size (ES) for SC was not significant, *ES* = .056, 95% CI: [-.087-.198], z = .77, p = .443 (see Figure S2). The distribution of the effect sizes in these samples did not show strong evidence for heterogeneity, $Q(3) = 2.8$, $p = .424$, I^2 = 0%. We also tested whether the estimated effect sizes systematically differed by Culture (US/East Asian), Country (US/Taiwan/Japan), or EEG Amplifier (Neuroscan/BioSemi). None of these subgroups significantly differed in effect size (all *p*s > .1).

Figure S 2. *Meta-analysis for Total Spectral Power and SC in the Eyes Open Condition.*



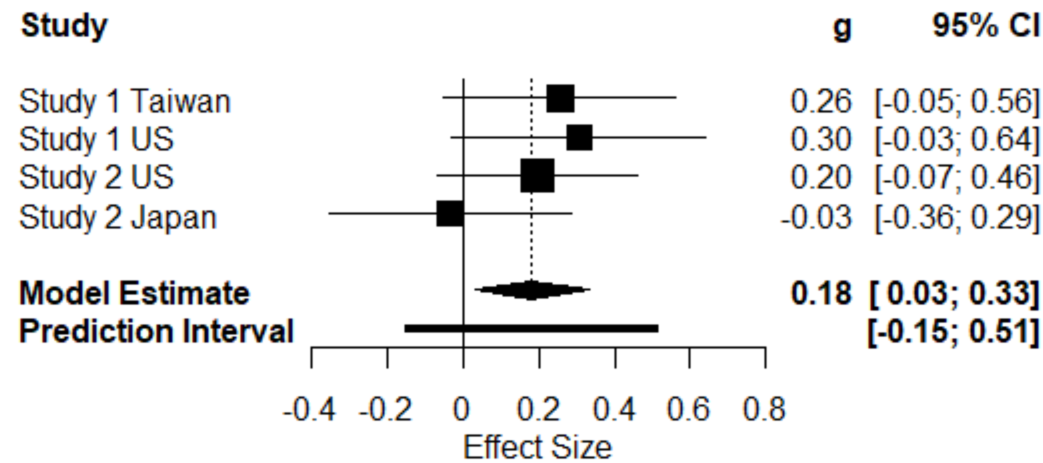
Note. A forest plot of the effect sizes for the relationship between SC and total alpha power in the eyes open condition is shown for all 4 samples reported. The square size indicates the relative weight of a study in the analysis and the lines indicate the range of the confidence interval.

Independent SC

In the eyes closed condition, the weighted mean effect size (ES) for Independence showed a significant positive effect with total alpha power, *ES* = .182, 95% CI: [.03-.333], z = 2.35, p = .019 (see Figure S3). The distribution of the effect sizes in these samples did not show strong evidence for heterogeneity, $Q(3) = 2.49$, $p = .478$, I^2 = 0%. We also tested whether the estimated effect sizes systematically differed by Culture (US/East Asian), Country

(US/Taiwan/Japan), or EEG Amplifier (Neuroscan/BioSemi). None of these subgroups significantly differed in effect size (all *ps* > .3).

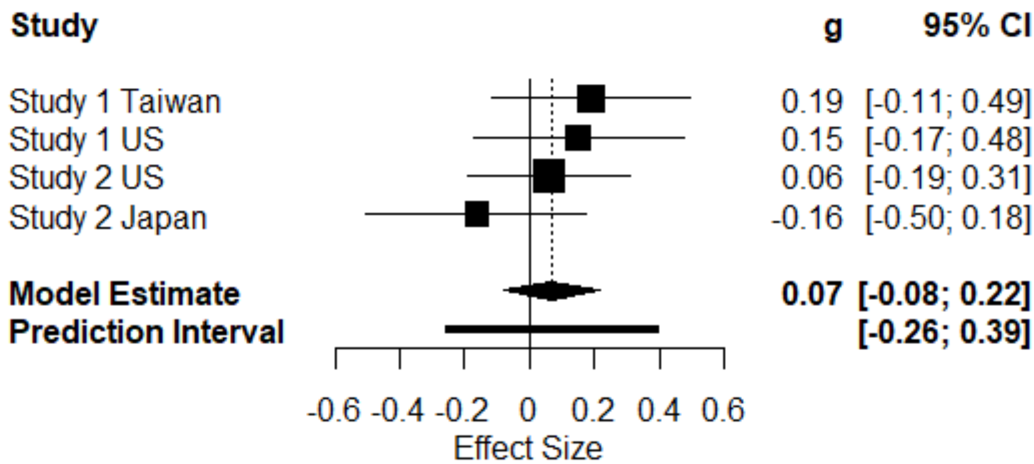
Figure S 3. *Meta-analysis for Total Spectral Power and Independence in the Eyes Closed Condition.*



Note. A forest plot of the effect sizes for the relationship between Independence and total alpha power in the eyes closed condition is shown for all 4 samples reported. The square size indicates the relative weight of a study in the analysis and the lines indicate the range of the confidence interval.

In the eyes open condition, the weighted mean effect size (ES) for Independence showed a non-significant positive effect with total alpha power, ES = .068, 95% CI: [-.081-.216], z = .89, p = .372 (see Figure S4). The distribution of the effect sizes in these samples did not show strong evidence for heterogeneity, $Q(3) = 2.67$, $p = .446$, $I^2 = 0\%$. We also tested whether the estimated effect sizes systematically differed by Culture (US/East Asian), Country (US/Taiwan/Japan), or EEG Amplifier (Neuroscan/BioSemi). None of these subgroups significantly differed in effect size (all *ps* > .2).

Figure S 4. *Meta-analysis for Total Spectral Power and Independence in the Eyes Open Condition.*

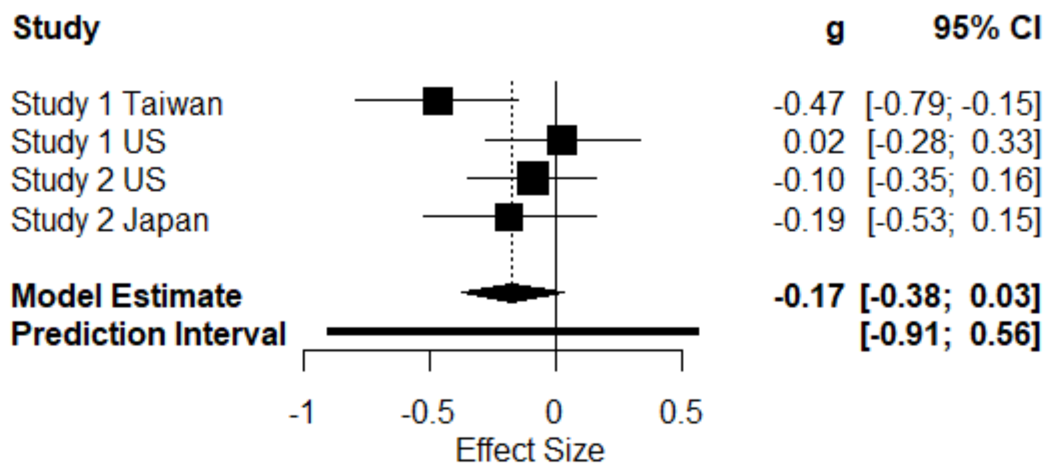


Note. A forest plot of the effect sizes for the relationship between Independence and total alpha power in the eyes open condition is shown for all 4 samples reported. The square size indicates the relative weight of a study in the analysis and the lines indicate the range of the confidence interval.

Interdependent SC

In the eyes closed condition, the weighted mean effect size (ES) for Interdependence showed a non-significant negative effect with total alpha power, *ES* = -.174, 95% CI: [-.376-.028], z = -1.69, p = .091 (see Figure S5). The distribution of the effect sizes in these samples showed some evidence for heterogeneity and thus this estimate should be interpreted with caution, $Q(3) = 5.36$, $p = .147$, $I^2 = 44.1\%$. We also tested whether the estimated effect sizes systematically differed by Culture (US/East Asian), Country (US/Taiwan/Japan), or EEG Amplifier (Neuroscan/BioSemi). The type of EEG amplifier used significantly moderated the effect of Interdependence on total alpha power, $Q(1) = 4.52$, $p = .034$, with the Neuroscan system, *ES* = -.174, 95% CI: [-.793-.154], showing a larger effect than the BioSemi system, *ES* = -.081, 95% CI: [-.25-.088]. This indicates that the effect in Study 1 is likely an overestimate of the true size of the relationship between Interdependence and total alpha power.

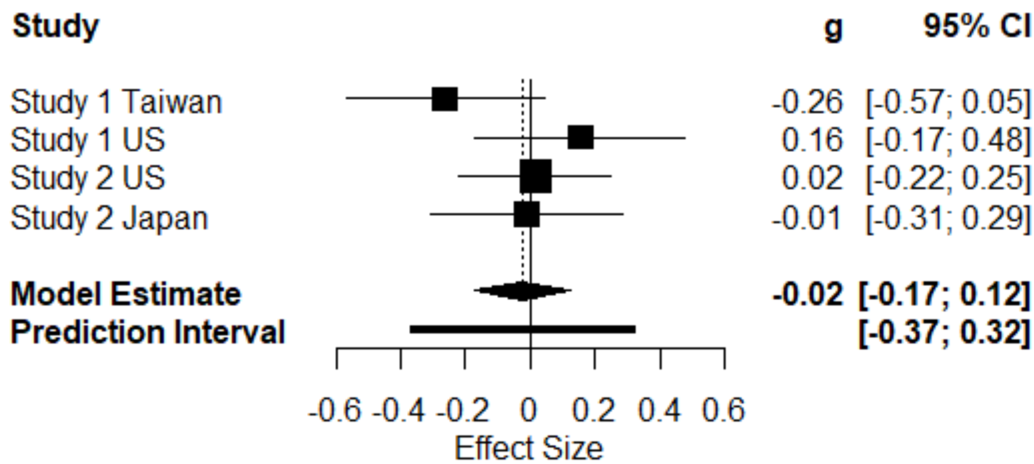
Figure S 5. *Meta-analysis for Total Spectral Power and Interdependence in the Eyes Closed Condition.*



Note. A forest plot of the effect sizes for the relationship between Interdependence and total alpha power in the eyes closed condition is shown for all 4 samples reported. The square size indicates the relative weight of a study in the analysis and the lines indicate the range of the confidence interval.

In the eyes open condition, the weighted mean effect size (ES) for Interdependence showed a non-significant negative effect with total alpha power, $ES = -.023$, 95% CI: [-.168-.123], $z = -.31$, $p = .76$ (see Figure S6). The distribution of the effect sizes in these samples did not show strong evidence for heterogeneity, $Q(3) = 3.57$, $p = .311$, $I^2 = 16.1\%$. We also tested whether the estimated effect sizes systematically differed by Culture (US/East Asian), Country (US/Taiwan/Japan), or EEG Amplifier (Neuroscan/BioSemi). None of these subgroups significantly differed in effect size (all *p*s > .05).

Figure S 6. *Meta-analysis for Total Spectral Power and Interdependence in the Eyes Open Condition.*



Note. A forest plot of the effect sizes for the relationship between Interdependence and total alpha power in the eyes open condition is shown for all 4 samples reported. The square size indicates the relative weight of a study in the analysis and the lines indicate the range of the confidence interval.

Aperiodic Slope (Power Log Exponent)

In addition to the periodic (oscillatory) element of the signal, we also examined its aperiodic aspect. Past research has demonstrated that the slope of the aperiodic signal (power law exponent; PLE) correlates with private self-consciousness (Wolff et al., 2019). We tested to see whether this relationship would also exist with SC.

Method

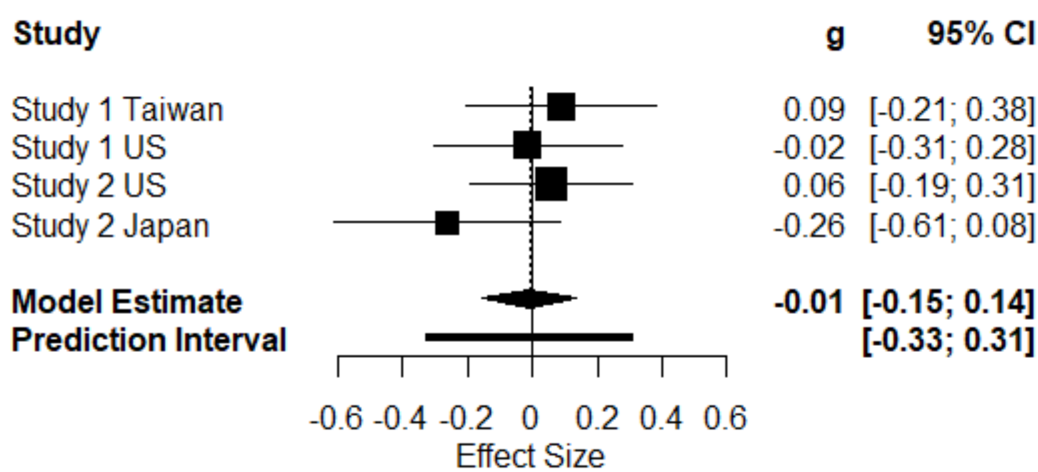
Using FOOOF (Donoghue et al., 2020) with the parameters outlined in section 2.1.5.3 in the main manuscript, we estimated the PLE between 1 and 20 Hz. This estimate was performed separately for eyes open and eyes closed conditions. This slope estimate was used as the dependent variable in the multilevel models outlined in the main manuscript. A meta-analysis was then performed on the estimates from these multilevel models for each sample as outlined in in the main manuscript for SC, Independence, and Interdependence scores.

Results

In the eyes closed condition, the weighted mean effect size (ES) for SC showed a non-significant negative effect with the PLE, *ES* = -.009, 95% CI: [-.154-.135], z = -.12, p = .902

(see Figure S7). The distribution of the effect sizes in these samples did not show strong evidence for heterogeneity, $Q(3) = 2.77$, $p = .429$, $I^2 = 0\%$. We also tested whether the estimated effect sizes systematically differed by Culture (US/East Asian), Country (US/Taiwan/Japan), or EEG Amplifier (Neuroscan/BioSemi). None of these subgroups significantly differed in effect size (all *p*s > .2).

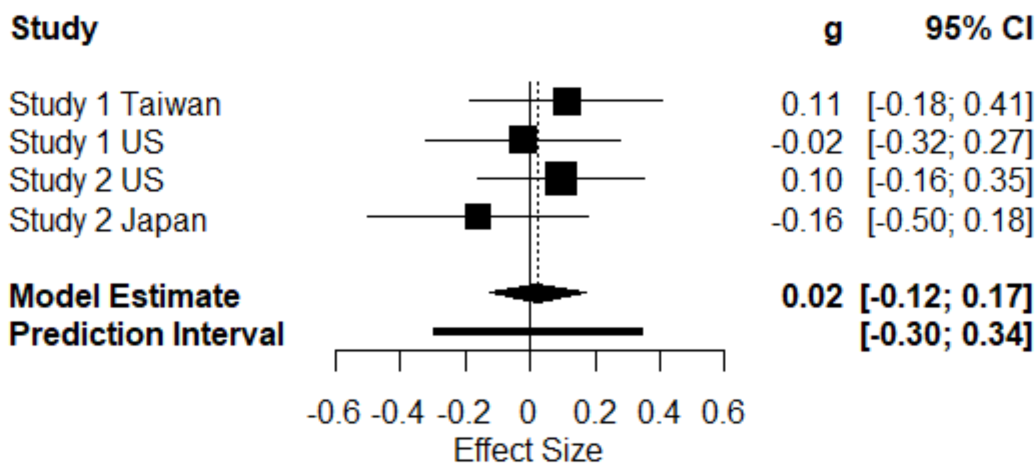
Figure S 7. *Meta-analysis for the PLE and Overall SC in the Eyes Closed Condition*



Note. A forest plot of the effect sizes for the relationship between SC and the PLE in the eyes closed condition is shown for all 4 samples reported. The square size indicates the relative weight of a study in the analysis and the lines indicate the range of the confidence interval.

In the eyes open condition, the weighted mean effect size (ES) for SC showed a non-significant positive effect with the PLE, $ES = .023$, 95% CI: [-.123-.169], $z = .31$, $p = .757$ (see Figure S8). The distribution of the effect sizes in these samples did not show strong evidence for heterogeneity, $Q(3) = 1.9$, $p = .593$, $I^2 = 0\%$. We also tested whether the estimated effect sizes systematically differed by Culture (US/East Asian), Country (US/Taiwan/Japan), or EEG Amplifier (Neuroscan/BioSemi). None of these subgroups significantly differed in effect size (all *p*s > .4).

Figure S 8. *Meta-analysis for the PLE and Overall SC in the Eyes Open Condition*

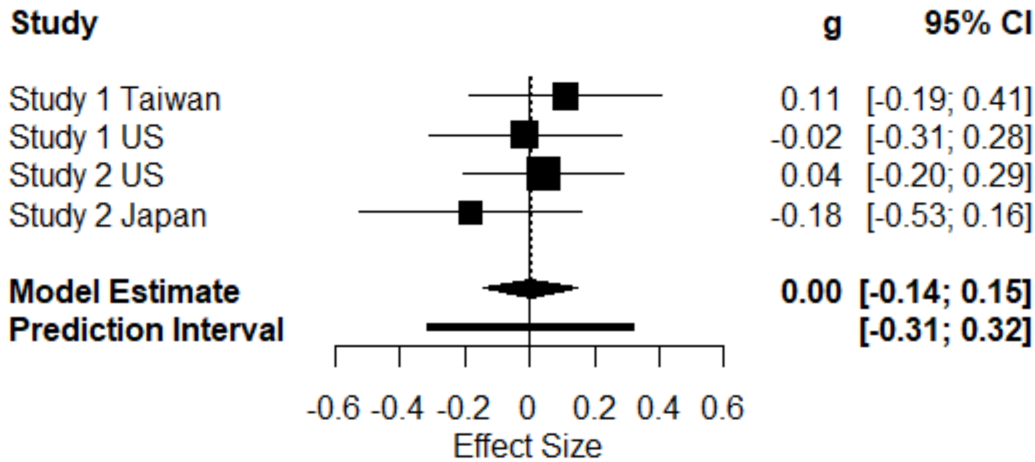


Note. A forest plot of the effect sizes for the relationship between SC and the PLE in the eyes open condition is shown for all 4 samples reported. The square size indicates the relative weight of a study in the analysis and the lines indicate the range of the confidence interval.

Independent SC

In the eyes closed condition, the weighted mean effect size (ES) for Independence showed a non-significant positive effect with the PLE, *ES* =.004, 95% CI: [-.141-.149], z = .05, p = .96 (see Figure S9). The distribution of the effect sizes in these samples did not show strong evidence for heterogeneity, $Q(3) = 1.76$, $p = .624$, $I^2 = 0\%$. We also tested whether the estimated effect sizes systematically differed by Culture (US/East Asian), Country (US/Taiwan/Japan), or EEG Amplifier (Neuroscan/BioSemi). None of these subgroups significantly differed in effect size (all *p*s > .4).

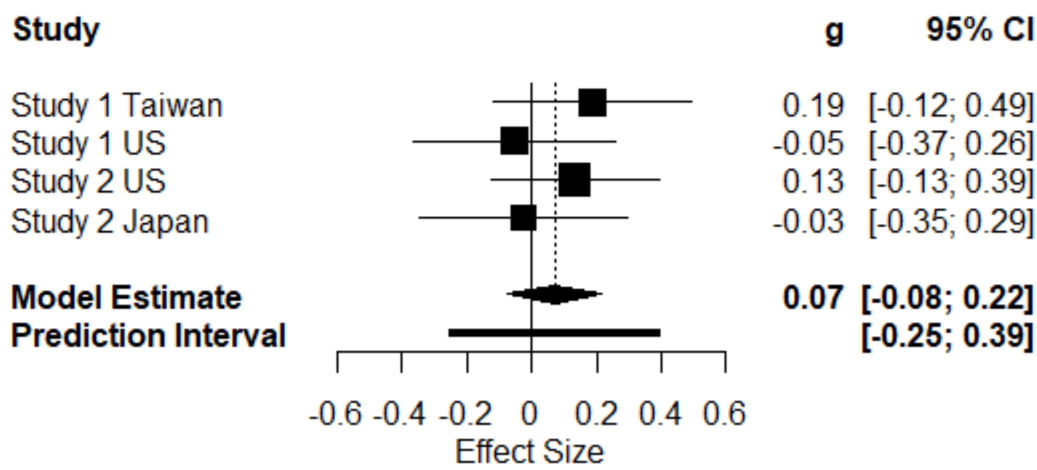
Figure S 9. *Meta-analysis for the PLE and Independence in the Eyes Closed Condition.*



Note. A forest plot of the effect sizes for the relationship between Independence and the PLE in the eyes closed condition is shown for all 4 samples reported. The square size indicates the relative weight of a study in the analysis and the lines indicate the range of the confidence interval.

In the eyes open condition, the weighted mean effect size (ES) for Independence showed a non-significant positive effect with the PLE, ES = .07, 95% CI: [-.078-.218], z = .93, p = .354 (see Figure S10). The distribution of the effect sizes in these samples did not show strong evidence for heterogeneity, $Q(3) = 1.75$, $p = .625$, $I^2 = 0\%$. We also tested whether the estimated effect sizes systematically differed by Culture (US/East Asian), Country (US/Taiwan/Japan), or EEG Amplifier (Neuroscan/BioSemi). None of these subgroups significantly differed in effect size (all *p*s > .3).

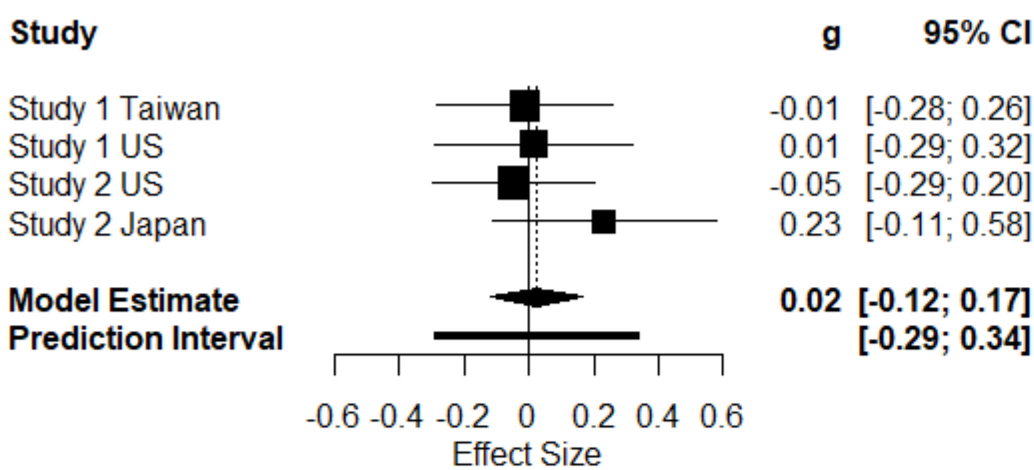
Figure S 10. *Meta-analysis for the PLE and Independence in the Eyes Open Condition.*



Note. A forest plot of the effect sizes for the relationship between Independence and the PLE in the eyes open condition is shown for all 4 samples reported. The square size indicates the relative weight of a study in the analysis and the lines indicate the range of the confidence interval.

