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Culture and Context: East Asian American and European American Differences in P3 Event-Related Potentials and Self-Construal

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Research has demonstrated differences in social and cognitive processes between East Asians and European Americans. Whereas East Asians have been characterized as being more sensitive to situational context and attending more to the perceptual field, European Americans have been characterized as being more focused on the object and being more field independent. The goal of the present experiment was to investigate differences in neural responses to target objects and stimulus context between East Asian Americans and European Americans using a three-stimulus novelty P3 event-related potential design. As hypothesized, European Americans displayed relatively greater target P3 amplitudes, indexing attention to target events, whereas East Asian Americans displayed relatively greater novelty P3 amplitudes, indexing attention to contextually deviant events. Furthermore, the authors found that interdependent self-construal mediated the relationship between culture and the novelty P3. These findings identify a specific pattern of neural activity associated with established cultural differences in contextual sensitivity.

Keywords: *cross-cultural differences; collectivism; individualism; interdependent self-construal; independent self-construal; event-related potentials*

Psychological processes vary across cultures in compelling ways. Differences in conceptions of the self and relations to others (e.g., see Fiske, Kitayama, Markus, & Nisbett, 1998; Hofstede, 2001; Markus & Kitayama, 1991; Triandis, 1995) are a prime example. These studies most typically contrast European American and East Asian cultures. European American cultures have been characterized as displaying independent self-construal. That is, they view themselves as being independent, autonomous, and separate from others. Individuals with independent self-construal emphasize self-reliance, competition, and uniqueness and see their behavior as resulting from their own internal thoughts, attitudes, and feelings rather than stemming from relations to others. In contrast, East Asian cultures have been characterized as displaying interdependent self-construal. That is, they view themselves as being interdependent and connected to each other. Individuals with an interdependent self-construal emphasize sociability and in-group harmony and see their behavior in relation to others' thoughts, attitudes, feelings, and actions.

Differences in self-construal have implications for how we think, feel, and behave (e.g., see Markus & Kitayama, 1991; Triandis & Suh, 2002). For example, the interdependent self tends to be more sensitive to contextual cues from the environment. Morris and Peng (1994) found that Chinese students were more likely than American students to consider situational and contextual factors when making judgments about

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the cause of other people's behavior. Studies have also shown that interdependent individuals are more sensitive to the needs and emotions of others within their group (Markus & Kitayama, 1991; Matsumoto, 1989; Gudykunst, 1993, as cited in Triandis, 1995) and are more sensitive to ingroup/outgroup status when making decisions that affect another (Leung & Bond, 1984). This monitoring of social contextual factors is associated with greater situational dependency and stands in contrast to the stronger independence and behavioral stability across situations of those with an independent self-construal.

Basic cognitive processes have also been found to vary between European American and East Asian cultures. Much of this work has concentrated on differences in the focus of attention. For example, Chua, Borland, and Nisbett (2005) monitored eye movements when Americans and Chinese viewed photographs. After 420 ms of viewing photographs, Chinese began to display more saccades to the background, whereas Americans fixated more on focal objects. East Asians have also been found to be more field dependent on the Rod-and-Frame Test (Ji, Peng, & Nisbett, 2000), more likely to incorporate visual contextual information in a line-matching task (Kitayama, Duffy, Kawamura, & Larsen, 2003), more likely to report background fish and objects when viewing underwater scenes (Masuda & Nisbett, 2001), and more likely to provide whole responses on the Rorschach (Abel & Hsu, 1949). Nisbett and colleagues characterized European Americans as having a more analytic cognitive style, attending to focal objects and engaging in logical analysis and systematic categorization in attempting to understand behavior. In contrast, they proposed that East Asians tend to engage in a more holistic cognitive style, focusing on a broad perceptual and conceptual field and taking into account context and interrelationships in attempting to understand behavior (Nisbett & Masuda, 2003; Nisbett, Peng, Choi, & Norenzayan, 2001). It has been hypothesized that the differential attention to context and object are socialized early during development (Chua et al., 2005) and result from long-standing differences in European American and East Asian social and economic systems (see Nisbett et al., 2001).

Research on East Asian and European American differences in social and cognitive processes has resulted in consistent conclusions. Despite the fact that social psychological processes have focused on sensitivity to social cues and situational context, and that basic cognitive studies have focused primarily on attention to the perceptual field, both areas of research have found East Asians to attend more to the broader context and the relations among focal and surrounding events than European Americans.