In the eyes closed condition, the weighted mean effect size (ES) for Interdependence showed a non-significant positive effect with the PLE, ES =.023, 95% CI: [-.12-.166], z = .32, p = .748 (see Figure S11). The distribution of the effect sizes in these samples did not show strong evidence for heterogeneity, $Q(3) = 1.77$, $p = .622$, $I^2 = 0\%$. We also tested whether the estimated effect sizes systematically differed by Culture (US/East Asian), Country (US/Taiwan/Japan), or EEG Amplifier (Neuroscan/BioSemi). None of these subgroups significantly differed in effect size (all $ps > .4$).

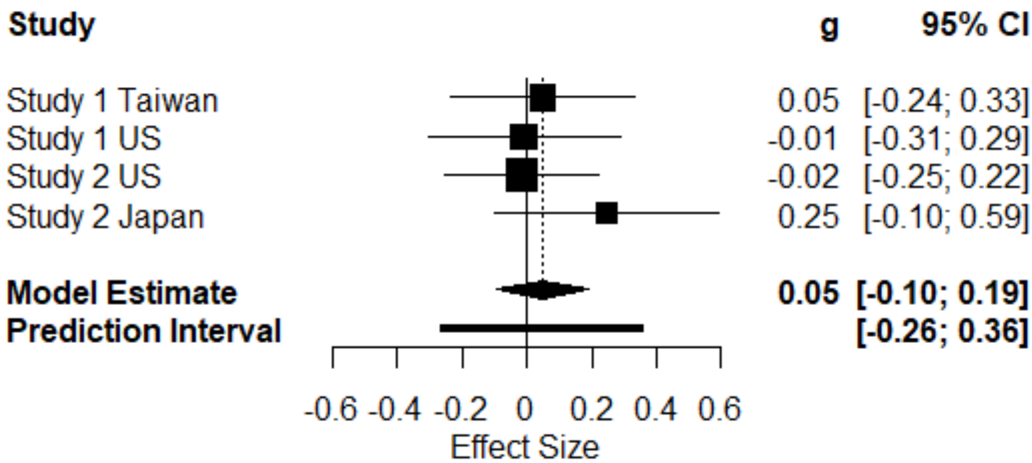
Figure S 11. *Meta-analysis for the PLE and Interdependence in the Eyes Closed Condition.*



Note. A forest plot of the effect sizes for the relationship between Interdependence and the PLE in the eyes closed condition is shown for all 4 samples reported. The square size indicates the relative weight of a study in the analysis and the lines indicate the range of the confidence interval.

In the eyes open condition, the weighted mean effect size (ES) for Interdependence showed a non-significant negative effect with the PLE, ES = .046, 95% CI: [-.096-.187], z = .63, p = .527 (see Figure S12). The distribution of the effect sizes in these samples did not show strong evidence for heterogeneity, $Q(3) = 1.68$, $p = .641$, $I^2 = 0\%$. We also tested whether the estimated effect sizes systematically differed by Culture (US/East Asian), Country (US/Taiwan/Japan), or EEG Amplifier (Neuroscan/BioSemi). None of these subgroups significantly differed in effect size (all ps > .3).

Figure S 12. *Meta-analysis for the PLE and Interdependence in the Eyes Open Condition.*



Note. A forest plot of the effect sizes for the relationship between Interdependence and the PLE in the eyes open condition is shown for all 4 samples reported. The square size indicates the relative weight of a study in the analysis and the lines indicate the range of the confidence interval.

Appendix II: Chapter II: Study 3 Supplement

Methods

LPP Analysis

To quantify the Late Positive Potential (LPP), the averaged activity at electrodes Cz, CPz, and Pz was used. Consistent with past studies using brief presentation periods for emotionally arousing stimuli (Schupp et al., 2004), the LPP occurred for a briefer time window than is typically observed during longer stimulus presentations. Thus, for analysis we used a 200ms wide time window between 445-645ms post-stimulus presentation. First, the peak latency was obtained from the grand average waveform (all participants combined). The grand average peak latency was then used in order to determine a 60ms time window to extract the average peak latency for each subject. This average peak latency across subjects was used as the midpoint of the 200ms time-window to extract the average mean amplitude.

To analyze the LPP data we extracted data from individual trials. Trials, the level-1 variable, were subsumed under two within-subjects (level-2) variables (Protagonist and Outcome). The level-3 variables included two between-subjects variables (Culture and Gender). We first attempted to fit the maximal model, which included random intercepts for each subject and all 160 trials with random slopes estimated for each subject for outcome, protagonist, and their interaction. Since that model did not converge, we dropped the random slope for the interaction and for the main effect of protagonist from the model. We were left with random intercepts for subject and trials, with a random slope for the outcome of the scenario. We analyzed only the trials for which both usable self-report data and EEG data were available (i.e.

trials where participants indicated a self-esteem change consistent with the outcome and no EEG artifacts were present).

Results

LPP Analysis

Average waveforms at the three midline central-parietal electrodes (Cz, CPz, and Pz) are shown in Figure S13. The time windows for the LPP are highlighted with a grey shadow. The analysis was performed using a mixed linear model (MLM) with the magnitude of the LPP on each trial as the DV and Protagonist (Self or Other), Outcome (Success or Failure), Gender (Male or Female) and Culture (European-American or Taiwanese) as IVs. The only significant effect was a 3-way interaction involving Gender, Outcome, and Protagonist, $F(1, 7084.1) = 5.48$, $p = .019$, $d = .03$. Of importance, however, in the cells defined by Gender and Protagonist the LPP magnitude was statistically no different between success and failures situations (*p*s < .05). Hence, we obtained no reliable effect of Outcome in any of the conditions, thereby providing no evidence that a greater LPP in response to failures (vs. success) situations can serve as a marker of self-enhancement.

Do The Behavioral Indices of Self-Enhancement Track the LPP?

The analysis of the trial-level LPP revealed no effect of Culture or other experimental conditions paralleling the patterns observed in the analysis of the behavioral indices of self-enhancement or criticism. Nevertheless, there could still be associations at the subject-level such that those who show a greater LPP to failures (vs. success) situations (the putative marker of self-enhancement) also show the behavioral signatures of self-enhancement (i.e., judging more success [vs. failure] situations as relevant to their self-esteem and impactful to their self-esteem). This LPP measure for self-enhancement and each of the two behavioral markers of self-enhancement are plotted in Figure S14. As can be seen, in the self-condition the association between the LPP, situational relevance, and the impact judgements on self-esteem are in the opposite direction, $r(64) = -.226$, $p = .073$ and $r(64) = -.253$, $p = .044$, respectively (Figure S14-A and B). In other words, the more self-enhancement, the smaller the observed LPP for failures (vs. successes) about the self. The comparable correlations for other-enhancement were not significant (Figure S14-C and D).

Discussion

We found no evidence that the LPP for failures (vs. successes) predicts cultural variation in self-enhancement. First, there were no differences in the LPP dependent on the Cultural background of the participant, Protagonist of the situation, nor Outcome (success or failure). Next, when we examined the correlation between the LPP in response to failures (vs. successes) and self-enhancement, we found correlations in the opposite direction. Specifically, the greater LPP response to failures (vs. successes), the weaker the self-enhancement. Altogether, we were unable to find any evidence for Cai et al.'s (2016) proposal that the LPP is an index of pancultural self-enhancement in the current paradigm.

Table S 1. *Stimuli used in the present study in English (A) and Chinese (B) for the self and other conditions. Words in parentheses represent the outcome of the situation (either a success or failure).*

A.

Self	Other
1. You recently moved to a new school. So far the other students have been very (welcoming/mean)	Steve recently moved to a new school. So far the other students have been very (welcoming/mean)

2. Your father asks you to help him with a building project. When he sees your work he tells you it is very (impressive/sloppy)	Sarah's father asks her to help him with a building project. When he sees her work he tells her it is very (impressive/sloppy)
3. While working you get into a debate with coworkers. When you gave your opinion your coworkers thought you were very (intelligent/ignorant)	While working Tom gets into a debate with coworkers. When he gave his opinion his coworkers thought he was very (intelligent/ignorant)
4. You were coordinating an important project. When you gave instructions your team members followed your orders (perfectly/poorly)	Sally was coordinating an important project. When she gave instructions her team members followed her orders (perfectly/poorly)
5. You got into an argument with someone who you strongly dislike. After a few minutes of arguing you (won/lost)	Matt got into an argument with someone who he strongly dislikes. After a few minutes of arguing he (won/lost)
6. You forgot your shopping list at home when you went to the store. When you checked your list after returning home the items you had bought were (correct/wrong)	Trisha forgot her shopping list at home when she went to the store. When she checked her list after returning home the items she had bought were(correct/wrong)
7. You accidentally forgot your girlfriend's/boyfriend's birthday. When you called the next day he/she was very (understanding/angry)	Jason accidentally forgot his girlfriend's birthday. When he called the next day she was very (understanding/angry)

8. A recruiter from a top company contacted you. In response to your application they treated you very (kindly/poorly)	A recruiter from a top company contacted Alyssa. In response to her application they treated her very (kindly/poorly)
9. You were talking with a coworker over lunch. Your coworker said other people at your job think you are very (cool/incompetent)	James was talking with a coworker over lunch. His coworker said other people at his job think he is very (cool/incompetent)
10. You finished your school exams last week. Soon after you found out that on the most important one you (passed/failed)	Christina finished her school exams last week. Soon after she found out that on the most important one she (passed/failed)
11. You have been studying a foreign language for a long time. When you travel to that country you communicate very (fluently/poorly)	Josh has been studying a foreign language for a long time. When he travels to that country he communicates very (fluently/poorly)
12. When talking with new friends, you make a joke. In response your friends (laugh/frown)	When talking with new friends, Brittany makes a joke. In response her friends (laugh/frown)
13. Your friend asks you for help with a complex math problem. When you try to help them you are (helpful/unsuccessful)	Tim's friend asks for his help with a complex math problem. When he tries to help them he is (helpful/unsuccessful)
14. You have been worried about your health. When you visited the doctor he said you looked (great / sick)	Emily has been worried about her health. When she visited the doctor he said she looked (great/sick)

15. You had a potted plant that you were taking care of. When you checked on it after the weekend it had (grown/died)	Scott had a potted plant that he was taking care of. When he checked on it after the weekend it had (grown/died)
16. After an exam, your professor gives the test scores to the class. When you received your exam you had scored the (highest/lowest)	After an exam, Sasha's professor gives the test scores to the class. When she received her exam she had scored the (highest/lowest)
17. You went out dancing with your friends at a nightclub. You could tell the men and women at the club thought you were very (attractive/ugly)	Dan went out dancing with his friends at a nightclub. He could tell the men and women at the club thought he was very (attractive/ugly)
18. You have been training to run a marathon. When you run the race you finish (first/last)	Molly has been training to run a marathon. When she runs the race she finishes (first/last)
19. You were helping your parents get the house ready for company. They told you your effort was (appreciated/useless)	Gabe was helping his parents get the house ready for company. They told him his effort was (appreciated/useless)
20. You attended a friend's party over the weekend. When you arrived everyone was very (friendly/mean)	Ashley attended a friend's party over the weekend. When she arrived everyone was very (friendly/mean)
21. A close friend of yours recently moved away. When you spoke to your friend they said they missed you very (much/little)	A close friend of Paul's recently moved away. When he spoke to his friend they said he missed him very (much/little)

22. You have worked very hard to get the career you really want. Finally your efforts were (rewarded/ignored)	Betty has worked very hard to get the career she really wants. Finally her efforts were (rewarded/ignored)
23. You presented a final project to your class. During your presentation the students seemed (interested/bored)	Kyle presented a final project to his class. During his presentation the students seemed (interested/bored)
24. In class, you raised your hand to answer an easy question. The professor said your answer was (correct/wrong)	In class, Samantha raised her hand to answer an easy question. The professor said her answer was (correct/wrong)
25. You did not make any plans for the weekend. Being by yourself you felt (relaxed/lonely)	Kevin did not make any plans for the weekend. Being by himself he felt (relaxed/lonely)
26. Walking downtown, you saw your reflection in a store window. You thought you looked very (good/ugly)	Walking downtown, Carrie saw her reflection in a store window. She thought she looked very (good/ugly)
27. You heard a rumor about yourself at school. The rumor was very (flattering/mean)	Michael heard a rumor about himself at school. The rumor was very (flattering/mean)
28. At work your boss was choosing people to work on an important project. When he made his selections you were (chosen/forgotten)	At work Alexis's boss was choosing people to work on an important project. When he made his selections she was (chosen/forgotten)
29. You went out to the movies with a group of friends. When they were joking around you felt socially (accepted/awkward)	Bill went out to the movies with a group of friends. When they were joking around he felt socially (accepted/awkward)

30. Your girlfriend/boyfriend recommended a book that they really liked. You found reading it very (interesting/boring)	Stacey's boyfriend recommended a book that he really liked. She found reading it very (interesting/boring)
31. Your best friend accidentally sent you an email meant for someone else. In the message they talked about you saying things that were very (positive/negative)	Jay's best friend accidentally sent him an email meant for someone else. In the message they talked about him saying things that were very (positive/negative)
32. You have been saving your money to buy a car. The one you can afford to buy is very (nice/old)	Carly has been saving her money to buy a car. The one she can afford to buy is very (nice/old)
33. You worked very hard to write a difficult essay for class. When it was returned the professor wrote that it was (amazing/poor)	Mike worked very hard to write a difficult essay for class. When it was returned the professor wrote that it was (amazing/poor)
34. Recently you were interviewed for a very exciting job. Shortly thereafter the interviewer called to say you were (hired/wrong)	Recently Jennifer was interviewed for a very exciting job. Shortly thereafter the interviewer called to say she was (hired/wrong)
35. You went yesterday to get a haircut. Your girlfriend/boyfriend told you it looked (amazing/bad)	Rob went yesterday to get a haircut. His girlfriend told him it looked (amazing/bad)
36. You were hanging out with a group of new friends. When they asked your opinion you were (comfortable/uncomfortable)	Rachel was hanging out with a group of new friends. When they asked her opinion she was (comfortable/uncomfortable)
37. You recently had your birthday. Your girlfriend/boyfriend (celebrated/forgot)	Chris recently had his birthday. His girlfriend (celebrated/forgot)

38. When you had family issues you called your best friend to talk. They were (helpful/distracted)	When Elizabeth had family issues she called her best friend to talk. They were (helpful/distracted)
39. A friend of yours asked you a silly question. In response your comment to your friend was (funny/mocking)	A friend of Sam's asked him a silly question. In response his comment to his friend was (funny/mocking)
40. You tell the girl/boy that you have a crush on that you like them. In response he/she (smiles/frowns)	Kayla tells the boy she has a crush on that she likes him. In response he (smiles/frowns)

B.

Self	Other
1. 你最近轉到了一所新學校。到/目前為止/其他/學生/非常/(歡迎你/排擠你)	小智最近轉到了一所新學校。到/目前為止/其他/學生/非常(歡迎他/排擠他)
2. 你的父親要求你幫他做一個建築計畫。當/父親看到/你的/作品/他/告訴你/這非常/(棒/差勁)	莎莎的父親要求她幫他做一個建築計畫。當/父親看到/她的/作品/他/告訴她/這非常/(棒/差勁)
3. 當你工作的時候, 你和你的同事開始辯論。當/你發表/你的/意見時/你的/同事/認為/你/非常/(聰明/無知)	當小湯工作的時候, 他和他的同事開始辯論。當/他發表/他的/意見時/他的/同事/認為/他/非常/(聰明/無知)
4. 你正在協調一個重要的專案。當/你下達/指令時/你的/團隊成員/對你的/命令(讚成/反對)	麗麗正在協調一個重要的專案。當/她下達/指令時/她的/團隊成員/對她的/命令/(讚成/反對)

5. 你和一個你非常不喜歡的人吵架了。經過/幾分鐘/的爭論/你/(贏了/輸了)	小馬和一個他非常不喜歡的人吵架了。經過/幾分鐘/的爭論/他/(贏了/輸了)
6. 當你去商店時, 你把你的購物清單忘在家裡了。當/你回家後/檢查/你的/單子時/你買的/東西是/(正確/錯誤的)	當麗莎去商店時, 她把她的購物清單忘在家裡了。當/她回家後/檢查/她的/單子時/她買的/東西是/(正確/錯誤的)
7. 你不小心忘記了你女朋友/男朋友的生日。當你/第二天/打電話時/她・他/非常/(理解/生氣)	小傑不小心忘記了他女朋友的生日。當他/第二天/打電話時/她/非常/(理解/生氣)
8. 一家大公司的招聘人員與你聯繫了。針對/你的/申請/他們/對你/非常/(親切/無理)	一家大公司的招聘人員與艾莉聯繫了。針對/她的/申請/他們/對她/非常/(親切/無理)
9. 你在午餐時和同事談話。你的/同事/說/其他人/認為/你工作很/(酷/無能)	志宏在午餐時和同事談話。他的/同事/說/其他人/認為/他工作很/(酷/無能)
10. 你上週完成了你的學校考試。出結果/之後/你/發現/最重要的/一個考試/你/(通過了/失敗了)	愛麗絲上週完成了她的學校考試。出結果/之後/她/發現/最重要的/一個考試/她/(通過了/失敗了)
11. 你已經學習一種外語很長時間了。當你/到那個國家/旅行時/你的/交流/非常(流利/糟糕)	喬希已經學習一種外語很長時間了。當他/到那個國家/旅行時/他的/交流/非常(流利/糟糕)
12. 和新朋友交談時, 你開個玩笑。然後/你的/朋友/(笑了/皺眉了)	和新朋友交談時, 小布開個玩笑。然後/她的/朋友/(笑了/皺眉了)

13. 你的朋友要求你幫忙解決一個複雜的數學問題。當你/去幫助/他們時/你/(成功了/沒有成功)	明明的朋友要求他幫忙解決一個複雜的數學問題。當他/去幫助/他們時/他/(成功了/沒有成功)
14. 你一直在擔心自己的健康。當你/去看/醫生/的時候/他說你/(健康/虛弱)	艾米一直在擔心自己的健康。當她/去看/醫生/的時候/他說她/(健康/虛弱)
15. 你正在照顧盆栽植物。週末過後/當你/檢查它時/它/(生長了/枯萎了)	阿正正在照顧盆栽植物。週末過後/當他/檢查它時/它/(生長了/枯萎了)
16. 考試結束後, 你的教授把考試成績給全班同學。你/看到/你的/考試結果/你/取得了/(最高分/最低分)	考試結束後, 慧敏的教授把考試成績給全班同學。她/看到/她的/考試結果/她/取得了/(最高分/最低分)
17. 你和你的朋友去夜店跳舞。夜店裡的/人/都/認為/你很/(迷人/難看)	小明和他的朋友去夜店跳舞。夜店裡的/人/都/認為/他很/(迷人/難看)
18. 你為了馬拉松比賽在專心訓練。比賽時/你/跑了/(第一名/最後一名)	莫莉為了馬拉松比賽在專心訓練。比賽時/她/跑了/(第一名/最後一名)
19. 因為有人來做客，你幫助了你的父母做了準備。他們/告訴你/你的/幫助是/(有用的/沒用的)	因為有人來做客，阿峰幫助了他的父母做了準備。他們/告訴他/他的/幫助是/(有用的/沒用的)
20. 你週末參加了一個朋友的聚會。當你/到達時/每個人/都/非常/(友好/冷漠)	小美週末參加了一個朋友的聚會。當她/到達時/每個人/都/非常/(友好/冷漠)

21. 你的一個親密好友最近搬走了。當你/和你的/朋友/交談時/他們說/他很/(想念你/不太想念你)	保羅的一個親密好友最近搬走了。當他/和他的/朋友/交談時/他們說/他很/(想念他/不太想念他)
22. 你為了得到你真正想要的事業而努力工作。最後/你的/努力是/(有回報的/白費的)	貝貝為了得到她真正想要的事業而努力工作。最後/她的/努力是/(有回報的/白費的)
23. 你給你的班上提供了一個最後的計畫。在/你的/演講中/學生們/似乎/(有興趣/不耐煩)	世傑給他的班上提供了一個最後的計畫。在/他的/演講中/學生們/似乎/(有興趣/不耐煩)
24. 在課堂上, 你舉手回答了一個簡單的問題。教授/說/你的/回答是/(正確/錯誤)	在課堂上, 小曼舉手回答了一個簡單的問題。教授/說/她的/回答是/(正確/錯誤)
25. 你週末沒有做任何計畫。獨自/一人/你/感到/(放鬆/孤獨)	凱文週末沒有做任何計畫。獨自/一人/他/感到(/放鬆/孤獨)
26. 漫步在市中心, 你在商店的櫥窗裡看到了你的倒影。你認為/你/看上去很/(美/醜)	漫步在市中心, 嘉莉在商店的櫥窗裡看到了她的倒影。她認為/她/看上去很/(美/醜)
27. 你在學校裡聽到了關於你自己的傳言。這個/傳言/非常/(奉承/卑鄙)	邁克在學校裡聽到了關於他自己的傳言。這個/傳言/非常/(奉承/卑鄙)
28. 在工作中, 你的老闆正在挑選人來做一個重要的專案。當他/選擇時/你被/(選中/遺忘)	在工作中, 琳琳的老闆正在挑選人來做一個重要的專案。當他/選擇時/他被/(選中/遺忘)