While there have been many social and perceptual studies examining differences in the psychological processes that vary cross-culturally, there have been few studies to date looking at the neural correlates that underlie such differences in cognition. One exception is a functional magnetic resonance imaging (fMRI) study investigating brain hemodynamic responses to pictures of objects, backgrounds, and combinations of objects and backgrounds (Gutchess, Welsh, Boduroglu, & Park, 2006). When viewing focal objects, Americans, relative to East Asians, showed greater activity in cortical areas involved in visual perceptual processing, including the temporal and parietal lobes. Their data are consistent with Americans' greater attention to objects reported in behavioral studies cited above. However, they did not find any significant increases in brain activity associated with East Asians' processing of background regions. Gutchess et al. (2006), therefore, concluded that "cultural differences in the encoding of complex scenes result predominantly from additional processing of objects by Westerners" (p. 107). One limitation of fMRI is its relatively poor temporal resolution, thus making it difficult to determine at exactly which stage of cognitive processing cultural differences between European Americans and East Asians occurred in this study.

Event-related potentials (ERPs) represent another technique that is widely used to measure brain activity in humans. While this technique is limited in its ability to spatially resolve brain activity, it is superior to fMRI in terms of its millisecond resolution of neural activity. ERPs have also been widely used to measure attention to target objects and stimulus context and may, therefore, provide insight into which stages of cognitive processing are reflective of cultural influences.

In the two-stimulus version of the so-called oddball task, subjects are presented with frequent nontarget stimuli, called the standard, and infrequent (i.e., oddball) target stimuli. Scalp electrical recordings during the task show a larger "late" positive wave occurring over the parietal scalp region in response to target stimuli, typically showing maximal values at the posterior midline electrode Pz. This positive potential peaks around 300-400 ms after the onset of the stimulus, is the third positive ERP wave, and has been referred to as the P300, P3, and target P3. The magnitude of the target P3 has been shown to positively correlate with stimulus probability and task relevance and is proportional to attentional resources allocated to processing the target (Johnson, 1988). The target P3 is thought to reflect part of a neurally distributed orienting attentional system for detecting rare, meaningful events (Herrmann & Knight, 2001).

In the three-stimulus variation of the oddball task, a third category of stimulus is presented that is also infrequent, but is not the object of a response. The infrequent, nontarget stimulus elicits a more frontocentral P3 ERP referred to as the novelty P300, P3a, and novelty P3. The novelty P3 is typically characterized by its amplitude at the vertex, electrode Cz, and frontal midline electrode Fz. The resulting novelty P3 has been shown to be particularly sensitive to deviations from the immediate stimulus context, which is determined by the nature of the standard and the target. For example, Polich and Comerchero (2003) systematically varied the size and type of the infrequent nontarget stimulus in a three-stimulus oddball design. When the standard and target were perceptually similar (e.g., when one was a slightly larger circle), they found that perceptually discrepant nontargets (e.g., a very large square or a large, unusual design) resulted in a larger novelty P3 than when stimuli varied in only category type (i.e., letters of the alphabet similar in size to the standard and target). Similarly, within the auditory modality, perceptually discrepant nontarget environmental sounds (e.g., dog barking or car horn) elicit novelty P3 ERPs when presented against a stimulus context of high and low tones for the targets and standards (Katayama & Polich, 1998). In general, the more perceptually discrepant the infrequent, nontarget is compared to the standard and target, the greater the novelty P3 amplitude (see, e.g., Courchesne, Courchesne, & Hillyard, 1978; Daffner et al., 2000; Debner, Makeig, Delorme, & Engel, 2005). Consequently, the novelty P3 has been used as an index of attention to deviations of stimulus context (Ranganath & Rainer, 2003) and has been proposed to reflect brain processes that occur in response to a detected perceptually deviant event (Friedman, Cycowicz, & Gaeta, 2001).