29. 你和一群朋友一起去看電影了。當他們/在/開玩笑/的時候/你/覺得/很/(享受/尷尬)	嘉爾和一群朋友一起去看電影了。當他們/在/開玩笑/的時候/他/覺得/很/(享受/尷尬)
30. 你的女朋友/男朋友推薦了一本她/他非常喜歡的書。你/發現/讀它/非常/(有趣/枯燥)	黛西的男朋友推薦了一本他非常喜歡的書。她/發現/讀它/非常/(有趣/枯燥)
31. 你最好的朋友無意中給你發了一封給別人的郵件。在/郵件中/他們/談到你/說的/非常/(正面/負面)	杰陸最好的朋友無意中給他發了一封給別人的郵件。在/郵件中/他們/談到他/說的/非常/(正面/負面)
32. 你一直在存錢買車。最後/你買了/一輛/(新車/二手車)	舒敏一直在存錢買車。最後/她買了/一輛/(新車/二手車)
33. 你非常努力地為班上寫一篇困難的報告。當它/被歸還時/教授/寫道/這篇文章/非常的/(優秀/差勁)	麥克非常努力地為班上寫一篇困難的報告。當它/被歸還時/教授/寫道/這篇文章/非常的/(優秀/差勁)
34. 最近你面試了一個非常有趣的工作。緊接著/面試官/打電話/給你/說你/(被雇用/沒被雇用)	最近珍妮面試了一個非常有趣的工作。緊接著/面試官/打電話/給她/說她/(被雇用/沒被雇用)
35. 你昨天去理髮了。你的/女朋友・男朋友/告訴你/它/看起來/(漂亮/糟糕)	小羅昨天去理髮了。他的/女朋友/告訴他/它/看起來/(漂亮/糟糕)
36. 你和一群新朋友在一起。當他們/問你/意見時/你很/(了解/困惑)	小優和一群新朋友在一起。當他們/問她/意見時/她很/(了解/困惑)

37. 你最近過生日。你的/女朋友・男朋友/(為你慶祝了/忘記了)	安妮最近過生日。他的/女朋友/(為他慶祝了/忘記了)
38. 當你有家庭問題, 你打電話給你最好的朋友聊天。他們/(有幫助/心不在焉)	當智林有家庭問題, 她打電話給她最好的朋友聊天。他們/(有幫助/心不在焉)
39. 你的一個朋友問你一個愚蠢的問題。你/聽了/之後/(覺得有趣/嘲笑了他)	大山的一個朋友問他一個愚蠢的問題。他/聽了/之後/(覺得有趣/嘲笑了他)
40. 你對自己一見鐘情的女孩/男孩告白了。他・她的/回應是/(微笑/皺眉)	小紅對自己一見鐘情的男孩告白了。他的/回應是/(微笑/皺眉)

Figure S 13. *ERP waveform for Americans and Taiwanese. The LPP time-window is indicated with a gray shadow.*

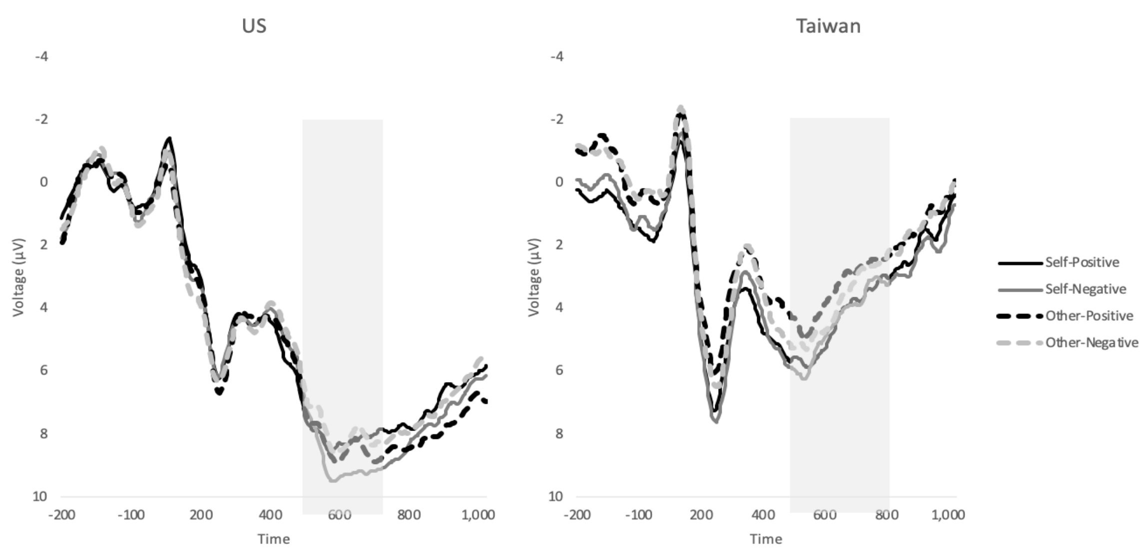
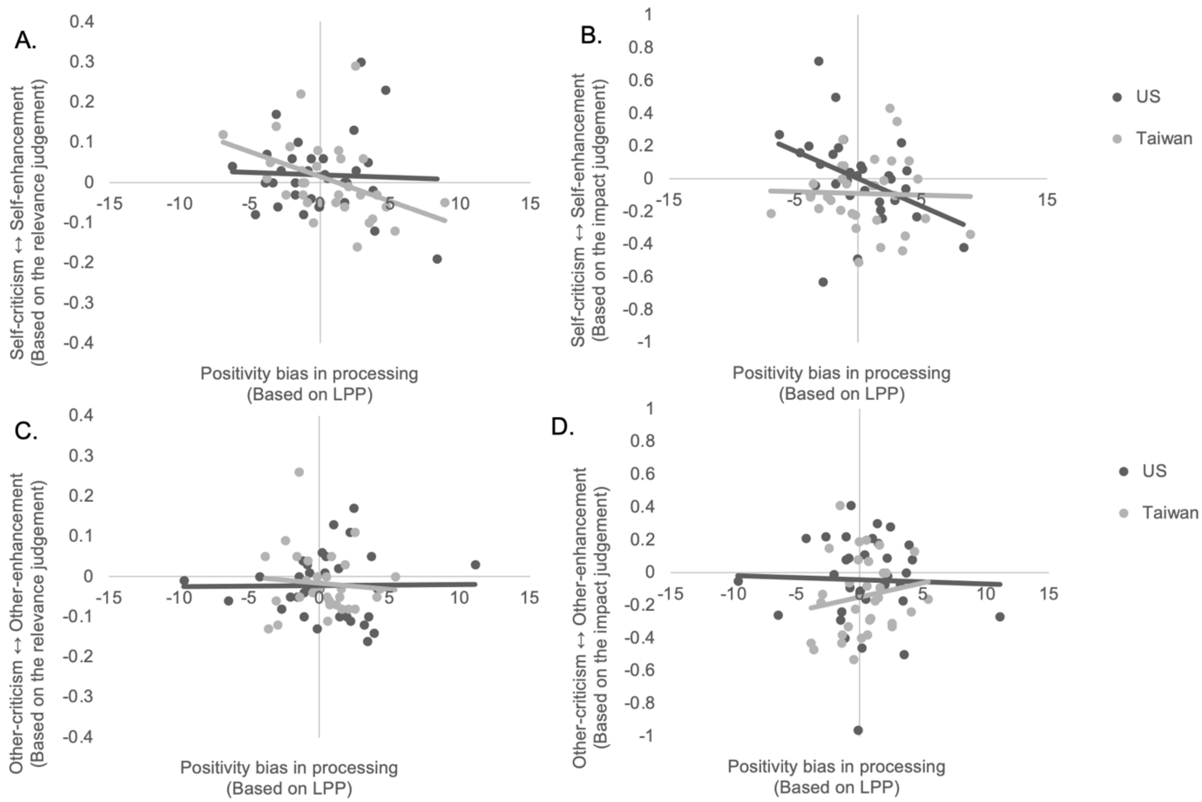


Figure S 14. *The correlations between the LPP in response to failures (vs. successes) and the two self-report indices of self-enhancement. The top panels (A, B) include the self judgement condition, and the bottom panels (C, D) include the other judgement condition. The self-report indices include the perceived relevance of successes (vs. failures) to self-esteem (left) and the perceived impact of successes (vs. failures) on self-esteem (right).*


A.
B.
C.
D.
Self-criticism ↔ Self-enhancement (Based on the relevance judgement)
Self-criticism ↔ Self-enhancement (Based on the impact judgement)
Other-criticism ↔ Other-enhancement (Based on the relevance judgement)
Other-criticism ↔ Other-enhancement (Based on the impact judgement)
Positivity bias in processing (Based on LPP)
US
Taiwan

Appendix III: Chapter III: Study 1 Supplement

Supplementary Analysis 1: Effects of Possible Outliers

On the upper right corner of Figure 15-C, there is an apparent outlier. To test if this observation resulted in a deviation from normality, we ran the Shapiro-Wilk test. In the control condition, there was a significant deviation from normality, $W(47) = .944$, $p = .025$. The removal of the most extreme outlier resulted in no significant deviation from normality, $W(46) = .959$, $p = .108$. We then re-ran the same analyses reported in the main text without the outlier. Both the Prime main effect and its interaction with TL Belief proved significant, $F(1, 86) = 6.07$, $p = .016$ and $F(1, 86) = 7.46$, $p = .008$. On Figure 15-B, a data point on the upper right-hand corner could be suspected as an outlier. With the same criterion, this data point did not qualify as an outlier, $W(44) = .969$, $p = .284$.

Supplementary Analysis 2: Multi-level Modeling Analysis of the Data

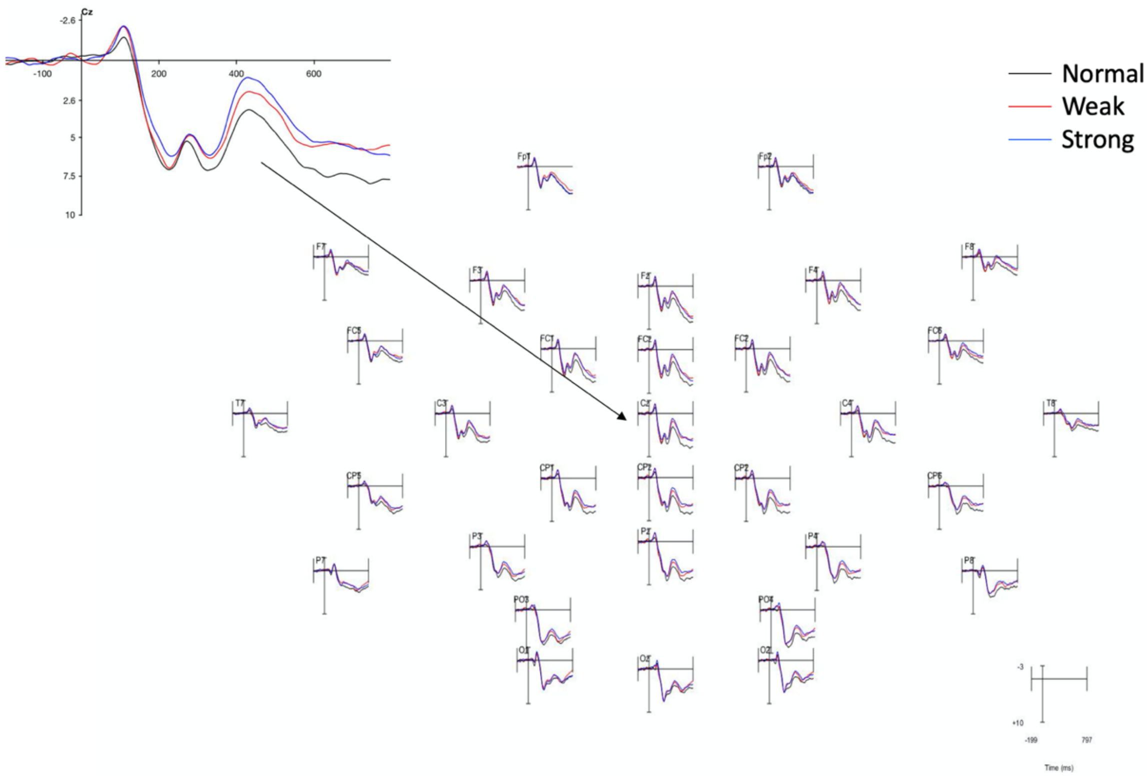
We ran a multi-level model and estimated random effects for electrode nested in subjects and Behavior type nested in stimuli. In this analysis, we used the average N400 amplitude of the midline electrode sites as a dependent variable. We found a main effect of Behavior type, $F(2,99) = 8.58$, $p < .001$. Weakly and strongly violating behaviors showed a significantly greater N400 than normal behaviors, $t(99.12) = 2.76$, $p = .007$ and $t(99.33) = 3.89$, $p < .001$ respectively. However, weakly and strongly violating behaviors were no different from each other, $t(99.61) = .701$, $p = .485$. An interaction between Tightness/looseness belief and Behavior-type and Prime and Behavior type also emerged, $F(2,53721) = 8.08$, $p < .001$ and $F(2,54938) = 6.30$, $p = .002$ respectively. Most importantly, the Behavior type x Prime x Tightness/looseness belief interaction proved significant, $F(2,54925) = 24.33$, $p < .001$. The pattern of this interaction paralleled the pattern observed in Fig. 15-B and C.

Supplementary Analysis 3: Analysis of Norm-violation N400 at the frontal electrodes

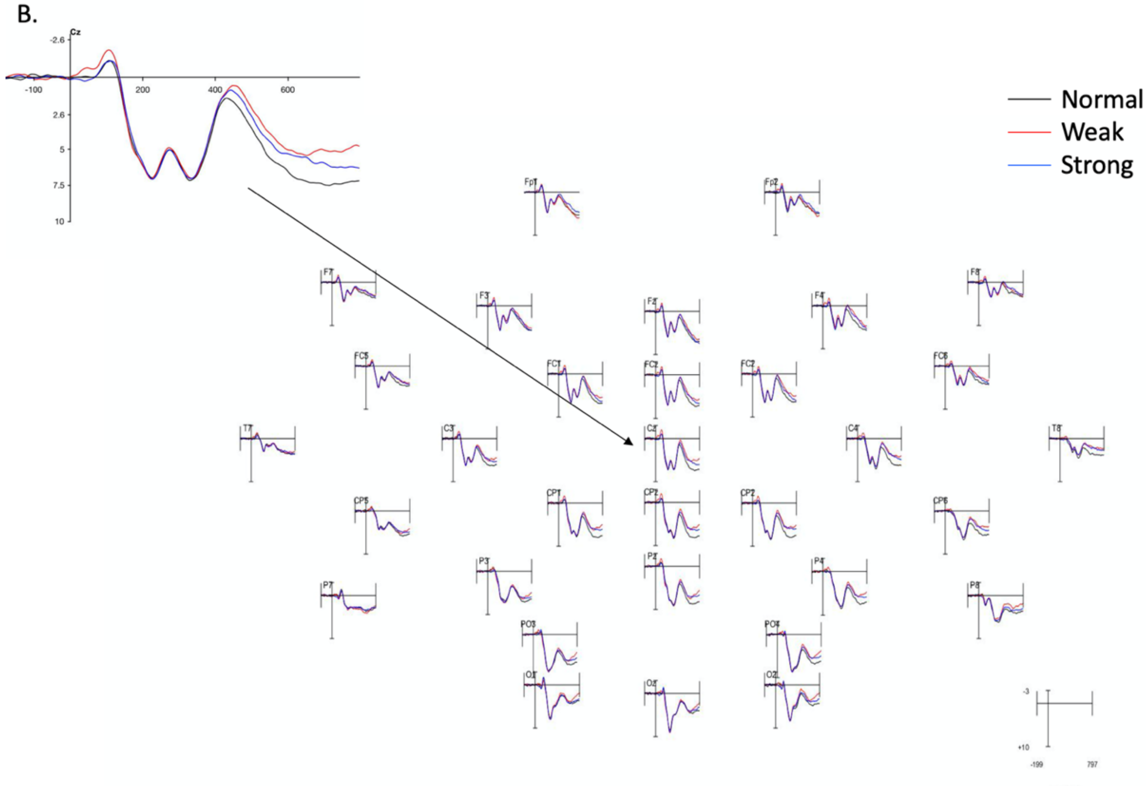
As in the main analysis, the relative N400 was analyzed with two between-subjects variables (Prime and Tightness/looseness belief) and the interaction between them.
This analysis showed a significant main effect of Prime, $F(1,87) = 5.59$, $p = .020$, $\eta_p^2 = 0.060$. Moreover, the key interaction between these two variables remained significant, $F(1,87) = 7.10$, $p = .009$, $\eta_p^2 = 0.075$. As in the central-parietal sites, the effect of Tightness/looseness belief was significant, predicting a stronger norm violation N400 effect in the relational priming condition, $r(44) = -0.374$, $p = 0.012$. The control priming condition showed no significant effect, $r(47) = 0.186$, $p = 0.212$. The norm violation N400 was significantly greater in the relational priming condition than in the control priming condition for those who were 1SD higher than the mean in Tightness/looseness belief, $F(1,87) = 7.98$, $p = .006$, $\eta_p^2 = 0.084$, whereas the priming effect was negligible for those who were 1SD lower than the mean in Tightness/looseness belief, $F(1,87) = .161$, $p = .682$, $\eta_p^2 = 0.002$.

Figure S 15. *Waveforms for all the 32 electrode sites in the relational and control priming conditions (A and B, respectively).*

A.



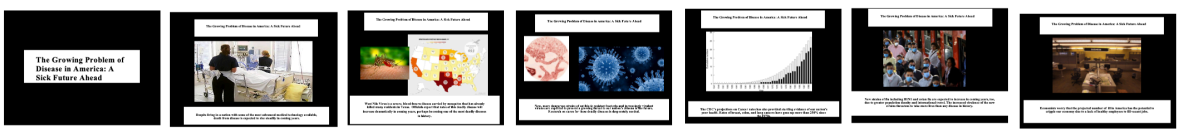
B.



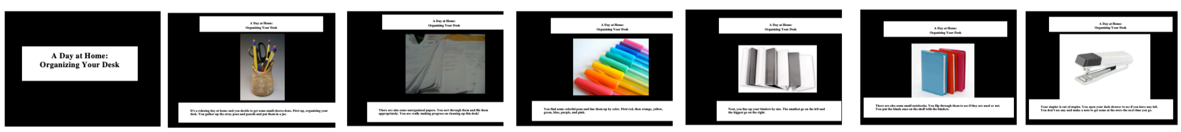
Appendix IV: Chapter III: Study 2 Supplement

Figure S 16. *Slideshows used in the A. threat prime condition and the B. control prime condition.*

A.



B.



Appendix V: Chapter III: Study 3 Supplement

Table S 2. *Countries included in the analyses of confirmed cases and deaths. For each country, the date of the first 100 confirmed cases, the date of the first death, and the date of lockdown are noted. NI stands for not implemented.*

Country	Date of first 100 cases	Date of first death	Date of lockdown
Australia	3.10.20	3.1.20	3.23.20
Brazil	3.13.20	3.17.20	3.24.20
Canada	3.11.20	3.9.20	NI
Chile	3.16.20	3.22.20	3.19.20
Colombia	3.18.20	3.22.20	3.25.20
Egypt	3.14.20	3.8.20	3.19.20
Estonia	3.14.20	3.25.20	3.27.20
France	2.29.20	2.15.20	3.17.20
Germany	3.1.20	3.9.20	3.23.20
Hong Kong	3.2.20	2.4.20	NI
Hungary	3.21.20	3.15.20	3.28.20
Israel	3.12.20	3.21.20	4.02.20
Japan	2.21.20	2.13.20	4.07.20
Jordan	3.22.20	3.27.20	3.18.20
Lebanon	3.15.20	3.10.20	3.15.20
Libya	5.28.20	4.2.20	3.22.20

Malaysia	3.9.20	3.17.20	3.18.20
Mauritius	3.28.20	3.21.20	3.24.20
Mexico	3.18.20	3.19.20	3.26.20
Morocco	3.22.20	3.10.20	3.19.20
Netherlands	3.6.20	3.6.20	3.16.20
New Zealand	3.22.20	3.29.20	3.26.20
Philippines	3.14.20	2.2.20	3.16.20
Poland	3.14.20	3.12.20	3.13.20
Portugal	3.13.20	3.17.20	3.19.20
Puerto Rico	3.28.20	3.21.20	3.15.20
Singapore	2.29.20	3.21.20	4.07.20
South Korea	2.20.20	2.20.20	NI
Spain	3.2.20	3.3.20	3.14.20
Sweden	3.6.20	3.11.20	NI
Taiwan	3.18.20	2.16.20	NI
Trinidad and Tobago	4.4.20	3.25.20	3.17.20
Tunisia	3.24.20	3.19.20	3.22.20
Turkey	3.19.20	3.17.20	4.11.20
Ukraine	3.25.20	3.13.20	NI
United Kingdom	3.2.20	3.5.20	3.23.20
United States	3.4.20	2.29.20	3.19.20 (CA)

Venezuela	3.26.20	3.27.20	3.17.20
West Bank and Gaza	3.29.20	3.26.20	3.22.20

Table S 3. *Regression coefficients predicting the number of confirmed cases (A) and deaths (B) over the first 30 days of country-wise outbreaks. Individualism is added as a covariate. Model 1 includes total population (called Population) and Individualism. Model 2 includes all demographic covariates and Individualism. Model 3 includes only those demographic variables that prove at least marginally significant in Model 2 and Individualism. The results are based on 35 of the 39 countries, except in Model 2, which is based on 34 countries because of a missing value for Tourism in Taiwan.*

	Model 1				Model 2				Model 3			
A. Predictor	b	t	df	p	b	t	df	p	b	t	df	p
Intercept	6.778	24.778	3.282	<.001	6.712	23.311	2.975	<.001	6.731	27.782	3.350	<.001
Day	0.116	9.698	2.473	0.005	0.114	11.987	2.489	0.003	0.115	14.026	2.455	0.002
Relational Mobility	1.815	2.386	29.059	0.024	1.697	2.443	23.913	0.022	1.881	2.751	26.806	0.011
Individualism	0.146	0.973	29.551	0.339	-0.272	-1.608	22.707	0.122	-0.005	-0.036	27.911	0.972
Population	0.891	4.744	28.385	<.001	0.734	3.554	21.286	0.002	0.817	4.155	25.169	<.001
Migration					0.542	3.338	19.854	0.003	0.498	2.982	25.032	0.006
GDP					0.180	0.715	21.298	0.482				
Population Density					-0.420	-2.299	19.954	0.032				
Tourism					0.152	1.078	21.179	0.293	0.140	1.007	26.853	0.323
Percent Urban					0.184	1.419	21.808	0.170				
Median Age					-0.054	-0.304	23.804	0.764				
Day x Relational Mobility	0.088	2.372	25.048	0.026	0.077	2.280	19.874	0.034	0.084	2.869	19.355	0.010
Day x Individualism	0.018	2.405	26.757	0.023	0.005	0.547	23.990	0.589	0.010	1.590	26.220	0.124
Day x Population	0.049	5.271	27.959	<.001	0.040	3.748	23.331	0.001	0.038	4.186	25.770	<.001
Day x Migration					0.022	2.553	20.732	0.019	0.024	3.053	25.370	0.005
Day x GDP					0.010	0.763	23.131	0.453				
Day x Population Density					-0.007	-0.729	20.876	0.474				