In contrast to the target P3, the novelty P3 has a more anterior scalp distribution (Friedman et al., 2001; Ranganath & Rainer, 2003). The novelty P3 represents a relatively late, conscious, and evaluative stage of the orienting response, and its magnitude reflects the degree of processing of potentially significant events in the contextual environment (Friedman et al., 2001). The target and novelty P3 ERPs are thought to reflect a distributed neural network involving anterior and posterior structures. However, the novelty P3 appears to be more dependent on anterior structures whereas the target P3 appears to be more dependent on posterior structures (Daffner et al., 2003). To be consistent with the nomenclature proposed by Friedman et al. (2001), we will use the term *target P3* to "refer to the P3 component elicited by events about which the subject has been instructed and to which the subject is required to generate some kind of response" and the term *novelty P3* to refer to "the P3 component elicited by events about which the subject has not been instructed prior to the experiment" (p. 358). However, it is important to note that the perceptual distinctiveness of a stimulus is probably a more important determining factor of the magnitude of the novelty P3 than its unexpectedness (see Debener et al., 2005).

The three-stimulus oddball design appears to be a useful task for investigating neural differences in allocation of attention to target objects and stimulus context. As such, ERP responses to this task may be an effective neural measure of culturally related differences in attention. Because the ERP technique requires that electroencephalogram (EEG) be time-locked to a discrete event, it does not lend itself to the free-field viewing tasks using complex pictorial scenes typically found in the culture and cognition literature. Instead, we have used a well-established paradigm for measuring brain activity in response to target objects and stimulus context with the expectation that the advantages outweigh the cost of an inexact replication of cognition and culture findings. The complex stimuli of perceptual field experiments, typical in much of the culture and cognition literature, occur at a single cross section in time, defining context as perception of ground relative to figure. The three-stimulus novelty oddball task cuts the pie of "context" differently by slicing across time. The timing is akin to a social situation where in stages the situation is perceived, appraised, and expectations are formed. This is conceptually similar to the paradigm used to study cultural differences in mnemonic context. Duffy and Kitayama (2007) found that memory representations of stimuli "serve as a context that helps inform judgments" about future stimuli. Using this paradigm, they found that Japanese judgments of the magnitude of target stimuli were more influenced by mnemonic context (i.e., previously presented stimuli) than American judgments.

In sum, the novelty P3 paradigm does not measure attention to context per se; rather it measures attention to events that deviate from the context. The directions and previous stimuli constitute a context for the task. If Asian Americans are more context sensitive than European Americans, then we would expect them to allocate more attention to the context. This increased allocation of attention to context should result in greater responses to events that deviate from the context (i.e., larger novelty P3s).

The goal of the present study was to investigate the cultural influence of neural differences in attention to target objects and events that deviated from the stimulus context created by the standard and target stimuli. Whereas the bulk of the previous studies have emphasized differences in cognition between European Americans and East Asians, our study will investigate cultural differences between European Americans and East Asian Americans. Not surprisingly, Asian Americans have been shown to have a pattern of self-construal similar to East Asians and different from European Americans (see Oyserman, Coon, & Kemmelmeier, 2002, for a review). East Asian Americans have also been included in tests of cultural differences in cognition between East Asian and European American cultures (e.g., Kim, 2002), and are of interest in their own right.

We hypothesized that (a) European Americans would attend more to target objects, as measured by a larger target posterior P3 (at electrode Pz) compared to East Asian Americans, and (b) East Asian Americans would attend more to contextually novel events, as measured by a larger novelty P3 at frontocentral electrodes (at electrodes Cz and Fz) compared to European Americans. Furthermore, we wanted to investigate a theoretically based mechanism through which culture might influence neural processing of context. We investigated whether self-construal mediates the relationship between culture and the ERPs.

METHOD

Participants

Forty undergraduate students from a West Coast liberal arts college, ranging in age from 18 to 20 years, participated in the experiment for partial course credit or payment. Twenty of the subjects were European American (10 men and 10 women), and 20 were Asian American of East Asian descent (9 men and 11 women). Sixteen of the Asian Americans were of Chinese descent, 2 were of Korean descent, and 2 were of Japanese descent. Average verbal SAT scores did not differ between the European Americans (M = 712; SD = 51) and Asian Americans (M = 723; SD = 51), $t(36)$ = .62, *ns*. All subjects spoke English as their first language, were right-handed, and had normal or corrected-to-normal vision.