Day x Tourism					0.015	2.076	23.200	0.049	0.017	2.757	27.763	0.010
Day x Percent Urban					0.001	0.138	23.138	0.892				
Day x Median Age					-0.001	-0.097	20.786	0.924				
R^2 fixed effects	0.671				0.733				0.747			
R^2 fixed and random effects	0.973				0.974				0.972			
B. Predictor	b	t	df	p	b	t	df	p	b	t	df	p
Intercept	2.519	6.478	4.093	0.003	2.399	5.354	3.757	0.007	2.448	6.049	4.222	0.003
Day	0.140	7.202	4.297	0.001	0.137	6.480	3.943	0.003	0.136	6.728	4.415	0.002
Relational Mobility	1.725	1.378	26.377	0.180	0.578	0.445	23.656	0.660	1.831	1.473	27.078	0.152
Individualism	0.105	0.424	27.829	0.675	-0.579	-1.804	23.628	0.084	-0.014	-0.054	29.092	0.957
Population	0.686	2.137	29.280	0.041	0.810	2.048	22.641	0.052	0.710	2.265	28.244	0.031
Migration					0.381	1.215	21.147	0.238	0.465	1.490	28.057	0.147
GDP					0.874	1.813	22.590	0.083				
Population Density					-0.781	-2.217	21.244	0.038				
Tourism					-0.048	-0.177	22.542	0.861				
Percent Urban					0.295	1.194	22.871	0.245				
Median Age					-0.071	-0.212	23.854	0.834				
Day x Relational Mobility	0.094	1.708	29.271	0.098	0.075	1.312	23.942	0.202	0.101	1.930	29.488	0.063
Day x Individualism	0.024	2.175	29.733	0.038	0.002	0.114	23.450	0.910	0.016	1.533	29.928	0.136
Day x Population	0.043	3.115	29.071	0.004	0.045	2.636	22.429	0.015	0.044	3.457	27.961	0.002
Day x Migration					0.024	1.783	21.116	0.089	0.028	2.210	27.671	0.036

Day x GDP					0.019	0.887	22.405	0.385				
Day x Population Density					-0.017	-1.117	21.204	0.276				
Day x Tourism					0.004	0.315	22.338	0.755				
Day x Percent Urban					0.005	0.509	22.732	0.616				
Day x Median Age					0.011	0.741	23.996	0.466				
R^2 fixed effects	0.491				0.535				0.504			
R^2 fixed and random effects	0.967				0.970				0.968			

Table S 4. *Regression coefficients predicting the number of confirmed cases (A) and deaths (B) over the first 30 days of country-wise outbreaks. Government efficiency is added as a covariate. Model 1 includes total population (called Population) and Government efficiency. Model 2 includes all demographic covariates and Government efficiency. Model 3 includes only those demographic variables that prove at least marginally significant in Model 2 and Government efficiency. The results are based on 34 of the 39 countries.*

	Model 1				Model 2				Model 3			
A. Predictor	b	t	df	p	b	t	df	p	b	t	df	p
Intercept	7.029	21.247	3.053	<.001	6.888	28.652	1.848	0.002	6.886	28.180	2.715	<.001
Day	0.131	6.725	2.854	0.008	0.120	11.164	1.471	0.021	0.121	10.112	2.439	0.005
Relational Mobility	2.279	2.916	29.816	0.007	1.490	1.865	23.974	0.075	1.951	2.791	27.962	0.009
Government Efficiency	0.174	1.125	29.381	0.270	-0.203	-0.841	20.019	0.410	-0.224	-1.200	27.416	0.240
Population	0.663	4.488	21.364	<.001	0.347	2.177	20.784	0.041	0.444	3.045	20.230	0.006
Migration					0.644	2.780	18.436	0.012	0.655	2.939	23.550	0.007
GDP					0.109	0.380	20.521	0.708				

Population Density					-0.313	-1.829	20.292	0.082				
Tourism					0.271	1.830	22.471	0.081	0.247	1.716	27.648	0.097
Percent Urban					0.111	0.784	21.464	0.441				
Median Age					-0.084	-0.412	23.994	0.684				
Day x Relational Mobility	0.133	3.570	28.168	0.001	0.085	2.174	23.775	0.040	0.116	3.529	27.993	0.001
Day x Government Efficiency	0.016	2.131	27.682	0.042	-0.008	-0.662	20.094	0.515	-0.002	-0.267	27.001	0.791
Day x Population	0.041	5.562	22.123	<.001	0.022	2.844	20.869	0.010	0.026	3.721	19.115	0.001
Day x Migration					0.028	2.435	18.106	0.025	0.027	2.620	22.802	0.015
Day x GDP					0.017	1.202	20.394	0.243				
Day x Population Density					-0.012	-1.416	20.306	0.172				
Day x Tourism					0.019	2.623	22.606	0.015	0.019	2.836	27.378	0.008
Day x Percent Urban					0.001	0.078	21.531	0.939				
Day x Median Age					-0.006	-0.567	23.340	0.576				
R^2 fixed effects	0.634				0.739				0.731			
R^2 fixed and random effects	0.977				0.974				0.974			

B. Predictor	b	t	df	p	b	t	df	p	b	t	df	p
Intercept	2.752	7.174	4.002	0.002	2.687	7.577	2.771	0.006	2.752	7.174	4.002	0.002
Day	0.155	6.542	3.950	0.003	0.151	7.543	3.408	0.003	0.155	6.542	3.950	0.003

Relational Mobility	1.499	1.254	29.001	0.220	0.215	0.152	23.331	0.881	1.499	1.254	29.001	0.220
Government Efficiency	0.224	0.940	29.779	0.355	-0.388	-0.886	22.438	0.385	0.224	0.940	29.779	0.355
Population	0.479	2.231	24.958	0.035	0.170	0.610	22.758	0.548	0.479	2.231	24.958	0.035
Migration					0.543	1.281	21.189	0.214				
GDP					0.573	1.094	22.432	0.285				
Population Density					-0.509	-1.635	22.488	0.116				
Tourism					0.154	0.575	23.559	0.571				
Percent Urban					0.221	0.862	23.031	0.397				
Median Age					-0.127	-0.355	22.745	0.726				
Day x Relational Mobility	0.115	2.257	29.434	0.032	0.084	1.402	23.698	0.174	0.115	2.257	29.434	0.032
Day x Government Efficiency	0.027	2.672	29.037	0.012	0.013	0.709	21.264	0.486	0.027	2.672	29.037	0.012
Day x Population	0.038	3.868	23.240	0.001	0.027	2.221	21.818	0.037	0.038	3.868	23.240	0.001
Day x Migration					0.017	1.004	20.357	0.327				
Day x GDP					0.008	0.384	21.730	0.705				
Day x Population Density					-0.018	-1.424	21.483	0.169				
Day x Tourism					0.011	1.010	22.949	0.323				
Day x Percent Urban					0.002	0.157	22.250	0.876				
Day x Median Age					0.013	0.858	23.824	0.400				
R^2 fixed effects		0.507				0.549				0.507		

R^2 fixed and random effects	0.967	0.968	0.967

Table S 5. *Regression coefficients predicting the number of confirmed cases (A) and deaths (B) over the first 30 days of country-wise outbreaks. Tightness of cultural norms is added as a covariate. Model 1 includes total population (called Population) and Tightness. Model 2 includes all demographic covariates and Tightness. Model 3 includes only those demographic variables that prove at least marginally significant in Model 2 and Tightness. The results are based on 23 of the 39 countries.*

	Model 1				Model 2				Model 3			
A. Predictor	b	t	df	p	b	t	df	p	b	t	df	p
Intercept	6.950	14.835	4.208	<.001	7.119	18.453	1.863	0.004	6.961	19.192	3.834	<.001
Day	0.134	4.834	4.062	0.008	0.126	7.494	2.458	0.009	0.135	6.213	3.748	0.004
Relational Mobility	2.271	2.622	16.691	0.018	1.989	2.178	11.419	0.051	2.151	2.696	16.429	0.016
Tightness-Looseness	0.246	1.365	16.744	0.190	0.346	1.589	12.961	0.136	0.219	1.321	16.255	0.205
Population	0.866	3.162	18.003	0.005	0.426	1.230	12.768	0.241	0.793	3.168	17.637	0.005
Migration					0.602	2.667	11.351	0.021	0.483	2.438	17.644	0.026
GDP					-0.145	-0.425	12.843	0.678				
Population Density					-0.263	-1.421	10.956	0.183				
Tourism					0.077	0.439	11.348	0.669				
Percent Urban					0.146	0.397	12.681	0.698				
Median Age					-0.024	-0.099	12.602	0.923				
Day x Relational Mobility	0.108	2.510	16.048	0.023	0.061	1.382	12.200	0.192	0.100	2.786	15.229	0.014
Day x Tightness-Looseness	0.009	1.009	16.115	0.328	-0.000	-0.031	12.884	0.976	0.008	1.076	15.069	0.299
Day x Population	0.046	3.347	17.328	0.004	0.031	1.892	12.956	0.081	0.042	3.613	16.622	0.002
Day x Migration					0.025	2.277	12.137	0.042	0.029	3.169	16.309	0.006

Day x GDP					0.019	1.203	12.834	0.251				
Day x Population Density					-0.012	-1.378	11.909	0.194				
Day x Tourism					0.014	1.702	12.146	0.114				
Day x Percent Urban					-0.004	-0.220	12.583	0.829				
Day x Median Age					-0.006	-0.485	12.942	0.636				
R^2 fixed effects		0.603				0.711				0.699		
R^2 fixed and random effects		0.977				0.973				0.973		
B. Predictor	b	t	df	p	b	t	df	p	b	t	df	p
Intercept	2.822	5.670	3.023	0.011	3.136	4.006	2.813	0.031	3.261	5.893	3.197	0.008
Day	0.146	5.514	4.733	0.003	0.152	4.808	3.512	0.012	0.170	6.909	3.840	0.003
Relational Mobility	1.839	1.226	18.310	0.236	1.069	0.597	11.854	0.562	1.302	0.935	17.320	0.363
Tightness-Looseness	0.391	1.256	18.332	0.225	0.770	1.793	12.994	0.096	0.643	2.410	15.603	0.029
Population	0.676	1.472	18.983	0.157	0.251	0.368	12.796	0.719				
Migration					0.613	1.387	11.812	0.191	0.542	1.555	17.732	0.138
GDP					-0.054	-0.081	12.929	0.937				
Population Density					-0.427	-1.175	11.517	0.264	-0.358	-1.732	15.180	0.104
Tourism					-0.255	-0.745	11.816	0.471				
Percent Urban					0.552	0.762	12.858	0.460				
Median Age					0.005	0.011	12.640	0.991				
Day x Relational Mobility	0.105	1.657	18.007	0.115	0.062	0.949	11.766	0.362	0.096	1.669	17.155	0.113

Day x Tightness-Looseness	0.005	0.348	18.011	0.732	0.018	1.148	12.983	0.272	0.018	1.677	15.741	0.113
Day x Population	0.046	2.346	18.869	0.030	0.013	0.502	12.639	0.624				
Day x Migration					0.039	2.419	11.737	0.033	0.040	2.788	17.549	0.012
Day x GDP					-0.002	-0.064	12.991	0.950				
Day x Population Density					-0.024	-1.810	11.445	0.097	-0.017	-2.000	15.362	0.063
Day x Tourism					0.003	0.236	11.779	0.818				
Day x Percent Urban					0.037	1.375	12.980	0.192				
Day x Median Age					0.004	0.227	12.367	0.824				
R^2 fixed effects		0.505					0.443				0.531	
R^2 fixed and random effects		0.965					0.974				0.968	

Table S 6. *Regression coefficients predicting the number of confirmed cases (A) and deaths (B) over the first 30 days of country-wise outbreaks. BCG policy status is added as a covariate. Model 1 includes total population (called Population) and BCG. Model 2 includes all demographic covariates and BCG. Model 3 includes only those demographic variables that prove at least marginally significant in Model 2 and BCG. The results are based on 37 of the 39 countries, with the exception of Model 2, which is based on 36 countries because of a missing value for Tourism in one of the countries (Taiwan).*

	Model 1				Model 2				Model 3			
A. Predictor	b	t	df	p	b	t	df	p	b	t	df	p
Intercept	7.217	19.589	6.770	<.001	7.019	28.515	26.000	<.001	7.150	28.089	13.746	<.001
Day	0.149	7.045	4.799	0.001	0.137	12.429	26.000	<.001	0.142	14.268	13.883	<.001
Relational Mobility	1.877	2.254	28.768	0.032	1.462	2.602	26.000	0.015	1.721	2.705	15.851	0.016

BCG Current vs. Not Current	-0.297	-0.933	32.878	0.358	-0.105	-0.343	26.000	0.734	-0.338	-1.194	26.555	0.243
Population	0.558	3.996	20.488	0.001	0.327	2.705	26.000	0.012	0.405	3.406	27.323	0.002
Migration					0.493	2.902	26.000	0.007	0.484	3.069	28.243	0.005
GDP					0.082	0.346	26.000	0.732				
Population Density					-0.330	-1.945	26.000	0.063				
Tourism					0.331	2.603	26.000	0.015	0.304	2.498	28.363	0.019
Percent Urban					-0.126	-0.942	26.000	0.355	-0.214	-1.819	28.978	0.079
Median Age					0.117	0.800	26.000	0.431				
Day x Relational Mobility	0.091	2.124	32.359	0.041	0.081	3.213	26.000	0.003	0.088	3.514	11.925	0.004
Day x BCG Current vs. Not Current	-0.028	-1.727	32.821	0.094	-0.022	-1.624	26.000	0.116	-0.030	-2.589	25.999	0.016
Day x Population	0.035	4.678	17.876	<.001	0.021	3.904	26.000	0.001	0.021	4.197	28.532	<.001
Day x Migration					0.021	2.734	26.000	0.011	0.025	3.641	28.763	0.001
Day x GDP					0.010	0.948	26.000	0.352				
Day x Population Density					-0.008	-1.045	26.000	0.305				
Day x Tourism					0.022	3.922	26.000	0.001	0.025	4.926	26.107	<.001
Day x Percent Urban					-0.012	-2.038	26.000	0.052	-0.011	-2.230	28.842	0.034
Day x Median Age					0.002	0.333	26.000	0.742				

R^2 fixed effects	0.649				0.830				0.802			
R^2 fixed and random effects	0.975				0.972				0.971			
B. Predictor	b	t	df	p	b	t	df	p	b	t	df	p
Intercept	3.224	5.712	8.061	<.001	2.841	4.465	8.936	0.002	3.087	5.339	8.285	0.001
Day	0.185	6.546	7.649	<.001	0.169	6.201	9.633	<.001	0.175	6.306	7.304	<.001
Relational Mobility	0.974	0.727	26.039	0.473	0.674	0.465	17.351	0.647	1.072	0.803	26.588	0.429
BCG Current vs. Not Current	-0.764	-1.476	32.483	0.150	-0.244	-0.366	25.976	0.717	-0.635	-1.216	31.956	0.233
Population	0.443	1.993	22.634	0.058	0.336	1.238	19.198	0.231	0.445	2.013	21.631	0.057
Migration					0.290	0.868	21.511	0.395	0.402	1.367	29.214	0.182
GDP					0.363	0.743	25.125	0.464				
Population Density					-0.375	-1.104	22.888	0.281				
Tourism					0.127	0.484	25.127	0.633				
Percent Urban					-0.010	-0.035	25.628	0.973				
Median Age					0.097	0.288	25.661	0.775				
Day x Relational Mobility	0.075	1.224	31.198	0.230	0.055	0.944	23.809	0.354	0.083	1.440	31.279	0.160
Day x BCG Current vs. Not Current	-0.047	-2.018	32.997	0.052	-0.028	-1.077	25.808	0.291	-0.037	-1.707	31.790	0.098
Day x Population	0.030	2.914	21.713	0.008	0.024	2.193	18.543	0.041	0.031	3.138	20.760	0.005
Day x Migration					0.023	1.813	22.233	0.083	0.030	2.464	28.404	0.020
Day x GDP					0.017	0.899	24.861	0.377				

Day x Population Density					-0.015	-1.122	23.202	0.273				
Day x Tourism					0.011	1.117	25.244	0.275				
Day x Percent Urban					-0.010	-0.886	25.907	0.384				
Day x Median Age					0.014	1.093	25.838	0.285				
R^2 fixed effects	0.483				0.528				0.500			
R^2 fixed and random effects	0.970				0.971				0.971			

Table S 7-A. *Regression coefficients predicting the number of confirmed cases over the first 30 days of country-wise outbreaks, with the Russell et al. (2020) underreporting index used as a weighting factor. Model 1 includes total population (called Population). Model 2 includes all demographic covariates. Model 3 includes only those demographic variables that prove at least marginally significant in Model 2. The results are based on 29 of the 39 countries.*

	Model 1				Model 2				Model 3			
Predictor	b	t	df	p	b	t	df	p	b	t	df	p
Intercept	7.026	28.270	4.817	<.001	7.342	20.418	20.032	<.001	7.238	60.459	24.059	<.001
Day	0.124	8.003	4.035	0.001	0.138	8.626	19.192	<.001	0.134	23.453	23.411	<.001
Relational Mobility	1.880	2.647	25.590	0.014	1.690	2.309	20.012	0.032	1.550	2.503	24.105	0.019
Population	0.668	3.329	24.852	0.003	0.259	0.972	19.987	0.342				
Migration					0.239	1.556	20.197	0.135	0.255	2.034	24.250	0.053
GDP					0.192	0.756	20.103	0.458	0.149	0.900	24.274	0.377
Population Density					0.723	0.526	20.029	0.605				
Tourism					0.314	1.945	20.490	0.066	0.404	3.275	24.551	0.003
Percent Urban					-0.091	-0.493	20.072	0.627				
Median Age					0.069	0.378	19.901	0.710				

Day x Relational Mobility	0.121	3.130	26.497	0.004	0.099	3.053	19.210	0.006	0.095	3.199	23.664	0.004
Day x Population	0.044	4.078	24.454	<.001	0.017	1.401	19.179	0.177				
Day x Migration					0.012	1.778	20.670	0.090	0.016	2.662	24.868	0.013
Day x GDP					0.025	2.208	19.888	0.039	0.013	1.574	24.689	0.128
Day x Population Density					0.030	0.487	19.207	0.632				
Day x Tourism					0.020	2.705	22.298	0.013	0.026	4.405	26.095	<.001
Day x Percent Urban					-0.009	-1.068	19.790	0.298				
Day x Median Age					-0.005	-0.645	18.673	0.527				
R^2 fixed effects	0.721				0.812				0.823			
R^2 fixed and random effects	0.991				0.991				0.991			

Table S 8-B. *Regression coefficients predicting the number of confirmed cases over the first 30 days of country-wise outbreaks, with the Russell et al. (2020) underreporting index used as a covariate. Model 1 includes total population (called Population) and Underreporting. Model 2 includes all demographic covariates and Underreporting. Model 3 includes only those demographic variables that prove at least marginally significant in Model 2 and Underreporting. The results are based on 29 of the 39 countries.*

	Model 1				Model 2				Model 3			
Predictor	b	t	df	p	b	t	df	p	b	t	df	p
Intercept	6.938	23.570	4.324	<.001	7.317	20.067	19.000	<.001	7.240	56.800	24.000	<.001
Day	0.120	6.645	4.016	0.003	0.138	8.319	19.000	<.001	0.135	20.652	24.001	<.001
Relational Mobility	1.633	2.457	24.999	0.021	1.787	2.360	19.000	0.029	1.418	2.162	24.000	0.041

Reporting Index	0.329	2.480	24.808	0.020	0.099	0.627	19.000	0.538	0.126	0.895	24.000	0.379
Population	0.852	4.382	23.696	<.001	0.274	1.014	19.000	0.323				
Migration					0.211	1.310	19.000	0.206				
GDP					0.146	0.544	19.000	0.593	0.122	0.637	24.000	0.530
Population Density					0.692	0.498	19.000	0.624				
Tourism					0.346	2.021	19.000	0.058	0.488	3.462	24.000	0.002
Percent Urban					-0.122	-0.630	19.000	0.536				
Median Age					0.094	0.494	19.000	0.627				
Day x Relational Mobility	0.107	2.937	24.809	0.007	0.098	2.849	19.000	0.010	0.080	2.389	24.001	0.025
Day x Reporting Index	0.016	2.207	24.307	0.037	0.001	0.116	19.000	0.909	0.004	0.539	24.001	0.595
Day x Population	0.053	5.009	23.047	<.001	0.018	1.455	19.000	0.162				
Day x Migration					0.012	1.661	19.000	0.113				
Day x GDP					0.024	1.954	19.000	0.066	0.013	1.284	24.001	0.211
Day x Population Density					0.032	0.502	19.000	0.621				
Day x Tourism					0.020	2.588	19.000	0.018	0.030	4.182	24.001	<.001
Day x Percent Urban					-0.009	-1.033	19.000	0.315				
Day x Median Age					-0.004	-0.422	19.000	0.678				
R^2 fixed effects			0.690				0.788				0.777	

R^2 fixed and random effects	0.968	0.968	0.967

Table S 9-A. *Regression coefficients predicting the number of confirmed cases over the first 30 days of country-wise outbreaks, with testing availability used as a weighting factor. Model 1 includes total population (called Population). Model 2 includes all demographic covariates. Model 3 includes only those demographic variables that prove at least marginally significant in Model 2. The results are based on 29 of the 39 countries, except in Model 2, which is based on 28 countries because of a missing value in Tourism in one of the countries (Taiwan).*

	Model 1				Model 2				Model 3			
Predictor	b	t	df	p	b	t	df	p	b	t	df	p
Intercept	7.008	28.009	4.719	<.001	6.980	31.961	3.829	<.001	7.082	42.099	3.521	<.001
Day	0.124	8.312	3.859	0.001	0.121	11.833	5.025	<.001	0.125	15.176	3.205	<.001
Relational Mobility	1.956	2.795	25.477	0.010	1.254	1.655	17.167	0.116	1.302	1.910	19.419	0.071
Population	0.768	3.670	24.710	0.001	0.445	1.596	18.482	0.127	0.435	1.670	20.138	0.110
Migration					0.364	0.791	18.813	0.439				
GDP					0.212	0.676	15.941	0.509	0.220	1.165	20.755	0.257
Population Density					-0.352	-1.591	19.110	0.128	-0.380	-2.018	22.146	0.056
Tourism					0.262	1.499	19.388	0.150	0.242	1.545	21.470	0.137
Percent Urban					-0.114	-0.494	16.622	0.628				
Median Age					-0.041	-0.197	15.701	0.846				
Day x Relational Mobility	0.126	3.425	23.970	0.002	0.079	2.425	16.666	0.027	0.085	2.651	20.033	0.015
Day x Population	0.046	4.202	24.283	<.001	0.031	2.583	17.435	0.019	0.031	2.484	20.389	0.022
Day x Migration					0.014	0.682	18.770	0.504				
Day x GDP					0.031	2.226	18.243	0.039	0.019	2.111	21.537	0.047

Day x Population Density					-0.019	-1.925	20.749	0.068	-0.016	-1.761	24.882	0.090
Day x Tourism					0.016	2.090	21.920	0.048	0.017	2.158	25.103	0.041
Day x Percent Urban					-0.014	-1.407	16.730	0.178				
Day x Median Age					-0.010	-1.128	16.252	0.276				
R^2 fixed effects	0.279				0.310				0.312			
R^2 fixed and random effects	0.377				0.381				0.376			

Table S 10-B. Regression coefficients predicting the number of confirmed cases, with testing availability (referred to as Testing) used as a covariate. A. Model 1 includes total population (called Population) and Testing. Model 2 includes all demographic covariates and Testing. Model 3 includes only those demographic variables that prove at least marginally significant in Model 2 and Testing. The results are based on 29 of the 39 countries, except in Model 2, which is based on 28 countries because of a missing value in Tourism in one of the countries (Taiwan).

	Model 1				Model 2				Model 3			
Predictor	b	t	df	p	b	t	df	p	b	t	df	p
Intercept	7.000	26.609	4.628	<.001	7.012	36.280	1.863	<.001	7.114	48.948	21.001	<.001
Day	0.124	7.977	3.994	0.001	0.120	14.178	2.458	<.001	0.125	18.349	21.000	<.001
Relational Mobility	1.901	2.626	24.861	0.015	1.242	1.634	11.419	0.120	1.228	1.806	21.001	0.085
Testing	0.040	0.255	24.911	0.801	-0.119	-0.726	12.961	0.477	-0.112	-0.734	21.001	0.471
Population	0.790	3.425	24.063	0.002	0.321	1.118	12.768	0.278	0.317	1.206	21.001	0.241
Migration					0.382	0.810	11.351	0.429				
GDP					0.261	0.815	12.843	0.426	0.268	1.347	21.001	0.192
Population Density					-0.436	-1.782	10.956	0.092	-0.469	-2.277	21.001	0.033
Tourism					0.275	1.525	11.348	0.145	0.256	1.593	21.001	0.126

Percent Urban					-0.166	-0.720	12.681	0.481				
Median Age					-0.007	-0.036	12.602	0.971				
Day x Relational Mobility	0.125	3.237	24.997	0.003	0.077	2.310	12.200	0.033	0.076	2.388	21.000	0.026
Day x Testing	-0.004	-0.537	24.947	0.596	-0.011	-1.497	12.884	0.152	-0.009	-1.310	21.000	0.204
Day x Population	0.044	3.583	23.358	0.002	0.023	1.832	12.956	0.083	0.024	1.920	21.000	0.069
Day x Migration					0.018	0.875	12.137	0.393				
Day x GDP					0.033	2.327	12.834	0.032	0.024	2.526	21.000	0.020
Day x Population Density					-0.025	-2.372	11.909	0.029	-0.024	-2.433	21.000	0.024
Day x Tourism					0.016	1.986	12.146	0.062	0.015	2.050	21.000	0.053
Day x Percent Urban					-0.016	-1.567	12.583	0.135				
Day x Median Age					-0.008	-0.830	12.942	0.417				
R^2 fixed effects		0.698					0.787				0.797	
R^2 fixed and random effects		0.968					0.967				0.966	

Table S 11. *Regression coefficients predicting the number of confirmed cases over the first 30 days of country-wise outbreaks. Day 1 is defined as the date when 20 cases (rather than 100 cases as in the main analysis) were confirmed in each country. The Models vary in the covariates included. Model 1 includes only total population (called Population). Model 2 includes all demographic covariates. Model 3 includes only those that prove at least marginally significant in Model 2. The results are based on 39 countries, except in Model 2, which is based on 38 countries because of a missing value in Tourism in one of the countries (Taiwan).*

	Model 1				Model 2				Model 3			
Predictor	b	t	df	p	b	t	df	p	b	t	df	p
Intercept	5.900	16.756	3.668	<.001	5.785	23.964	3.934	<.001	5.805	25.019	4.228	<.001
Day	0.157	7.883	2.818	0.005	0.154	16.072	0.948	0.045	0.152	17.168	0.832	0.058
Relational Mobility	3.216	4.138	35.741	<.001	2.724	3.246	24.259	0.003	2.605	3.494	29.370	0.002
Population	0.458	3.112	28.178	0.004	0.155	0.923	26.715	0.364	0.181	1.194	26.541	0.243
Migration					0.245	1.711	27.427	0.098	0.232	1.789	31.223	0.083
GDP					-0.139	-0.504	29.174	0.618				
Population Density					-0.116	-0.606	28.236	0.549	-0.196	-1.464	31.655	0.153
Tourism					0.366	2.191	28.880	0.037	0.340	2.203	31.933	0.035
Percent Urban					-0.020	-0.124	28.062	0.902				
Median Age					-0.010	-0.049	26.866	0.961				
Day x Relational Mobility	0.182	4.061	34.214	<.001	0.126	2.900	10.012	0.016	0.131	3.350	8.017	0.010
Day x Population	0.039	4.559	26.498	<.001	0.024	2.691	24.750	0.013	0.021	2.547	23.703	0.018
Day x Migration					0.014	1.794	26.526	0.084	0.015	1.953	31.897	0.060
Day x GDP					-0.000	-0.029	28.531	0.977				
Day x Population Density					-0.019	-1.792	28.444	0.084	-0.015	-2.003	26.563	0.055
Day x Tourism					0.017	1.856	28.964	0.074	0.022	2.558	19.679	0.019
Day x Percent Urban					-0.001	-0.067	27.547	0.947				
Day x Median Age					0.017	1.517	14.847	0.150				

R^2 fixed effects	0.648	0.724	0.733
R^2 fixed and random effects	0.974	0.970	0.969

Table S 12. *Regression coefficients predicting the number of confirmed cases (A) and deaths (B) over the first 15 (rather than 30 as in the main analysis) days of country-wise outbreaks. Models vary in the covariates included. Model 1 includes only total population (called Population). Model 2 includes all demographic covariates. Model 3 includes only those that prove at least marginally significant in Model 2. The results are based on 39 countries, except in Model 2, which is based on 38 countries because of a missing value in Tourism in one of the countries (Taiwan).*

	Model 1				Model 2				Model 3			
A. Predictor	b	t	df	p	b	t	df	p	b	t	df	p
Intercept	6.034	32.669	3.822	<.001	6.044	71.522	29.000	<.001	6.018	57.589	2.819	<.001
Day	0.174	7.265	3.374	0.004	0.169	19.410	29.000	<.001	0.169	18.360	1.169	0.022
Relational Mobility	1.282	2.508	33.123	0.017	0.685	1.433	29.000	0.163	0.826	1.750	19.416	0.096
Population	0.334	3.566	29.136	0.001	0.173	1.656	29.000	0.109				
Migration					0.181	1.879	29.000	0.070	0.167	1.861	32.910	0.072
GDP					-0.022	-0.127	29.000	0.900				
Population Density					-0.277	-2.194	29.000	0.036	-0.265	-2.971	32.619	0.006
Tourism					0.179	1.636	29.000	0.113	0.276	3.003	31.126	0.005
Percent Urban					0.042	0.392	29.000	0.698				
Median Age					0.147	1.188	29.000	0.245				
Day x Relational Mobility	0.197	3.433	35.408	0.002	0.092	1.872	29.000	0.071	0.118	2.505	10.264	0.031
Day x Population	0.042	3.914	27.003	0.001	0.018	1.693	29.000	0.101				
Day x Migration					0.021	2.100	29.000	0.045	0.023	2.499	32.988	0.018
Day x GDP					0.013	0.717	29.000	0.479				

Day x Population Density					-0.036	-2.778	29.000	0.009	-0.028	-2.994	27.271	0.006
Day x Tourism					0.027	2.358	29.000	0.025	0.041	4.319	23.151	<.001
Day x Percent Urban					0.004	0.338	29.000	0.738				
Day x Median Age					0.007	0.547	29.000	0.588				
R^2 fixed effects		0.615				0.733				0.706		
R^2 fixed and random effects		0.986				0.985				0.985		
B. Predictor	b	t	df	p	b	t	df	p	b	t	df	p
Intercept	1.509	6.723	3.487	0.004	1.536	6.314	1.840	0.030	1.486	7.051	3.642	0.003
Day	0.187	6.110	4.310	0.003	0.190	6.450	2.728	0.010	0.183	6.294	4.441	0.002
Relational Mobility	1.152	1.424	22.833	0.168	0.508	0.513	17.816	0.614	1.194	1.441	22.494	0.163
Population	0.240	1.596	33.211	0.120	0.151	0.765	25.318	0.452				
Migration					0.132	0.764	26.946	0.451				
GDP					0.183	0.554	28.965	0.584				
Population Density					-0.275	-1.195	28.168	0.242	-0.125	-0.795	35.868	0.432
Tourism					0.057	0.284	28.784	0.778				
Percent Urban					0.096	0.495	27.807	0.624				
Median Age					0.016	0.066	23.132	0.948				
Day x Relational Mobility	0.140	1.469	30.256	0.152	0.046	0.419	23.024	0.679	0.135	1.386	29.928	0.176
Day x Population	0.026	1.469	31.464	0.152	0.020	0.928	25.526	0.362				
Day x Migration					0.014	0.729	27.207	0.472				

Day x GDP					0.041	1.128	28.996	0.269				
Day x Population Density					-0.046	-1.832	28.083	0.078	-0.019	-1.070	34.900	0.292
Day x Tourism					0.000	0.003	28.714	0.998				
Day x Percent Urban					0.001	0.031	27.943	0.976				
Day x Median Age					0.009	0.345	26.771	0.733				
R^2 fixed effects	0.398				0.414				0.375			
R^2 fixed and random effects	0.963				0.966				0.962			

Table S 13. *Regression coefficients predicting the number of confirmed cases (A) and deaths (B) over the first 60 (rather than 30 as in the main analysis) days of country-wise outbreaks. Models vary in the covariates included. Model 1 includes only total population (called Population). Model 2 includes all demographic covariates. Model 3 includes only those that prove at least marginally significant in Model 2. The results are based on 39 countries, except in Model 2, which is based on 38 countries because of a missing value in Tourism in one of the countries (Taiwan).*

	Model 1				Model 2				Model 3			
A. Predictor	b	t	df	p	b	t	df	p	b	t	df	p
Intercept	8.133	15.441	3.056	0.001	7.925	37.700	0.909	0.023	7.987	22.898	2.450	0.001
Day	0.071	7.174	2.501	0.010	0.068	12.734	0.515	0.172	0.067	18.581	1.394	0.012
Relational Mobility	2.925	3.430	34.282	0.002	1.904	2.273	15.212	0.038	2.571	3.134	33.910	0.004
Population	1.054	6.152	29.318	<.001	0.649	3.848	21.946	0.001	0.770	4.516	22.343	<.001
Migration					0.333	2.259	25.596	0.033				
GDP					0.244	0.867	28.890	0.393				
Population Density					-0.313	-1.597	27.360	0.122				
Tourism					0.446	2.605	28.579	0.014	0.409	2.449	33.441	0.020
Percent Urban					-0.002	-0.015	26.959	0.988				

Median Age					0.125	0.593	21.076	0.560				
Day x Relational Mobility	0.048	2.261	35.989	0.030	0.037	1.969	15.291	0.067	0.039	2.437	8.816	0.038
Day x Population	0.023	5.777	24.539	<.001	0.019	5.031	14.283	<.001	0.014	4.134	31.570	<.001
Day x Migration					0.005	1.650	19.752	0.115				
Day x GDP					0.009	1.503	28.588	0.144				
Day x Population Density					0.001	0.349	22.865	0.731				
Day x Tourism					0.009	2.524	26.678	0.018	0.016	4.312	20.585	<.001
Day x Percent Urban					-0.002	-0.627	22.710	0.537				
Day x Median Age					0.001	0.131	24.000	0.897				
R^2 fixed effects			0.561				0.752				0.666	
R^2 fixed and random effects			0.953				0.938				0.938	
B. Predictor	b	t	df	p	b	t	df	p	b	t	df	p
Intercept	4.045	7.181	3.422	0.004	3.982	9.089	2.189	0.009	3.939	9.486	3.587	0.001
Day	0.098	5.515	3.360	0.009	0.088	12.220	2.207	0.005	0.090	9.412	2.400	0.006
Relational Mobility	3.061	2.431	35.927	0.020	1.849	1.400	27.793	0.173	3.039	2.536	31.271	0.016
Population	0.956	4.027	26.933	<.001	0.704	2.671	21.456	0.014	0.657	2.722	26.061	0.011
Migration					0.337	1.578	25.317	0.127	0.349	1.676	31.555	0.104
GDP					0.497	1.186	28.443	0.245				
Population Density					-0.524	-1.827	26.327	0.079				
Tourism					0.341	1.348	28.085	0.188	0.447	1.814	32.973	0.079

Percent Urban					0.031	0.130	26.567	0.898				
Median Age					0.226	0.698	28.991	0.491				
Day x Relational Mobility	0.087	3.543	33.170	0.001	0.073	2.955	24.899	0.007	0.086	3.719	32.924	0.001
Day x Population	0.032	6.388	32.557	<.001	0.021	4.271	23.304	<.001	0.020	4.251	21.573	<.001
Day x Migration					0.007	1.731	26.158	0.095	0.007	1.712	29.372	0.097
Day x GDP					0.006	0.809	28.868	0.425				
Day x Population Density					-0.007	-1.337	27.237	0.192				
Day x Tourism					0.015	3.045	28.409	0.005	0.015	3.203	32.336	0.003
Day x Percent Urban					-0.005	-1.167	27.238	0.253				
Day x Median Age					0.009	1.435	28.074	0.162				
R^2 fixed effects		0.540				0.652				0.620		
R^2 fixed and random effects		0.948				0.940				0.936		

Table S 14-A. *Regression coefficients predicting the number of confirmed cases for the 39 countries with RM scores and an additional 46 countries with interpolated scores. Models vary in the covariates included. Model 1 includes only total population (called Population). Model 2 includes all demographic covariates. Model 3 includes only those that prove at least marginally significant in Model 2. The results are based on 83 countries in Model 1 due to missing COVID-19 data for a country and a missing value for population size for another. Model 2 included 78 countries due to missing data on a few demographic variables. Model 3 included 82 countries.*

	Model 1	Model 2	Model 3

Predictor	b	t	df	p	b	t	df	p	b	t	df	p
Intercept	6.721	30.909	4.412	<.001	6.741	43.771	3.139	<.001	6.706	51.693	4.327	<.001
Day	0.111	7.779	3.888	0.002	0.110	11.604	3.240	0.001	0.107	14.956	2.836	0.001
Relational Mobility	2.686	3.433	72.040	0.001	1.471	2.368	60.695	0.021	1.634	2.497	51.225	0.016
Population	0.140	1.433	76.410	0.156	0.028	0.369	63.475	0.713				
Migration					0.183	1.873	66.853	0.065	0.131	1.535	76.975	0.129
GDP					-0.052	-0.424	68.143	0.673				
Population Density					-0.260	-3.064	67.814	0.003				
Tourism					0.489	6.040	68.073	<.001	0.530	5.952	75.465	<.001
Percent Urban					0.198	1.639	57.414	0.107				
Median Age					-0.089	-0.736	54.844	0.465				
Day x Relational Mobility	0.148	3.623	78.916	0.001	0.095	2.856	66.739	0.006	0.090	2.793	53.620	0.007
Day x Population	0.007	1.495	74.122	0.139	0.002	0.459	62.386	0.648				
Day x Migration					0.011	2.045	65.553	0.045	0.008	1.994	75.605	0.050
Day x GDP					-0.002	-0.307	66.768	0.760				
Day x Population Density					-0.006	-1.231	66.178	0.223				
Day x Tourism					0.029	6.692	67.263	<.001	0.030	6.967	76.513	<.001
Day x Percent Urban					0.008	1.247	64.708	0.217				
Day x Median Age					-0.009	-1.361	64.406	0.178				
R^2 fixed effects		0.472				0.696				0.645		

R^2 fixed and random effects	0.972	0.970	0.969

Table S 15-B. *Regression coefficients predicting the number of confirmed deaths for the 39 countries with RM scores and an additional 46 countries with interpolated scores. Models vary in the covariates included. Model 1 includes only total population (called Population). Model 2 includes all demographic covariates. Model 3 includes only those that prove at least marginally significant in Model 2. The results are based on 82 countries in Model 1, due to missing COVID-19 data for two countries and a missing value for population size in one. Model 2 included 77 countries due to missing data on a few demographic variables. Model 3 included 81 countries.*

	Model 1				Model 2				Model 3			
Predictor	b	t	df	p	b	t	df	p	b	t	df	p
Intercept	2.370	11.322	5.162	<.001	2.432	14.744	2.690	0.001	2.405	14.423	3.714	<.001
Day	0.131	9.307	4.786	<.001	0.136	12.366	3.891	<.001	0.132	12.309	4.628	<.001
Relational Mobility	3.261	3.257	54.647	0.002	1.942	1.957	33.045	0.059	1.816	1.877	44.769	0.067
Population	0.144	1.084	77.767	0.282	0.016	0.117	66.628	0.907				
Migration					0.268	1.580	67.993	0.119	0.262	1.994	75.561	0.050
GDP					-0.131	-0.627	66.920	0.533				
Population Density					-0.242	-1.657	63.520	0.102	-0.258	-1.945	75.639	0.056
Tourism					0.375	2.673	67.993	0.009	0.444	3.394	71.026	0.001
Percent Urban					0.130	0.671	27.260	0.508				
Median Age					0.165	0.873	18.115	0.394				
Day x Relational Mobility	0.202	3.831	69.512	<.001	0.122	2.538	56.348	0.014	0.113	2.341	64.576	0.022
Day x Population	0.009	1.362	75.839	0.177	0.002	0.295	64.305	0.769				
Day x Migration					0.014	1.836	66.937	0.071	0.014	2.230	74.573	0.029
Day x GDP					-0.005	-0.499	67.785	0.619				

Day x Population Density		-0.012	-1.774	67.737	0.081	-0.012	-1.962	75.377	0.053
Day x Tourism		0.026	4.054	67.602	<.001	0.031	4.872	75.325	<.001
Day x Percent Urban		0.005	0.544	52.400	0.589				
Day x Median Age		0.011	1.153	49.958	0.255				
R^2 fixed effects	0.449	0.578				0.547			
R^2 fixed and random effects	0.966	0.967				0.966			

Figure S 17. *A correlation matrix of the demographic and cultural variables included in the present analysis. Only countries with RM scores are included to compute each correlation. Some covariates, particularly, cultural covariates, were not available for some countries. Each coefficient is based on the maximal number of countries that is possible given the data. Significant correlations are outlined with a square.*

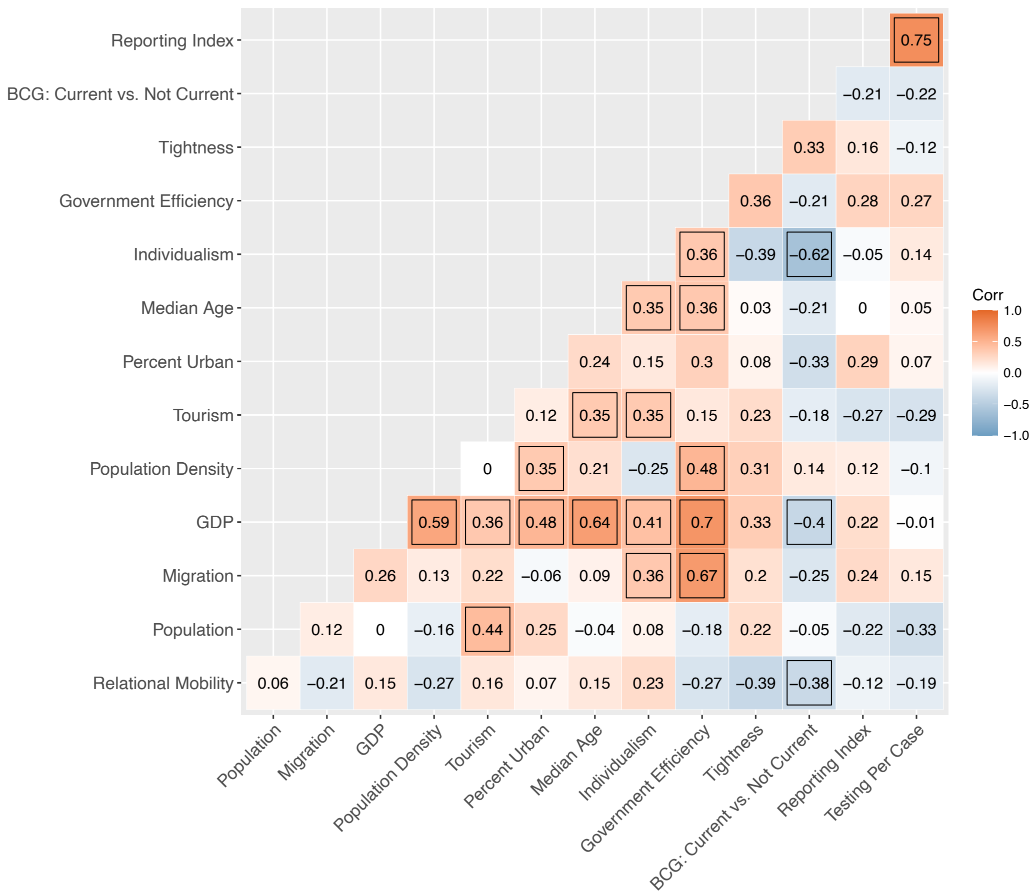
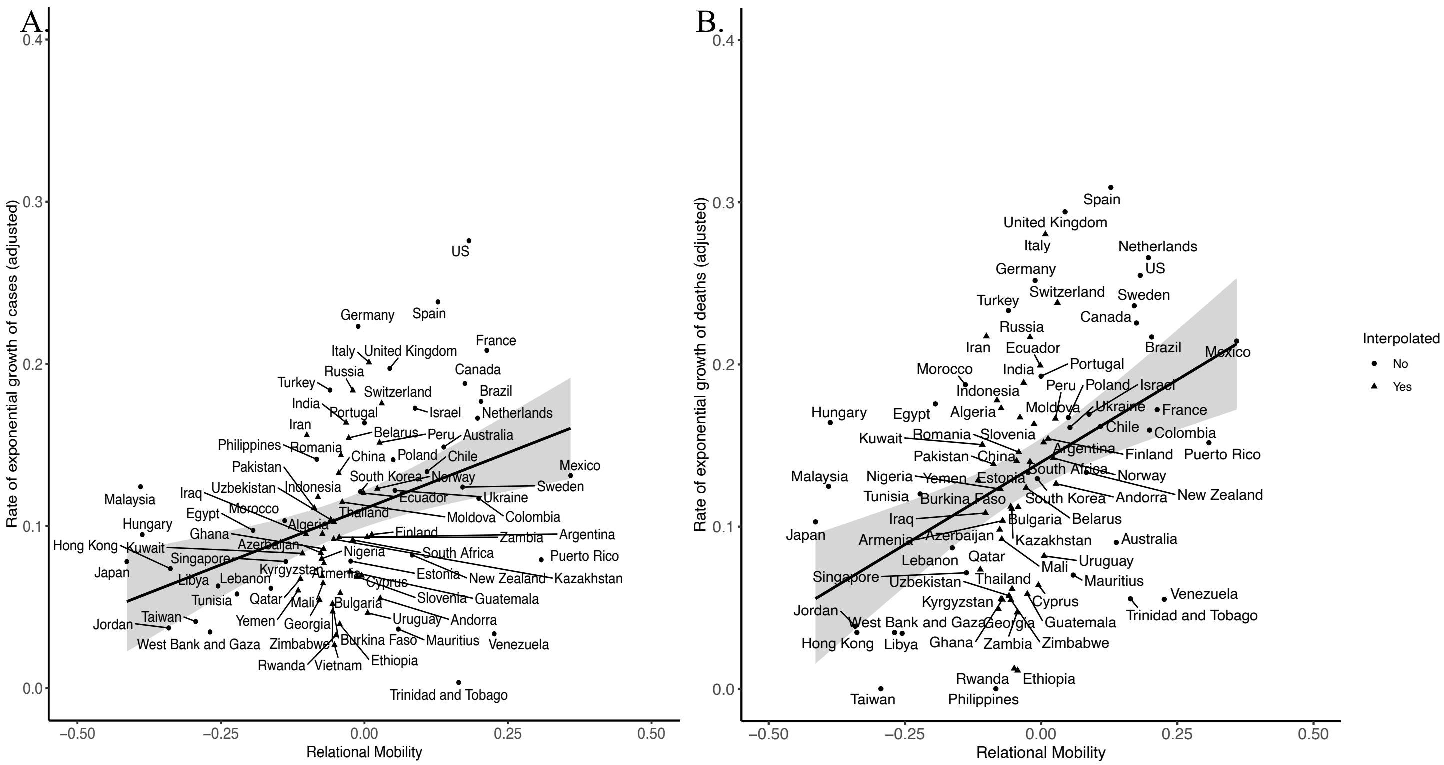