Stimuli and Materials

Three classes of stimuli were presented in white, Arial, 40-point font characters against a dark background on a 15-inch computer monitor. The standard (i.e., frequent, nontarget stimuli) consisted of the number “8” and the target object consisted of the number “6.” These stimuli were chosen because of their physical similarity, which has been shown to be an important variable in eliciting the novelty P3 (Katayama & Polich, 1998; Polich & Comerchero, 2003). The nontarget, contextually novel stimuli consisted of perceptually discrepant stimuli from the standard and target object and consisted of an equal number of unique three-character words (e.g., “DOG”), consonants (e.g., “TCQ”), and numbers (e.g., “305”). The standard (the number 8) was presented 76% of the time, the target object (the number 6) was presented 12% of the time, and the nontarget, perceptually discrepant stimuli (three-character stimuli) was presented 12% of the time.

To measure self-construal, participants were administered the Triandis (1995) Individualism and Collectivism Attitude Scale (IND/COL), which consists of 32 statements (e.g., “One should live one’s life independently of others” and “I usually sacrifice my self-interest for the benefit of my group”) asking how much subjects agree ranging from 1 (*strongly disagree*) to 9 (*strongly agree*).[1] Treating self-construal as orthogonal constructs, independent self-construal was measured by calculating the average response on the 16-item Individualism subscale, and interdependent self-construal was measured by calculating the average response on the 16-item Collectivism subscale. Although often used in cross-national comparisons, measures such as the IND/COL have been successfully used to discriminate populations within a country (see Oyserman et al., 2002).

Experimental Design and Procedure

Subjects were administered 300 trials of an oddball sequence. Subjects were instructed to respond to the target object by pressing a button with their right hand. In order to focus subjects’ attention on accurate discrimination of the standard and target (see Polich & Comerchero, 2003), accuracy of responding to the target was emphasized rather than speed of response. Prior to each trial, a fixation point (+) was presented in the center of the screen for a randomly determined interval ranging between 500 and 1,500 ms. The fixation point was followed by the stimulus for 250 ms and a blank screen for 1,000 ms. Testing was preceded by a practice session consisting of 20 trials of an equal number of target and distractor stimuli. Following completion of the three-stimulus novelty oddball task, subjects were administered the Triandis IND/COL Scale.

EEG Acquisition and Processing

EEG was recorded with an Electrical Geodesics Inc. (EGI) 128-channel Geodesic Netstation System. The EGI Sensor Net used Ag/AgCl sintered electrodes connected to an AC-coupled high-input impedance (200 MΩ) Netstation 200 amplifier. Analog voltages (amplified by a factor of 1,000 and using a bandpass .01 Hz to 100 Hz) were digitized with a 16-bit analog-digital converter at 250 Hz. Electrodes were adjusted to impedances below 50 kΩ, which preserves the signal integrity (<.1% error) for a system of this design (Ferree, Luu, Russell, & Tucker, 2001). Recording electrodes were referenced to vertex. Offline, a 30 Hz lowpass filter was applied to the EEG. Ocular artifacts were removed using the Gratton, Coles, and Donchin (1983) regression procedure. Single trials were epoched from 200 ms before onset of the stimulus to 1,000 ms after its onset. Trials were rejected if they contained remaining ocular artifacts (greater than 70 V difference between eye channels) or more than five bad channels (100 V difference between successive samples or reaching amplitudes of 200 V). Trials for each condition were averaged separately, rereferenced to the average reference, and baseline corrected.

Data analysis. The P3 component was defined as the largest positive peak occurring within a 250 to 500 ms window poststimulus onset. The peak amplitude was measured relative to the 200 ms prestimulus baseline. Data from the midline electrodes, Fz (EGI Geodesic Net #E6), Cz (vertex), and Pz (EGI Geodesic Net #E 62) electrodes (see Spencer, Dien, & Donchin, 2001) were analyzed because they tend to encompass the scalp sites of maximum deflection of the target P3 and novelty P3. Data were analyzed with repeated-measures mixed-design ANOVAs. Due to the well-known violation of sphericity when analyzing psychophysiological data using repeated-measures designs (Vasey & Thayer, 1987), we used the Greenhouse-Geiser correction where appropriate.

RESULTS

Behavioral Analysis

Error rates for each subject were less than 3%, which is consistent with the published literature. Trials with incorrect responses were eliminated from ERP analyses.