Figure S 18. *The rate of growth of confirmed cases and deaths of COVID-19 during the first 30 days of country-wise outbreaks after interpolation. A. Country-wise growth rates of confirmed cases as a function of RM for 83 countries. B. Country-wise growth rates of deaths as a function of RM for 82 countries.*



Bibliography

Ackerman, J. M., Hill, S. E., & Murray, D. R. (2018). The behavioral immune system: Current concerns and future directions. *Social and Personality Psychology Compass*, *12*(2), e12371. https://doi.org/10.1111/spc3.12371

Adams, G. (2005). The Cultural Grounding of Personal Relationship: Enemyship in North American and West African Worlds. *Journal of Personality and Social Psychology*, *88*(6), 948–968. https://doi.org/10.1037/0022-3514.88.6.948

Adams, G., & Markus, H. R. (2004). Toward a Conception of Culture Suitable for a Social Psychology of Culture. In *The psychological foundations of culture* (pp. 335–360). Lawrence Erlbaum Associates Publishers.

Ajzen, I., & Fishbein, M. (1977). Attitude-behavior relations: A theoretical analysis and review of empirical research. *Psychological Bulletin*, *84*(5), 888–918. https://doi.org/10.1037/0033-2909.84.5.888

Altman, D. G., & Bland, J. M. (2011). How to obtain the confidence interval from a P value. *Bmj*, *343*, d2090.

Andrews-Hanna, J. R., Kaiser, R. H., Turner, A. E., Reineberg, A., Godinez, D., Dimidjian, S., & Banich, M. (2013). A penny for your thoughts: Dimensions of self-generated thought content and relationships with individual differences in emotional wellbeing. *Frontiers in Psychology*, *4*, 900.

Andrews-Hanna, J. R., Smallwood, J., & Spreng, R. N. (2014). The default network and self-generated thought: Component processes, dynamic control, and clinical relevance. *Annals of the New York Academy of Sciences*, *1316*(1), 29.

Arnett, J. J. (2008). The neglected 95%: Why American psychology needs to become less American. *American Psychologist*, *63*(7), 602–614. https://doi.org/10.1037/0003-066X.63.7.602

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

Bai, Y., Nakao, T., Xu, J., Qin, P., Chaves, P., Heinzel, A., Duncan, N., Lane, T., Yen, N.-S., Tsai, S.-Y., & Northoff, G. (2016). Resting state glutamate predicts elevated pre-stimulus alpha during self-relatedness: A combined EEG-MRS study on "rest-self overlap." *Social Neuroscience*, *11*(3), 249–263. https://doi.org/10.1080/17470919.2015.1072582

Bargh, J. A., & Chartrand, T. L. (1999). The unbearable automaticity of being. *American Psychologist*, *54*(7), 462–479. https://doi.org/10.1037/0003-066X.54.7.462

Bargh, J. A., Lee-Chai, A., Barndollar, K., Gollwitzer, P. M., & Trötschel, R. (2001). The Automated Will: Nonconscious Activation and Pursuit of Behavioral Goals. *Journal of Personality and Social Psychology*, *81*(6), 1014–1027.

Bargh, J. A., & Morsella, E. (2008). The Unconscious Mind. *Perspectives on Psychological Science*, *3*(1), 73–79. https://doi.org/10.1111/j.1745-6916.2008.00064.x

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.

Bates, D., Kliegl, R., Vasishth, S., & Baayen, H. (2018). Parsimonious Mixed Models. *ArXiv:1506.04967 [Stat]*. http://arxiv.org/abs/1506.04967

Bates, D., Mächler, M., Bolker, B., & Walker, S. (2014). Fitting linear mixed-effects models using lme4. *ArXiv Preprint ArXiv:1406.5823*.

Baumeister, R. F., & Leary, M. R. (1995). The need to belong: Desire for interpersonal attachments as a fundamental human motivation. *Psychological Bulletin*, *117*(3), 497–529. https://doi.org/10.1037/0033-2909.117.3.497

Benedek, M., Schickel, R. J., Jauk, E., Fink, A., & Neubauer, A. C. (2014). Alpha power increases in right parietal cortex reflects focused internal attention. *Neuropsychologia*, *56*, 393–400. https://doi.org/10.1016/j.neuropsychologia.2014.02.010

Berg, M. K., Yu, Q., Salvador, C., Melani, I., & Kitayama, S. (2020). Mandated Bacillus Calmette-Guérin (BCG) vaccination predicts flattened curves for the spread of COVID-19. *Science Advances*, eabc1463. https://doi.org/10.1126/sciadv.abc1463

Berger, H. (1929). Über das elektroenkephalogramm des menschen. *Archiv Für Psychiatrie Und Nervenkrankheiten*, *87*(1), 527–570.

Berntsen, D., & Rubin, D. C. (2004). Cultural life scripts structure recall from autobiographical memory. *Memory & Cognition*, *32*(3), 427–442.

Bethell, L. (1984). *The Cambridge History of Latin America*. Cambridge University Press. https://doi.org/10.1017/CHOL9780521232234

Blouin-Hudon, E.-M. C., & Zelenski, J. M. (2016). The daydreamer: Exploring the personality underpinnings of daydreaming styles and their implications for well-being. *Consciousness and Cognition*, *44*, 114–129.

Bond, R., & Smith, P. B. (1996). Culture and conformity: A meta-analysis of studies using Asch's (1952b, 1956) line judgment task. *Psychological Bulletin*, *119*(1), 111–137. https://doi.org/10.1037/0033-2909.119.1.111

Bootsma, M. C. J., & Ferguson, N. M. (2007). The effect of public health measures on the 1918 influenza pandemic in U.S. cities. *Proceedings of the National Academy of Sciences*, *104*(18), 7588–7593. https://doi.org/10.1073/pnas.0611071104

Bowlby, J. (1990). *A Secure Base: Parent-Child Attachment and Healthy Human Development*. Basic Books.

Buckholtz, J. W., & Marois, R. (2012). The roots of modern justice: Cognitive and neural foundations of social norms and their enforcement. *Nature Neuroscience*, *15*(5), 655–661. https://doi.org/10.1038/nn.3087

Cacioppo, J. T., Crites, S. L., Berntson, G. G., & G. H. Coles, M. (1993). If Attitudes Affect How Stimuli Are Processed, Should They Not Affect the Event-Related Brain Potential? *Psychological Science*, *4*(2), 108–112. https://doi.org/10.1111/j.1467-9280.1993.tb00470.x

Cacioppo, J. T., Crites, S. L., Gardner, W. L., & Berntson, G. G. (1994). Bioelectrical echoes from evaluative categorizations: I. A late positive brain potential that varies as a function of trait negativity and extremity. *Journal of Personality and Social Psychology*, *67*(1), 115–125. https://doi.org/10.1037/0022-3514.67.1.115

Cai, H., Wu, L., Shi, Y., Gu, R., & Sedikides, C. (2016). Self-enhancement among Westerners and Easterners: A cultural neuroscience approach. *Social Cognitive and Affective Neuroscience*, *11*(10), 1569–1578. https://doi.org/10.1093/scan/nsw072

Campos, B., & Kim, H. S. (2017). Incorporating the cultural diversity of family and close relationships into the study of health. *American Psychologist*, *72*(6), 543–554. https://doi.org/10.1037/amp0000122

Carciofo, R., Yang, J., Song, N., Du, F., & Zhang, K. (2016). Psychometric evaluation of Chinese-language 44-item and 10-item big five personality inventories, including correlations with chronotype, mindfulness and mind wandering. *PloS One*, *11*(2).

Carter, C. S., & van Veen, V. (2007). Anterior cingulate cortex and conflict detection: An update of theory and data. *Cognitive, Affective, & Behavioral Neuroscience*, *7*(4), 367–379. https://doi.org/10.3758/CABN.7.4.367

Carver, C. S., & White, T. L. (1994). Behavioral inhibition, behavioral activation, and affective responses to impending reward and punishment: The BIS/BAS scales. *Journal of Personality and Social Psychology*, *67*(2), 319.

Chartrand, T. L., Maddux, W. W., & Lakin, J. L. (2006). Beyond the Perception-Behavior Link: The Ubiquitous Utility and Motivational Moderators of Nonconscious Mimicry. In R. R. Hassin, J. S. Uleman, & J. A. Bargh (Eds.), *The New Unconscious* (pp. 334–361). Oxford University Press. https://doi.org/10.1093/acprof:oso/9780195307696.003.0014

Chen, F. F. (2008). What happens if we compare chopsticks with forks? The impact of making inappropriate comparisons in cross-cultural research. *Journal of Personality and Social Psychology*, *95*(5), 1005–1018. https://doi.org/10.1037/a0013193

Chentsova-Dutton, Y. E., & Tsai, J. L. (2010). Self-focused attention and emotional reactivity: The role of culture. *Journal of Personality and Social Psychology*, *98*(3), 507–519. https://doi.org/10.1037/a0018534

Christian (Jr), C. C. (1970). Caracterización de los temas culturales en Hispanoamérica. *Revista de Ciencias Sociales*, *3*, 386.

Clayton, M. S., Yeung, N., & Cohen Kadosh, R. (2018). The many characters of visual alpha oscillations. *European Journal of Neuroscience*, *48*(7), 2498–2508.

Coan, J. A., Schaefer, H. S., & Davidson, R. J. (2006). Lending a Hand: Social Regulation of the Neural Response to Threat. *Psychological Science*, *17*(12), 1032–1039. https://doi.org/10.1111/j.1467-9280.2006.01832.x

Cohen, D., & Gunz, A. (2002). As Seen by the Other …: Perspectives on the Self in the Memories and Emotional Perceptions of Easterners and Westerners. *Psychological Science*, *13*(1), 55–59. https://doi.org/10.1111/1467-9280.00409

Cohen, M. X. (2014). Analyzing neural time series data: Theory and practice. *MIT Press*, 11.

Compton, R. J., Gearinger, D., & Wild, H. (2019). The wandering mind oscillates: EEG alpha power is enhanced during moments of mind-wandering. *Cognitive, Affective, & Behavioral Neuroscience*, *19*(5), 1184–1191. https://doi.org/10.3758/s13415-019-00745-9

Cousins, S. D. (1989). Culture and self-perception in Japan and the United States. *Journal of Personality and Social Psychology*, *56*(1), 124.

Croft, R. J., & Barry, R. J. (1998). EOG correction: A new perspective. *Electroencephalography and Clinical Neurophysiology*, *107*(6), 387–394. https://doi.org/10.1016/S0013-4694(98)00086-8

Croft, R. J., & Barry, R. J. (2000). Removal of ocular artifact from the EEG: A review. *Neurophysiologie Clinique/Clinical Neurophysiology*, *30*(1), 5–19.

de Oliveira, S., & Nisbett, R. E. (2017). Beyond East and West: Cognitive Style in Latin America. *Journal of Cross-Cultural Psychology*, *48*(10), 1554–1577. https://doi.org/10.1177/0022022117730816

Delorme, A., & Makeig, S. (2004). EEGLAB: An open source toolbox for analysis of single-trial EEG dynamics including independent component analysis. *Journal of Neuroscience Methods*, *134*(1), 9–21.

Diamond, J. (1999). *Guns, Germs, and Steel: The Fates of Human Societies*. W. W. Norton & Company.

Diamond, M. C., Krech, D., & Rosenzweig, M. R. (1964). The effects of an enriched environment on the histology of the rat cerebral cortex. *Journal of Comparative Neurology*, *123*(1), 111–119.

Donoghue, T., Haller, M., Peterson, E. J., Varma, P., Sebastian, P., Gao, R., Noto, T., Lara, A. H., Wallis, J. D., & Knight, R. T. (2020). Parameterizing neural power spectra into periodic and aperiodic components. *Nature Neuroscience*, *23*(12), 1655–1665.

Dunning, D., Meyerowitz, J. A., & Holzberg, A. D. (1989). Ambiguity and self-evaluation: The role of idiosyncratic trait definitions in self-serving assessments of ability. *Journal of Personality and Social Psychology*, *57*(6), 1082–1090. https://doi.org/10.1037/0022-3514.57.6.1082

Eisenberger, N. I., Taylor, S. E., Gable, S. L., Hilmert, C. J., & Lieberman, M. D. (2007). Neural pathways link social support to attenuated neuroendocrine stress responses. *NeuroImage*, *35*(4), 1601–1612. https://doi.org/10.1016/j.neuroimage.2007.01.038

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.

Feige, B., Scheffler, K., Esposito, F., Di Salle, F., Hennig, J., & Seifritz, E. (2005). Cortical and subcortical correlates of electroencephalographic alpha rhythm modulation. *Journal of Neurophysiology*, *93*(5), 2864–2872.

Fiske, S. T. (1980). Attention and weight in person perception: The impact of negative and extreme behavior. *Journal of Personality and Social Psychology*, *38*(6), 889–906. https://doi.org/10.1037/0022-3514.38.6.889

Flake, J. K., Pek, J., & Hehman, E. (2017). Construct Validation in Social and Personality Research: Current Practice and Recommendations. *Social Psychological and Personality Science*, *8*(4), 370–378. https://doi.org/10.1177/1948550617693063

Fries, P. (2005). A mechanism for cognitive dynamics: Neuronal communication through neuronal coherence. *Trends in Cognitive Sciences*, *9*(10), 474–480.

Fromm, E. (1994). *Escape from Freedom*. Macmillan.

Fuligni, A. J., Tseng, V., & Lam, M. (1999). Attitudes toward Family Obligations among American Adolescents with Asian, Latin American, and European Backgrounds. *Child Development*, *70*(4), 1030–1044. https://doi.org/10.1111/1467-8624.00075

Gardner, W. L., Gabriel, S., & Lee, A. Y. (1999). “I” Value Freedom, but “We” Value Relationships: Self-Construal Priming Mirrors Cultural Differences in Judgment. *Psychological Science*, *10*(4), 321–326. https://doi.org/10.1111/1467-9280.00162

Gardner, W. L., Pickett, C. L., & Knowles, M. (2005). Social Snacking and Shielding: Using Social Symbols, Selves, and Surrogates in the Service of Belonging Needs. In *The social outcast: Ostracism, social exclusion, rejection, and bullying* (pp. 227–241). Psychology Press.

Gavrilets, S., & Richerson, P. J. (2017). Collective action and the evolution of social norm internalization. *Proceedings of the National Academy of Sciences*, *114*(23), 6068–6073. https://doi.org/10.1073/pnas.1703857114

Gelfand, M. J., Raver, J. L., Nishii, L., Leslie, L. M., Lun, J., Lim, B. C., Duan, L., Almaliach, A., Ang, S., Arnadottir, J., Aycan, Z., Boehnke, K., Boski, P., Cabecinhas, R., Chan, D., Chhokar, J., D'Amato, A., Ferrer, M., Fischlmayr, I. C., … Yamaguchi, S. (2011). Differences Between Tight and Loose Cultures: A 33-Nation Study. *Science*, *332*(6033), 1100–1104. https://doi.org/10.1126/science.1197754

Goto, S. G., Ando, Y., Huang, C., Yee, A., & Lewis, R. S. (2010). Cultural differences in the visual processing of meaning: Detecting incongruities between background and foreground objects using the N400. *Social Cognitive and Affective Neuroscience*, *5*(2–3). https://doi.org/10.1093/scan/nsp038

Gratton, G., Coles, M. G. H., & Donchin, E. (1983). A new method for off-line removal of ocular artifact. *Electroencephalography and Clinical Neurophysiology*, *55*(4), 468–484. https://doi.org/10.1016/0013-4694(83)90135-9

Greenfield, P. M., Keller, H., Fuligni, A. J., & Maynard, A. (2003). Cultural Pathways Through Universal Development | Annual Review of Psychology. *Annual Review of Psychology*. https://www-annualreviews-org.proxy.lib.umich.edu/doi/abs/10.1146/annurev.psych.54.101601.145221

Haggard, P. (2019). The neurocognitive bases of human volition. *Annual Review of Psychology*, *70*, 9–28.

Hanslmayr, S., Pastötter, B., Bäuml, K.-H., Gruber, S., Wimber, M., & Klimesch, W. (2007). The Electrophysiological Dynamics of Interference during the Stroop Task. *Journal of Cognitive Neuroscience*, *20*(2), 215–225. https://doi.org/10.1162/jocn.2008.20020

Hayes, A. F. (2017). *Introduction to Mediation, Moderation, and Conditional Process Analysis, Second Edition: A Regression-Based Approach*. Guilford Publications. http://ebookcentral.proquest.com/lib/umichigan/detail.action?docID=5109647

He, B. J. (2014). Scale-free brain activity: Past, present, and future. *Trends in Cognitive Sciences*, *18*(9), 480–487.

Heine, S. J. (2015). *Cultural Psychology: Third International Student Edition*. W. W. Norton & Company.

Heine, S. J., Kitayama, S., Lehman, D. R., Takata, T., Ide, E., Leung, C., & Matsumoto, H. (2001). Divergent consequences of success and failure in Japan and North America: An investigation of self-improving motivations and malleable selves. *Journal of Personality and Social Psychology*, *81*(4), 599–615. https://doi.org/10.1037/0022-3514.81.4.599

Heine, S. J., & Lehman, D. R. (1995). Cultural variation in unrealistic optimism: Does the West feel more vulnerable than the East? *Journal of Personality and Social Psychology*, *68*(4), 595–607. https://doi.org/10.1037/0022-3514.68.4.595

Heine, S. J., Lehman, D. R., Markus, H. R., & Kitayama, S. (1999). Is there a universal need for positive self-regard? *Psychological Review*, *106*(4), 766–794. https://doi.org/10.1037/0033-295X.106.4.766

Heine, S. J., Lehman, D. R., Peng, K., & Greenholtz, J. (2002). What's wrong with cross-cultural comparisons of subjective Likert scales?: The reference-group effect. *Journal of*

Personality and Social Psychology, *82*(6), 903–918. https://doi.org/10.1037/0022-3514.82.6.903

Henrich, J. (2015). *The Secret of Our Success: How Culture Is Driving Human Evolution, Domesticating Our Species, and Making Us Smarter*. Princeton University Press.

Henrich, J., Heine, S. J., & Norenzayan, A. (2010). The weirdest people in the world? *Behavioral and Brain Sciences*, *33*(2–3), 61–83. https://doi.org/10.1017/S0140525X0999152X

Higgins, E. T., Friedman, R. S., Harlow, R. E., Idson, L. C., Ayduk, O. N., & Taylor, A. (2001). Achievement orientations from subjective histories of success: Promotion pride versus prevention pride. *European Journal of Social Psychology*, *31*(1), 3–23.

Higgins, E. T., Roney, C. J. R., Crowe, E., & Hymes, C. (1994). Ideal versus ought predilections for approach and avoidance distinct self-regulatory systems. *Journal of Personality and Social Psychology*, *66*(2), 276–286. https://doi.org/10.1037/0022-3514.66.2.276

Hill, S. E., Prokosch, M. L., & DelPriore, D. J. (2015). The impact of perceived disease threat on women's desire for novel dating and sexual partners: Is variety the best medicine? *Journal of Personality and Social Psychology*, *109*(2), 244–261. https://doi.org/10.1037/pspi0000024

Hofstede, G. (1980). *Culture's Consequences: International Differences in Work-Related Values*. SAGE.

Holloway, R. A., Waldrip, A. M., & Ickes, W. (2009). Evidence that a simpático self-schema accounts for differences in the self-concepts and social behavior of Latinos versus Whites (and Blacks). *Journal of Personality and Social Psychology*, *96*(5), 1012–1028. https://doi.org/10.1037/a0013883

Hong, Y., Morris, M. W., Chiu, C., & Benet-Martinez, V. (2000). Multicultural minds: A dynamic constructivist approach to culture and cognition. *American Psychologist*, *55*(7), 709.

Ito, T. A., Larsen, J. T., Smith, N. K., & Cacioppo, J. T. (1998). Negative information weighs more heavily on the brain: The negativity bias in evaluative categorizations. *Journal of Personality and Social Psychology*, *75*(4), 887–900. https://doi.org/10.1037/0022-3514.75.4.887

Jackson, J. C., Gelfand, M., & Ember, C. R. (2020). A global analysis of cultural tightness in non-industrial societies. *Proceedings of the Royal Society B: Biological Sciences*, *287*(1930), 20201036. https://doi.org/10.1098/rspb.2020.1036

Jaeger, T. F. (2008). Categorical Data Analysis: Away from ANOVAs (transformation or not) and towards Logit Mixed Models. *Journal of Memory and Language*, *59*(4), 434–446. https://doi.org/10.1016/j.jml.2007.11.007

James, W. (1890). *The Principles of Psychology*. Cosimo, Inc.

Jann, K., Dierks, T., Boesch, C., Kottlow, M., Strik, W., & Koenig, T. (2009). BOLD correlates of EEG alpha phase-locking and the fMRI default mode network. *Neuroimage*, *45*(3), 903–916.

Jann, K., Kottlow, M., Dierks, T., Boesch, C., & Koenig, T. (2010). Topographic electrophysiological signatures of fMRI resting state networks. *PloS One*, *5*(9), e12945.

Ji, L.-J., Nisbett, R. E., & Su, Y. (2001). Culture, Change, and Prediction. *Psychological Science*, *12*(6), 450–456. https://doi.org/10.1111/1467-9280.00384

Ji, T., Tybur, J. M., & van Vugt, M. (2019). Generalized or Origin-Specific Out-Group Prejudice?: The Role of Temporary and Chronic Pathogen-Avoidance Motivation in

Intergroup Relations. *Evolutionary Psychology*, *17*(1), 1474704919826851. https://doi.org/10.1177/1474704919826851

Judd, C. M., Westfall, J., & Kenny, D. A. (2017). Experiments with More Than One Random Factor: Designs, Analytic Models, and Statistical Power. *Annual Review of Psychology*, *68*(1), 601–625. https://doi.org/10.1146/annurev-psych-122414-033702

Kahneman, D., & Miller, D. T. (1986). Norm theory: Comparing reality to its alternatives. *Psychological Review*, *93*(2), 136–153. https://doi.org/10.1037/0033-295X.93.2.136

Kane, M. J., Brown, L. H., McVay, J. C., Silvia, P. J., Myin-Germeys, I., & Kwapil, T. R. (2007). For whom the mind wanders, and when: An experience-sampling study of working memory and executive control in daily life. *Psychological Science*, *18*(7), 614–621.

Kane, M. J., Gross, G. M., Chun, C. A., Smeekens, B. A., Meier, M. E., Silvia, P. J., & Kwapil, T. R. (2017). For whom the mind wanders, and when, varies across laboratory and daily-life settings. *Psychological Science*, *28*(9), 1271–1289.

Karasawa M. (2001). A Japanese perception of self and others: Self-critical and other-enhancing biases. *The Japanese journal of psychology*, *72*(3), 195–203. https://doi.org/10.4992/jjpsy.72.195

Karinen, A. K., Molho, C., Kupfer, T. R., & Tybur, J. M. (2019). Disgust sensitivity and opposition to immigration: Does contact avoidance or resistance to foreign norms explain the relationship? *Journal of Experimental Social Psychology*, *84*, 103817. https://doi.org/10.1016/j.jesp.2019.103817

Kayser, J., & Tenke, C. E. (2006a). Principal components analysis of Laplacian waveforms as a generic method for identifying ERP generator patterns: I. Evaluation with auditory oddball tasks. *Clinical Neurophysiology*, *117*(2), 348–368.

Kayser, J., & Tenke, C. E. (2006b). Principal components analysis of Laplacian waveforms as a generic method for identifying ERP generator patterns: II. Adequacy of low-density estimates. *Clinical Neurophysiology*, *117*(2), 369–380.

Kayser, J., Tenke, C. E., & Bruder, G. E. (2003). Evaluating the quality of ERP measures across recording systems: A commentary on Debener et al.(2002). *International Journal of Psychophysiology*, *48*(3), 315–316.

Kelley, H. H. (1950). The Warm-Cold Variable in First Impressions of Persons. *Journal of Personality*, *18*(4), 431–439. https://doi.org/10.1111/j.1467-6494.1950.tb01260.x

Kelley, W. M., Macrae, C. N., Wyland, C. L., Caglar, S., Inati, S., & Heatherton, T. F. (2002). Finding the Self? An Event-Related fMRI Study. *Journal of Cognitive Neuroscience*, *14*(5), 785–794. https://doi.org/10.1162/08989290260138672

Kim, H. S., & 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

Kim, H. S., Sherman, D. K., & Updegraff, J. A. (2016). Fear of Ebola: The Influence of Collectivism on Xenophobic Threat Responses. *Psychological Science*, *27*(7), 935–944. https://doi.org/10.1177/0956797616642596

Kim, H., Schimmack, U., Oishi, S., & Tsutsui, Y. (2018). Extraversion and life satisfaction: A cross-cultural examination of student and nationally representative samples. *Journal of Personality*, *86*(4), 604–618. https://doi.org/10.1111/jopy.12339

Kimel, S. Y., Grossmann, I., & Kitayama, S. (2012). When gift-giving produces dissonance: Effects of subliminal affiliation priming on choices for one's self versus close others. *Journal of Experimental Social Psychology*, *48*(5), 1221–1224. https://doi.org/10.1016/j.jesp.2012.05.012

Kitayama, S. (2002). Culture and basic psychological processes--Toward a system view of culture: Comment on Oyserman et al. (2002). *Psychological Bulletin*, *128*(1), 89–96. https://doi.org/10.1037/0033-2909.128.1.89

Kitayama, S., Duffy, S., Kawamura, T., & Larsen, J. T. (2003). Perceiving an Object and Its Context in Different Cultures: A Cultural Look at New Look. *Psychological Science*, *14*(3), 201–206. https://doi.org/10.1111/1467-9280.02432

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), 369–384. https://doi.org/10.1037/0022-3514.91.3.369

Kitayama, S., & Markus, H. R. (2000). The pursuit of happiness and the realization of sympathy: Cultural patterns of self, social relations, and well-being. In *Culture and subjective well-being* (pp. 113–161). The MIT Press.

Kitayama, S., Markus, H. R., & Kurokawa, M. (2000). Culture, Emotion, and Well-being: Good Feelings in Japan and the United States. *Cognition & Emotion*, *14*(1), 93–124. https://doi.org/10.1080/026999300379003

Kitayama, S., Markus, H. R., Matsumoto, H., & Norasakkunkit, V. (1997). Individual and collective processes in the construction of the self: Self-enhancement in the United States and self-criticism in Japan. *Journal of Personality and Social Psychology*, *72*(6), 1245–1267. https://doi.org/10.1037/0022-3514.72.6.1245

Kitayama, S., Mesquita, B., & Karasawa, M. (2006). Cultural affordances and emotional experience: Socially engaging and disengaging emotions in Japan and the United States. *Journal of Personality and Social Psychology*, *91*(5), 890–903. https://doi.org/10.1037/0022-3514.91.5.890

Kitayama, S., Park, H., Sevincer, A. T., Karasawa, M., & Uskul, A. K. (2009). A cultural task analysis of implicit independence: Comparing North America, Western Europe, and East Asia. *Journal of Personality and Social Psychology*, *97*(2), 236–255. https://doi.org/10.1037/a0015999

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., & Salvador, C. E. (2017). Culture Embrained: Going Beyond the Nature-Nurture Dichotomy. *Perspectives on Psychological Science*, *12*(5), 841–854. https://doi.org/10.1177/1745691617707317

Kitayama, S., Snibbe, A. C., Markus, H. R., & Suzuki, T. (2004). Is There Any "Free" Choice?: Self and Dissonance in Two Cultures. *Psychological Science*, *15*(8), 527–533. https://doi.org/10.1111/j.0956-7976.2004.00714.x

Kitayama, S., & Tompson, S. (2015). A Biosocial Model of Affective Decision Making. In *Advances in Experimental Social Psychology* (Vol. 52, pp. 71–137). Elsevier. https://doi.org/10.1016/bs.aesp.2015.04.001

Kitayama, S., & Uskul, A. K. (2011). Culture, Mind, and the Brain: Current Evidence and Future Directions. *Annual Review of Psychology*, *62*(1), 419–449. https://doi.org/10.1146/annurev-psych-120709-145357

Kitayama, S., Yanagisawa, K., Ito, A., Ueda, R., Uchida, Y., & Abe, N. (2017). Reduced orbitofrontal cortical volume is associated with interdependent self-construal. *Proceedings of the National Academy of Sciences*, *114*(30), 7969–7974.

Kitayama, S., Yu, Q., King, A. P., Yoon, C., & Liberzon, I. (2020). The gray matter volume of the temporoparietal junction varies across cultures: A moderating role of the dopamine D4 receptor gene (DRD4). *Social Cognitive and Affective Neuroscience*, *15*(2), 193–202. https://doi.org/10.1093/scan/nsaa032

Klimesch, W. (2012). Alpha-band oscillations, attention, and controlled access to stored information. *Trends in Cognitive Sciences*, *16*(12), 606–617. https://doi.org/10.1016/j.tics.2012.10.007

Klimesch, W., Sauseng, P., & Hanslmayr, S. (2007). EEG alpha oscillations: The inhibition–timing hypothesis. *Brain Research Reviews*, *53*(1), 63–88. https://doi.org/10.1016/j.brainresrev.2006.06.003

Knyazev, G. G. (2013). EEG Correlates of Self-Referential Processing. *Frontiers in Human Neuroscience*, *7*. https://doi.org/10.3389/fnhum.2013.00264

Knyazev, G. G., Savostyanov, A. N., Bocharov, A. V., Dorosheva, E. A., Tamozhnikov, S. S., & Saprigyn, A. E. (2015). Oscillatory correlates of autobiographical memory. *International Journal of Psychophysiology*, *95*(3), 322–332. https://doi.org/10.1016/j.ijpsycho.2014.12.006

Knyazev, G. G., Savostyanov, A. N., Bocharov, A. V., Levin, E. A., & Rudych, P. D. (2020). The default mode network in self- and other-referential processing: Effect of cultural values. *Culture and Brain*. https://doi.org/10.1007/s40167-020-00094-2

Knyazev, G. G., Savostyanov, A. N., Volf, N. V., Liou, M., & Bocharov, A. V. (2012). EEG correlates of spontaneous self-referential thoughts: A cross-cultural study. *International Journal of Psychophysiology*, *86*(2), 173–181. https://doi.org/10.1016/j.ijpsycho.2012.09.002

Knyazev, G. G., Slobodskoj-Plusnin, J. Y., Bocharov, A. V., & Pylkova, L. V. (2011). The default mode network and EEG alpha oscillations: An independent component analysis. *Brain Research*, *1402*, 67–79. https://doi.org/10.1016/j.brainres.2011.05.052

Kraus, B., Cadle, C., & Simon-Dack, S. (2019). EEG alpha activity is moderated by the serial order effect during divergent thinking. *Biological Psychology*, *145*, 84–95. https://doi.org/10.1016/j.biopsycho.2019.04.003

Kraus, B., & Kitayama, S. (2019). Interdependent self-construal predicts emotion suppression in Asian Americans: An electro-cortical investigation. *Biological Psychology*, *146*, 107733. https://doi.org/10.1016/j.biopsycho.2019.107733

Kraus, B., Salvador, C. E., Kamikubo, A., Hsaio, N.-C., Hu, J.-F., Karasawa, M., & Kitayama, S. (revise & resubmit). Oscillatory Alpha Power at Rest Reveals the Independent Self: A Cross-cultural Investigation. *Biological Psychology*.

Kruger, J., & Dunning, D. (1999). Unskilled and Unaware of It: How Difficulties in Recognizing One's Own Incompetence Lead to Inflated Self-Assessments. *Journal of Personality and Social Psychology*, 14.

Kruglanski, A. W., Chernikova, M., Rosenzweig, E., & Kopetz, C. (2014). On motivational readiness. *Psychological Review*, *121*(3), 367–388. https://doi.org/10.1037/a0037013

Kurman, J. (2001). Self-Enhancement: Is it Restricted to Individualistic Cultures? *Personality and Social Psychology Bulletin*, *27*(12), 1705–1716. https://doi.org/10.1177/01461672012712013

Kutas, M., & Federmeier, K. D. (2011). Thirty Years and Counting: Finding Meaning in the N400 Component of the Event-Related Brain Potential (ERP). *Annual Review of Psychology*, *62*(1), 621–647. https://doi.org/10.1146/annurev.psych.093008.131123

Kutas, M., & Hillyard, S. A. (1980). Reading senseless sentences: Brain potentials reflect semantic incongruity. *Science*, *207*(4427), 203–205. https://doi.org/10.1126/science.7350657

Kuznetsova, A., Brockhoff, P. B., & Christensen, R. H. B. (2017). lmerTest package: Tests in linear mixed effects models. *Journal of Statistical Software*, *82*(13).

Lakens, D. (2013). Calculating and reporting effect sizes to facilitate cumulative science: A practical primer for t-tests and ANOVAs. *Frontiers in Psychology*, *4*, 863.

Lakin, J. L., & Chartrand, T. L. (2003). Using Nonconscious Behavioral Mimicry to Create Affiliation and Rapport. *Psychological Science*, *14*(4), 334–339. https://doi.org/10.1111/1467-9280.14481

Laumann, T. O., Gordon, E. M., Adeyemo, B., Snyder, A. Z., Joo, S. J., Chen, M.-Y., Gilmore, A. W., McDermott, K. B., Nelson, S. M., & Dosenbach, N. U. (2015). Functional system and areal organization of a highly sampled individual human brain. *Neuron*, *87*(3), 657–670.

Leary, M. R. (1983). A brief version of the Fear of Negative Evaluation Scale. *Personality and Social Psychology Bulletin*, *9*(3), 371–375.

Leary, M. R., Kelly, K. M., Cottrell, C. A., & Schreindorfer, L. S. (2013). Construct validity of the need to belong scale: Mapping the nomological network. *Journal of Personality Assessment*, *95*(6), 610–624.

Lenth, R. V. (2016). Least-squares means: The R package lsmeans. *Journal of Statistical Software*, *69*(1), 1–33.

Li, L. M. W., Luo, S., Ma, J., Lin, Y., Fan, L., Zhong, S., Yang, J., Huang, Y., Gu, L., & Fan, L. (2018). Functional connectivity pattern underlies individual differences in independent self-construal. *Social Cognitive and Affective Neuroscience*, *13*(3), 269–280.

Lisansky, J. (1981). *Interpersonal Relations Among Hispanics in the United States: A Content Analysis of the Social Science Literature.* https://apps.dtic.mil/docs/citations/ADA107460

Liu, Z., de Zwart, J. A., Yao, B., van Gelderen, P., Kuo, L.-W., & Duyn, J. H. (2012). Finding thalamic BOLD correlates to posterior alpha EEG. *Neuroimage*, *63*(3), 1060–1069.

Luck, S. J. (2014). *An Introduction to the Event-Related Potential Technique*. MIT Press.

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.

Mantini, D., Perrucci, M. G., Del Gratta, C., Romani, G. L., & Corbetta, M. (2007). Electrophysiological signatures of resting state networks in the human brain. *Proceedings of the National Academy of Sciences*, *104*(32), 13170–13175.

Marino, M., Arcara, G., Porcaro, C., & Mantini, D. (2019). Hemodynamic correlates of electrophysiological activity in the default mode network. *Frontiers in Neuroscience*, *13*, 1060.

Markett, S., Montag, C., & Reuter, M. (2018). Network neuroscience and personality. *Personality Neuroscience*, *1*.

Markus, H. R., & Kitayama, S. (1991). Culture and the self: Implications for cognition, emotion, and motivation. *Psychological Review*, *98*(2), 224–253. https://doi.org/10.1037/0033-295X.98.2.224

Markus, H. R., & Nurius, P. (1986). Possible selves. *American Psychologist*, *41*(9), 954–969. https://doi.org/10.1037/0003-066X.41.9.954

Martínez-Echazábal, L. (1998). Mestizaje and the Discourse of National/Cultural Identity in Latin America, 1845-1959. *Latin American Perspectives*, *25*(3), 21–42. https://doi.org/10.1177/0094582X9802500302

Masuda, T., & Nisbett, R. E. (2001). Attending holistically versus analytically: Comparing the context sensitivity of Japanese and Americans. *Journal of Personality and Social Psychology*, *81*(5), 922–934. https://doi.org/10.1037/0022-3514.81.5.922

McMenamin, B. W., Shackman, A. J., Maxwell, J. S., Bachhuber, D. R., 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.

Meyer, M. L., & Lieberman, M. D. (2018). Why people are always thinking about themselves: Medial prefrontal cortex activity during rest primes self-referential processing. *Journal of Cognitive Neuroscience*, *30*(5), 714–721.

Mo, J., Liu, Y., Huang, H., & Ding, M. (2013). Coupling between visual alpha oscillations and default mode activity. *Neuroimage*, *68*, 112–118.

Montagrin, A., Brosch, T., & Sander, D. (2013). Goal conduciveness as a key determinant of memory facilitation. *Emotion*, *13*(4), 622–628. https://doi.org/10.1037/a0033066

Moretti, M., & Higgins, E. T. (1990). Relating self-discrepancy to self-esteem: The contribution of discrepancy beyond actual-self ratings. *Journal of Experimental Social Psychology*, *26*(2), 108–123. https://doi.org/10.1016/0022-1031(90)90071-S

Morling, B., Kitayama, S., & Miyamoto, Y. (2002). Cultural practices emphasize influence in the United States and adjustment in Japan. *Personality and Social Psychology Bulletin*, *28*(3), 311–323.

Morris, B. (1991). *Western Conceptions of the Individual*. Bloomsbury Academic.

Morris, M. W., Hong, Y., Chiu, C., & Liu, Z. (2015). Normology: Integrating insights about social norms to understand cultural dynamics. *Organizational Behavior and Human Decision Processes*, *129*, 1–13. https://doi.org/10.1016/j.obhdp.2015.03.001

Morris, M. W., & Peng, K. (1994). Culture and cause: American and Chinese attributions for social and physical events. *Journal of Personality and Social Psychology*, *67*(6), 949–971. https://doi.org/10.1037/0022-3514.67.6.949

Mortensen, C. R., Becker, D. V., Ackerman, J. M., Neuberg, S. L., & Kenrick, D. T. (2010). Infection Breeds Reticence: The Effects of Disease Salience on Self-Perceptions of Personality and Behavioral Avoidance Tendencies. *Psychological Science*, *21*(3), 440–447. https://doi.org/10.1177/0956797610361706

Mu, Y., & Han, S. (2013). Neural oscillations dissociate between self-related attentional orientation versus evaluation. *NeuroImage*, *67*, 247–256. https://doi.org/10.1016/j.neuroimage.2012.11.016

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. https://doi.org/10.1073/pnas.1509839112

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

Murray, D. R., & Schaller, M. (2012). Threat(s) and conformity deconstructed: Perceived threat of infectious disease and its implications for conformist attitudes and behavior: Infectious disease and conformity. *European Journal of Social Psychology*, *42*(2), 180–188. https://doi.org/10.1002/ejsp.863

Murray, D. R., & Schaller, M. (2016). The Behavioral Immune System. In *Advances in Experimental Social Psychology* (Vol. 53, pp. 75–129). Elsevier. https://doi.org/10.1016/bs.aesp.2015.09.002

Murray, D. R., Trudeau, R., & Schaller, M. (2011). On the Origins of Cultural Differences in Conformity: Four Tests of the Pathogen Prevalence Hypothesis. *Personality and Social Psychology Bulletin*, *37*(3), 318–329. https://doi.org/10.1177/0146167210394451

Muthukrishna, M., Bell, A. V., Henrich, J., Curtin, C. M., Gedranovich, A., McInerney, J., & Thue, B. (2020). Beyond Western, Educated, Industrial, Rich, and Democratic (WEIRD)

Psychology: Measuring and Mapping Scales of Cultural and Psychological Distance. *Psychological Science*, *31*(6), 678–701. https://doi.org/10.1177/0956797620916782

Na, J., Grossmann, I., Varnum, M. E. W., Karasawa, M., Cho, Y., Kitayama, S., & Nisbett, R. E. (2019). Culture and personality revisited: Behavioral profiles and within-person stability in interdependent (vs. independent) social orientation and holistic (vs. analytic) cognitive style. *Journal of Personality*. https://doi.org/10.1111/jopy.12536

Na, J., Grossmann, I., Varnum, M. E. W., Kitayama, S., Gonzalez, R., & Nisbett, R. E. (2010). Cultural differences are not always reducible to individual differences. *Proceedings of the National Academy of Sciences*, *107*(14), 6192–6197. https://doi.org/10.1073/pnas.1001911107

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., Johnson, P. C., & Schielzeth, H. (2017). The coefficient of determination R 2 and intra-class correlation coefficient from generalized linear mixed-effects models revisited and expanded. *Journal of the Royal Society Interface*, *14*(134), 20170213.

Nesselroade, J. R., & Molenaar, P. C. M. (2016). Some Behaviorial Science Measurement Concerns and Proposals. *Multivariate Behavioral Research*, *51*(2–3), 396–412. https://doi.org/10.1080/00273171.2015.1050481

Niedenthal, P. M., Rychlowska, M., Wood, A., & Zhao, F. (2018). Heterogeneity of long-history migration predicts smiling, laughter and positive emotion across the globe and within the United States. *PLOS ONE*, *13*(8), e0197651. https://doi.org/10.1371/journal.pone.0197651

Niedenthal, P. M., Rychlowska, M., Zhao, F., & Wood, A. (2019). Historical Migration Patterns Shape Contemporary Cultures of Emotion. *Perspectives on Psychological Science*, *14*(4), 560–573. https://doi.org/10.1177/1745691619849591

Nisbett, R. E., Peng, K., Choi, I., & Norenzayan, A. (2001). Culture and systems of thought: Holistic versus analytic cognition. *Psychological Review*, *108*(2), 291–310. https://doi.org/10.1037/0033-295X.108.2.291

Nisbett, R. E., & Wilson, T. D. (1977). Telling more than we can know: Verbal reports on mental processes. *Psychological Review*, *84*(3), 231–259. https://doi.org/10.1037/0033-295X.84.3.231

Norenzayan, A., Shariff, A. F., Gervais, W. M., Willard, A. K., McNamara, R. A., Slingerland, E., & Henrich, J. (2016). The cultural evolution of prosocial religions. *Behavioral and Brain Sciences*, *39*, e1. https://doi.org/10.1017/S0140525X14001356

Northoff, G. (2016). Is the self a higher-order or fundamental function of the brain? The "basis model of self-specificity" and its encoding by the brain's spontaneous activity. *Cognitive Neuroscience*, *7*(1–4), 203–222. https://doi.org/10.1080/17588928.2015.1111868

Oishi, S. (2000). *Goals as cornerstones of subjective well-being: Linking individuals and cultures.: Vol. Culture and subjective well-being* (E. Diener & E. M. Suh, Eds.). MIT Press.