ERP analysis of midline electrodes. For the standard condition (i.e., trials involving the frequent, nontarget stimulus), there was no main effect of amplitude between the European Americans and East Asian Americans, $F(1, 38) = .13$, *ns*, nor was there an interaction between amplitude of the midline electrodes and ethnicity of the subjects, $F(2, 37) = 1.47$, *ns*. Consequently, the amplitude of the standard condition was subtracted from the amplitudes for the infrequent target and nontarget novelty conditions for the remaining P3 analyses.

The maximum amplitudes for the target and nontarget novelty conditions (subtracted from the standard condition) were analyzed using a 2 × 3 × 2 mixed-design, multivariate ANOVA with Condition (target, novelty) and Electrode (Fz, Cz, Pz) as the within-subjects factors and Culture (European American, East Asian American) as the between-subjects factor.

There was an anterior to posterior gradient of P3 amplitudes such that more posterior amplitudes were larger than more anterior amplitudes, $F(1, 38) = 34.4$, $p < .001$. There was no main effect of Culture, $F(1, 38) = .03$, *ns*, or Condition, $F(1, 38) = .063$, *ns*. Additionally, Culture was not found to interact with Electrode, $F(2, 37) = 1.96$, *ns*. However, Condition interacted with Electrode, $F(2, 37) = 17.4$, $p < .001$. Visual inspection of the ERPs suggests that Pz was larger during the target condition than during the novelty condition, whereas Fz was larger during the novelty condition than during the target condition.

There was a significant interaction between Culture and Condition, $F(2, 37) = 8.6$, $p = .006$, such that amplitudes for the novelty condition were larger for Asian Americans than European Americans, $F(1, 38) = 5.1$, $p = .03$, whereas amplitudes for the target condition tended to be larger for European Americans than Asian Americans, $F(1, 38) = 2.6$, $p = .07$ (see Figures 1-3). Visual inspection of the ERPs suggests that the larger amplitude of Asian Americans during the novelty condition occurred at the frontal and vertex electrodes, and the larger amplitude of European Americans during the target condition occurred primarily at Pz. However, no three-way interaction was found, $F(2, 38) = .56$, *ns*. In accordance with our hypotheses, though, significantly larger P3 ERPs were found at electrodes Fz, $t(38) = 2.1$, $p < .05$, and Cz, $t(38) = 2.6$, $p < .05$, for Asian Americans during the novelty condition, and there was a trend for European Americans to show a larger P3 amplitude at electrode Pz during the target condition, $t(38) = 1.08$, $p < .1$.

Relationship Between Self-Construal and ERPs

Independent and interdependent self-construal scores. Retaining all items of the Triandis Individualism and Collectivism subscales resulted in moderately high interitem reliability (Cronbach's alpha was .77 and .80, respectively).

The East Asian Americans ($M = 6.2$, $SD = 0.96$) were significantly more interdependent than the European Americans ($M = 5.3$, $SD = 0.85$) on the Triandis Collectivism subscale, $t(38) = 3.0$, $p = .004$. Although the European Americans ($M = 6.0$, $SD = 0.69$) scored higher on independent self-construal than the Asian Americans ($M = 5.7$, $SD = 0.97$) on the Triandis Individualism subscale, the difference did not approach significance, $t(38) = 1.0$, *ns*.

To investigate the relationship between self-construal and the target and novelty P3 amplitudes, correlational analyses were conducted between the Triandis Individualism and Collectivism subscales and the magnitude of the target and novelty P3 ERPs for the three midline electrodes across all subjects. The results of these analyses are shown in Table 1. The magnitude of the novelty P3 was associated with interdependent self-construal such that