Omata, K., Hanakawa, T., Morimoto, M., & Honda, M. (2013). Spontaneous slow fluctuation of EEG alpha rhythm reflects activity in deep-brain structures: A simultaneous EEG-fMRI study. *PloS One*, *8*(6).

Ondish, P., Cohen, D., Lucas, K. W., & Vandello, J. (2019). The Resonance of Metaphor: Evidence for Latino Preferences for Metaphor and Analogy. *Personality and Social Psychology Bulletin*, *45*(11), 1531–1548. https://doi.org/10.1177/0146167219833390

Over, H., & Uskul, A. K. (2016). Culture moderates children's responses to ostracism situations. *Journal of Personality and Social Psychology*, *110*(5), 710–724. https://doi.org/10.1037/pspi0000050

Park, J., & Kitayama, S. (2014). Interdependent selves show face-induced facilitation of error processing: Cultural neuroscience of self-threat. *Social Cognitive and Affective Neuroscience*, *9*(2), 201–208. https://doi.org/10.1093/scan/nss125

Pashler, H., Rohrer, D., & Harris, C. R. (2013). Can the goal of honesty be primed? *Journal of Experimental Social Psychology*, *49*(6), 959–964. https://doi.org/10.1016/j.jesp.2013.05.011

Payne, B. K., Brown-Iannuzzi, J. L., & Loersch, C. (2016). Replicable effects of primes on human behavior. *Journal of Experimental Psychology: General*, *145*(10), 1269–1279. https://doi.org/10.1037/xge0000201

Peng, K., Nisbett, R. E., & Wong, N. Y. C. (1997). Validity problems comparing values across cultures and possible solutions. *Psychological Methods*, *2*(4), 329–344. https://doi.org/10.1037/1082-989X.2.4.329

Petterson, B., & Paterson, H. M. (2012). Culture and Conformity: The Effects of Independent and Interdependent Self-Construal on Witness Memory. *Psychiatry, Psychology and Law*, *19*(5), 735–744. https://doi.org/10.1080/13218719.2011.615821

Pew Research Center, 1615 L. St. (2014, November 13). Religion in Latin America. *Pew Research Center's Religion & Public Life Project*. https://www.pewforum.org/2014/11/13/religion-in-latin-america/

Pfurtscheller, G., & Lopes da Silva, F. H. (1999). Event-related EEG/MEG synchronization and desynchronization: Basic principles. *Clinical Neurophysiology*, *110*(11), 1842–1857. https://doi.org/10.1016/S1388-2457(99)00141-8

Pfurtscheller, G., Stancák, A., & Neuper, Ch. (1996). Event-related synchronization (ERS) in the alpha band — an electrophysiological correlate of cortical idling: A review. *International Journal of Psychophysiology*, *24*(1), 39–46. https://doi.org/10.1016/S0167-8760(96)00066-9

Pike, F. B. (1978). Religion, Collectivism, and Intrahistory: The Peruvian Ideal of Dependence. *Journal of Latin American Studies*, *10*(2), 239–262. JSTOR.

Putterman, L., & Weil, D. N. (2010). Post-1500 Population Flows and The Long-Run Determinants of Economic Growth and Inequality. *The Quarterly Journal of Economics*, *125*(4), 1627–1682. https://doi.org/10.1162/qjec.2010.125.4.1627

Qin, P., & Northoff, G. (2011). How is our self related to midline regions and the default-mode network? *NeuroImage*, *57*(3), 1221–1233. https://doi.org/10.1016/j.neuroimage.2011.05.028

Rabovsky, M., Hansen, S. S., & McClelland, J. L. (2018). Modelling the N400 brain potential as change in a probabilistic representation of meaning. *Nature Human Behaviour*, *2*(9), 693–705. https://doi.org/10.1038/s41562-018-0406-4

Raichle, M. E. (2015). The brain's default mode network. *Annual Review of Neuroscience*, *38*, 433–447.

Raichle, M. E., MacLeod, A. M., Snyder, A. Z., Powers, W. J., Gusnard, D. A., & Shulman, G. L. (2001). A default mode of brain function. *Proceedings of the National Academy of Sciences*, *98*(2), 676–682.

Ramírez-Esparza, N., Gosling, S. D., & Pennebaker, J. W. (2008). Paradox Lost: Unraveling the Puzzle of Simpatía. *Journal of Cross-Cultural Psychology*, *39*(6), 703–715. https://doi.org/10.1177/0022022108323786

Ray, W. J., & Cole, H. W. (1985). EEG alpha activity reflects attentional demands, and beta activity reflects emotional and cognitive processes. *Science*, *228*(4700), 750–752. https://doi.org/10.1126/science.3992243

Ray, William J., & Cole, H. W. (1985). EEG activity during cognitive processing: Influence of attentional factors. *International Journal of Psychophysiology*, *3*(1), 43–48.

Ren, D., Wesselmann, E. D., & Williams, K. D. (2013). Interdependent self-construal moderates coping with (but not the initial pain of) ostracism. *Asian Journal of Social Psychology*, *16*(4), 320–326. https://doi.org/10.1111/ajsp.12037

Rhee, E., Uleman, J. S., Lee, H. K., & Roman, R. J. (1995). Spontaneous self-descriptions and ethnic identities in individualistic and collectivistic cultures. *Journal of Personality and Social Psychology*, *69*(1), 142.

Rosenberg, M. (1965). Rosenberg self-esteem scale (RSE). *Acceptance and Commitment Therapy. Measures Package*, *61*(52), 18.

Rubin, D. C. (2020). Self-Concept Focus: A Tendency to Perceive Autobiographical Events as Central to Identity. *Journal of Applied Research in Memory and Cognition*.

Ruby, M. B., Falk, C. F., Heine, S. J., Villa, C., & Silberstein, O. (2012). Not all collectivisms are equal: Opposing preferences for ideal affect between East Asians and Mexicans. *Emotion*, *12*(6), 1206–1209. https://doi.org/10.1037/a0029118

Russell, T. W., Hellewell, J., Abbott, S., Golding, N., Gibbs, H., Jarvis, C. I., van Zandvoort, K., Flasche, S., Eggo, R., Edmunds, W. J., & Kucharski, A. J. (2020). Using a delay-adjusted case fatality ratio to estimate under-reporting. *CMMID Repository*. https://cmmid.github.io/topics/covid19/severity/global_cfr_estimates.html

Rychlowska, M., Miyamoto, Y., Matsumoto, D., Hess, U., Gilboa-Schechtman, E., Kamble, S., Muluk, H., Masuda, T., & Niedenthal, P. M. (2015). Heterogeneity of long-history migration explains cultural differences in reports of emotional expressivity and the functions of smiles. *Proceedings of the National Academy of Sciences*, *112*(19), E2429–E2436. https://doi.org/10.1073/pnas.1413661112

Sabogal, F., Marín, G., Otero-Sabogal, R., Marín, B. V., & Perez-Stable, E. J. (1987). Hispanic Familism and Acculturation: What Changes and What Doesn't? *Hispanic Journal of Behavioral Sciences*, *9*(4), 397–412. https://doi.org/10.1177/07399863870094003

Sadaghiani, S., Scheeringa, R., Lehongre, K., Morillon, B., Giraud, A.-L., & Kleinschmidt, A. (2010). Intrinsic connectivity networks, alpha oscillations, and tonic alertness: A simultaneous electroencephalography/functional magnetic resonance imaging study. *Journal of Neuroscience*, *30*(30), 10243–10250.

Sakaki, M., Fryer, K., & Mather, M. (2014). Emotion Strengthens High-Priority Memory Traces but Weakens Low-Priority Memory Traces. *Psychological Science*, *25*(2), 387–395. https://doi.org/10.1177/0956797613504784

Salvador, C. E., Berg, M., Yu, Q., San Martin, A., & Kitayama, S. (2020). Relational mobility predicts faster spread of COVID-19: A 39 country study. *Psychological Science*.

Salvador, C. E., Idovro Carlier, S., Ishii, K., Torres Castillo, C., Nanakdewa, K., Savani, K., San Martin, A., & Kitayama, S. (2020). Expressive Interdependence in Latin America: A Colombia, US and Japan Comparison. *Unpublished Manuscript, University of Michigan*.

Salvador, C. E., Kamikubo, A., Kraus, B., Hsaio, N.-C., Hu, J.-F., Karasawa, M., & Kitayama, S. (revise & resubmit). Self-referential Processing Accounts for Cultural Variation in Self-enhancement vs. Criticism: An Electrocortical Investigation. *Journal of Experimental Psychology: General*.

Salvador, C. E., Kraus, B., Ackerman, J. M., Gelfand, M. J., & Kitayama, S. (2020). Interdependent Self-Construal Predicts Reduced Sensitivity to Norms Under Pathogen Threat: An Electrocortical Investigation. *Biological Psychology*. https://doi.org/10.1016/j.biopsycho.2020.107970

Salvador, C. E., Kraus, B., & Kitayama, S. (in preparation). Self-related Processing Increases Alpha Oscillations. *Unpublished Manuscript, University of Michigan*.

Salvador, C. E., Mu, Y., Gelfand, M. J., & Kitayama, S. (2020). When norm violations are spontaneously detected: An electrocortical investigation. *Social Cognitive and Affective Neuroscience*, *15*(3), 319–327. https://doi.org/10.1093/scan/nsaa035

San Martin, A., Schug, J., & Maddux, W. (2019). Relational Mobility and Cultural Differences in Analytic and Holistic Thinking. *Journal of Personality and Social Psychology*, 24.

San Martin, A., Sinaceur, M., Madi, A., Tompson, S., Maddux, W. W., & Kitayama, S. (2018). Self-assertive interdependence in Arab culture. *Nature Human Behaviour*, *2*(11), 830–837. https://doi.org/10.1038/s41562-018-0435-z

Sanchez-Burks, J. (2002). Protestant relational ideology and (in)attention to relational cues in work settings. *Journal of Personality and Social Psychology*, *83*(4), 919–929. https://doi.org/10.1037/0022-3514.83.4.919

Savani, K., Alvarez, A., Mesquita, B., & Markus, H. R. (2013). Feeling close and doing well: The prevalence and motivational effects of interpersonally engaging emotions in Mexican and European American cultural contexts. *International Journal of Psychology*, *48*(4), 682–694. https://doi.org/10.1080/00207594.2012.688131

Savani, K., Markus, H. R., & Conner, A. L. (2008). Let your preference be your guide? Preferences and choices are more tightly linked for North Americans than for Indians. *Journal of Personality and Social Psychology*, *95*(4), 861.

Scheeringa, R., Petersson, K. M., Kleinschmidt, A., Jensen, O., & Bastiaansen, M. C. (2012). EEG alpha power modulation of fMRI resting-state connectivity. *Brain Connectivity*, *2*(5), 254–264.

Schneider, W., Eschman, A., & Zuccolotto, A. (2002). *E-Prime: User's guide*. Psychology Software Incorporated.

Schug, J., Yuki, M., & Maddux, W. (2010). Relational Mobility Explains Between- and Within-Culture Differences in Self-Disclosure to Close Friends. *Psychological Science*, *21*(10), 1471–1478. https://doi.org/10.1177/0956797610382786

Schulz, J. F., Bahrami-Rad, D., Beauchamp, J. P., & Henrich, J. (2019). The Church, intensive kinship, and global psychological variation. *Science*, *366*(6466), eaau5141. https://doi.org/10.1126/science.aau5141

Schupp, H. T., Junghöfer, M., Weike, A. I., & Hamm, A. O. (2004). The selective processing of briefly presented affective pictures: An ERP analysis. *Psychophysiology*, *41*(3), 441–449.

Schwartz, S. H. (1992). Universals in the content and structure of values: Theoretical advances and empirical tests in 20 countries. *Advances in Experimental Social Psychology*.

Schwarzer, G. (2007). meta: An R package for meta-analysis. *R News*, *7*(3), 40–45.

Schwarzer, R., & Jerusalem, M. (2010). The general self-efficacy scale (GSE). *Anxiety, Stress, and Coping*, *12*(1), 329–345.

Singelis, T. M. (1994). The Measurement of Independent and Interdependent Self-Construals. *Personality and Social Psychology Bulletin*, *20*(5), 580–591. https://doi.org/10.1177/0146167294205014

Smallwood, J., & Andrews-Hanna, J. (2013). Not all minds that wander are lost: The importance of a balanced perspective on the mind-wandering state. *Frontiers in Psychology*, *4*, 441.

Smith, E. E., Reznik, S. J., Stewart, J. L., & Allen, J. J. (2017). Assessing and conceptualizing frontal EEG asymmetry: An updated primer on recording, processing, analyzing, and interpreting frontal alpha asymmetry. *International Journal of Psychophysiology*, *111*, 98–114.

Sng, O., Neuberg, S. L., Varnum, M. E. W., & Kenrick, D. T. (2018). The behavioral ecology of cultural psychological variation. *Psychological Review*, *125*(5), 714–743. https://doi.org/10.1037/rev0000104

Song, X., & Wang, X. (2012). Mind wandering in Chinese daily lives–an experience sampling study. *PloS One*, *7*(9).

Swick, D., & Turken, A. U. (2002). Dissociation between conflict detection and error monitoring in the human anterior cingulate cortex. *Proceedings of the National Academy of Sciences*, *99*(25), 16354–16359. https://doi.org/10.1073/pnas.252521499

Talhelm, T., Zhang, X., Oishi, S., Shimin, C., Duan, D., Lan, X., & Kitayama, S. (2014). Large-Scale Psychological Differences Within China Explained by Rice Versus Wheat Agriculture. *Science*, *344*(6184), 603–608. https://doi.org/10.1126/science.1246850

Taylor, S. E., & Brown, J. D. (1988). Illusion and well-being: A social psychological perspective on mental health. *Psychological Bulletin*, *103*(2), 193–210. https://doi.org/10.1037/0033-2909.103.2.193

Tchombé, T. M., Nsamenang, A. B., Keller, H., & Fülöp, M. (2013). *Cross-cultural Psychology: An Africentric Perspective*. Design House.

Tenke, C. E., Kayser, J., Alvarenga, J. E., Abraham, K. S., Warner, V., Talati, A., Weissman, M. M., & Bruder, G. E. (2018). Temporal stability of posterior EEG alpha over twelve years. *Clinical Neurophysiology*, *129*(7), 1410–1417.

The World Bank. (2018). *Latin America & Caribbean | Data*. https://data.worldbank.org/region/latin-america-and-caribbean

The World Bank. (2019). *International Comparison Program Database*.

Thomson, R., Yuki, M., Talhelm, T., Schug, J., Kito, M., Ayanian, A. H., Becker, J. C., Becker, M., Chiu, C., Choi, H.-S., Ferreira, C. M., Fülöp, M., Gul, P., Houghton-Illera, A. M., Joasoo, M., Jong, J., Kavanagh, C. M., Khutkyy, D., Manzi, C., … Visserman, M. L. (2018). Relational mobility predicts social behaviors in 39 countries and is tied to historical farming and threat. *Proceedings of the National Academy of Sciences*, *115*(29), 7521–7526. https://doi.org/10.1073/pnas.1713191115

Tomasello, M. (2019). *Becoming Human: A Theory of Ontogeny*. Harvard University Press.

Triandis, H. C. (1983). *Allocentric versus Idiocentric Social Behavior: A Major Cultural Difference between Hispanics and the Mainstream.* (TR-ONR-16). ILLINOIS UNIV AT URBANA DEPT OF PSYCHOLOGY. https://apps.dtic.mil/docs/citations/ADA126200

Triandis, H. C., & Gelfand, M. J. (1998). Converging measurement of horizontal and vertical individualism and collectivism. *Journal of Personality and Social Psychology*, *74*(1), 118–128. https://doi.org/10.1037/0022-3514.74.1.118

Triandis, H. C., Marín, G., Lisansky, J., & Betancourt, H. (1984). Simpatía as a cultural script of Hispanics. *Journal of Personality and Social Psychology*, *47*(6), 1363–1375. https://doi.org/10.1037/0022-3514.47.6.1363

Tsai, J. L., Ang, J. Y. Z., Blevins, E., Goernandt, J., Fung, H. H., Jiang, D., Elliott, J., Kölzer, A., Uchida, Y., Lee, Y.-C., Lin, Y., Zhang, X., Govindama, Y., & Haddouk, L. (2016). Leaders' Smiles Reflect Cultural Differences in Ideal Affect. *Emotion (Washington, D.C.)*, *16*(2), 183–195. https://doi.org/10.1037/emo0000133

Tsai, J. L., Knutson, B., & Fung, H. H. (2006). Cultural variation in affect valuation. *Journal of Personality and Social Psychology*, *90*(2), 288–307. https://doi.org/10.1037/0022-3514.90.2.288

Tsai, J. L., Miao, F. F., Seppala, E., Fung, H. H., & Yeung, D. Y. (2007). Influence and adjustment goals: Sources of cultural differences in ideal affect. *Journal of Personality and Social Psychology*, *92*(6), 1102–1117. https://doi.org/10.1037/0022-3514.92.6.1102

Uchida, Y., & Kitayama, S. (2009). Happiness and unhappiness in east and west: Themes and variations. *Emotion*, *9*(4), 441–456. https://doi.org/10.1037/a0015634

United Nations, Department of Economic and Social Affairs, Population Division. (2018). *World Population Prospects: The 2019 Revision, custom data acquired via website.*

Uskul, A. K., & Over, H. (2014). Responses to social exclusion in cultural context: Evidence from farming and herding communities. *Journal of Personality and Social Psychology*, *106*(5), 752. https://doi.org/10.1037/a0035810

Van Bavel, J. J., Baicker, K., Boggio, P. S., Capraro, V., Cichocka, A., Cikara, M., Crockett, M. J., Crum, A. J., Douglas, K. M., Druckman, J. N., Drury, J., Dube, O., Ellemers, N., Finkel, E. J., Fowler, J. H., Gelfand, M., Han, S., Haslam, S. A., Jetten, J., … Willer, R. (2020). Using social and behavioural science to support COVID-19 pandemic response. *Nature Human Behaviour*. https://doi.org/10.1038/s41562-020-0884-z

Varnum, M. E. W., Grossmann, I., Kitayama, S., & Nisbett, R. E. (2010). The Origin of Cultural Differences in Cognition: The Social Orientation Hypothesis. *Current Directions in Psychological Science*, *19*(1), 9–13. https://doi.org/10.1177/0963721409359301

Vygotsky, L. S. (1980). *Mind in Society: The Development of Higher Psychological Processes*. Harvard University Press.

Wang, C., Ma, Y., & Han, S. (2014). Self-construal priming modulates pain perception: Event-related potential evidence. *Cognitive Neuroscience*, *5*(1), 3–9. https://doi.org/10.1080/17588928.2013.797388

Wang, C., Oyserman, D., Liu, Q., Li, H., & Han, S. (2013). Accessible cultural mind-set modulates default mode activity: Evidence for the culturally situated brain. *Social Neuroscience*, *8*(3), 203–216.

Wang, F., Peng, K., Chechlacz, M., Humphreys, G. W., & Sui, J. (2017). The neural basis of independence versus interdependence orientations: A voxel-based morphometric analysis of brain volume. *Psychological Science*, *28*(4), 519–529.

Wang, Q. (2013). *The Autobiographical Self in Time and Culture*. Oxford University Press.

Wang, Q., & Conway, M. A. (2004). The stories we keep: Autobiographical memory in American and Chinese middle-aged adults. *Journal of Personality*, *72*(5), 911–938.

Wang, Q., Shao, Y., & Li, Y. J. (2010). “My way or mom’s way?” The bilingual and bicultural self in Hong Kong Chinese children and adolescents. *Child Development*, *81*(2), 555–567.

Ward, R. T., Smith, S. L., Kraus, B. T., Allen, A. V., Moses, M. A., & Simon-Dack, S. L. (2018). Alpha band frequency differences between low-trait and high-trait anxious individuals. *Neuroreport*, *29*(2), 79–83.

Webster, K., & Ro, T. (2020). Visual Modulation of Resting State α Oscillations. *ENeuro*, *7*(1).

Williams, L. E., & Bargh, J. A. (2008). Experiencing Physical Warmth Promotes Interpersonal Warmth. *Science*, *322*(5901), 606–607. https://doi.org/10.1126/science.1162548

Wolff, A., Di Giovanni, D. A., Gómez-Pilar, J., Nakao, T., Huang, Z., Longtin, A., & Northoff, G. (2019). The temporal signature of self: Temporal measures of resting-state EEG predict self-consciousness. *Human Brain Mapping*, *40*(3), 789–803.

Wood, A., Rychlowska, M., & Niedenthal, P. M. (2016). Heterogeneity of long-history migration predicts emotion recognition accuracy. *Emotion*, *16*(4), 413–420. https://doi.org/10.1037/emo0000137

Wood, W., & Neal, D. T. (2007). A new look at habits and the habit-goal interface. *Psychological Review*, *114*(4), 843–863. https://doi.org/10.1037/0033-295X.114.4.843

Wu, L., Eichele, T., & Calhoun, V. D. (2010). Reactivity of hemodynamic responses and functional connectivity to different states of alpha synchrony: A concurrent EEG-fMRI study. *Neuroimage*, *52*(4), 1252–1260.

Yu, Q., Abe, N., King, A., Yoon, C., Liberzon, I., & Kitayama, S. (2019). Cultural variation in the gray matter volume of the prefrontal cortex is moderated by the dopamine D4 receptor gene (DRD4). *Cerebral Cortex*, *29*(9), 3922–3931.

Yu, Q., Salvador, C. E., Melani, I., Berg, M., Neblett, E. W., & Kitayama, S. (2020). The lethal spiral: Racial segregation and economic disparity jointly exacerbate the COVID-19 fatality in large American cities. *Annals of the New York Academy of Science*. https://doi.org/10.31234/osf.io/xgbpy

Yuki, M., & Schug, J. (2020). Psychological consequences of relational mobility. *Current Opinion in Psychology*, *32*, 129–132. https://doi.org/10.1016/j.copsyc.2019.07.029

Zajonc, R. B. (1968). Attitudinal effects of mere exposure. *Journal of Personality and Social Psychology*, *9*(2, Pt.2), 1–27. https://doi.org/10.1037/h0025848