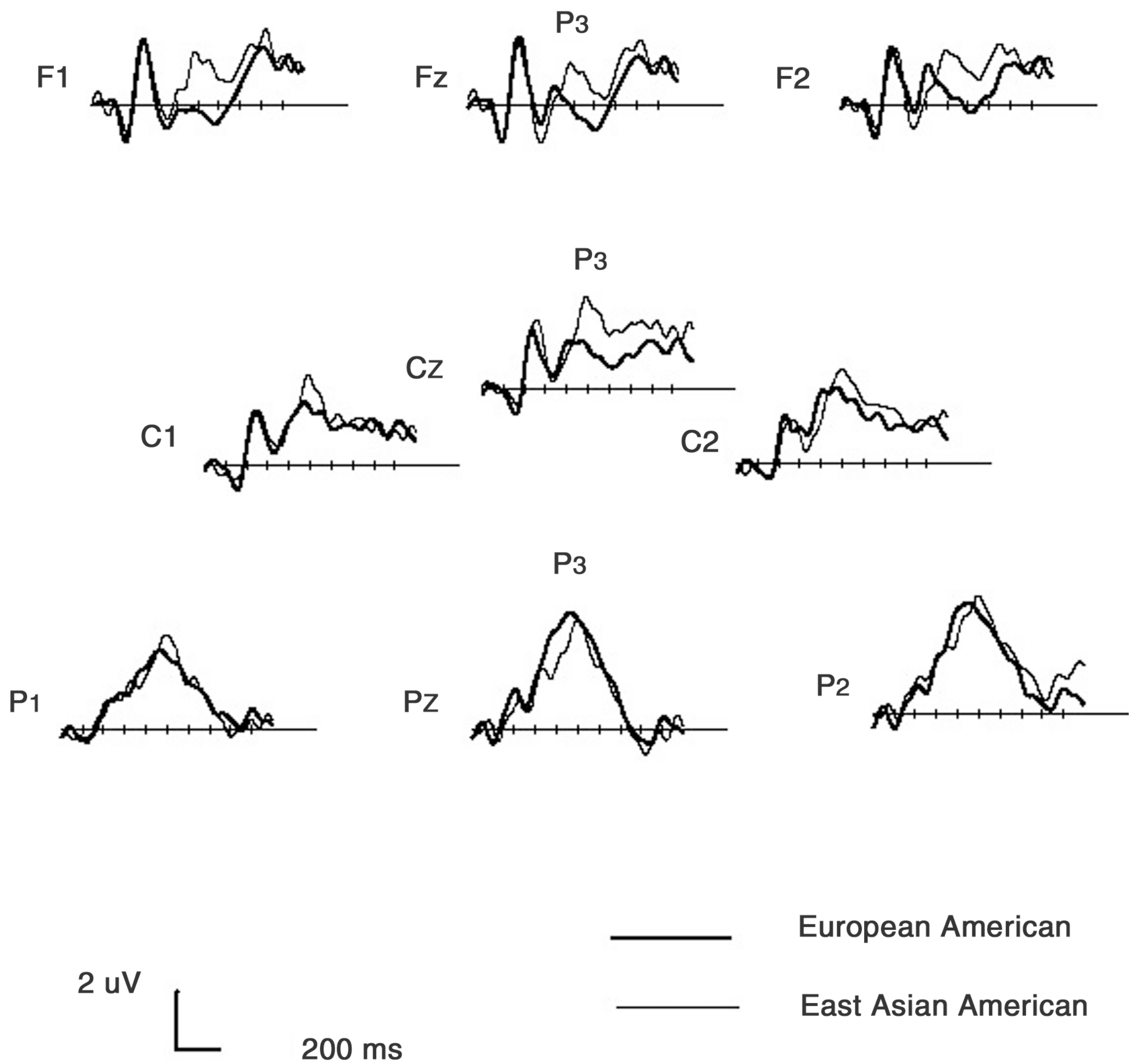

Figure 1 Event-related potentials for Asian American and European American groups during the novelty condition.
NOTE: Voltage is plotted as a function of time poststimulus onset. East Asian Americans show larger novelty P3 amplitudes at the central and frontal electrodes.

greater novelty P3 amplitudes were associated with a significantly greater interdependent self-construal at the Cz electrode (see Figure 4) and a nonsignificant trend at the Fz electrode. However, no relationship was found between the target P3 and self-construal.

To determine if the relationship between culture and novelty P3 was mediated by self-construal, a mediator analysis was performed. Baron and Kenny's (1986) three conditions for establishing mediation are (a) the independent variable (culture) must predict the mediator (self-construal); (b) the independent variable (culture) must predict the dependent variable (novelty P3); and (c) regressing the dependent variable (novelty P3) onto the mediator (self-construal) and the independent variable (culture), the mediator must predict the dependent variable (novelty P3), and the effects of the independent variable (culture) on the dependent variable (novelty P3) must be reduced in comparison to its effects in the second analysis.

The results of the three regression analyses are presented in Table 2. The first condition was met such that Culture significantly predicted the potential mediator, interdependent self-construal. The second condition

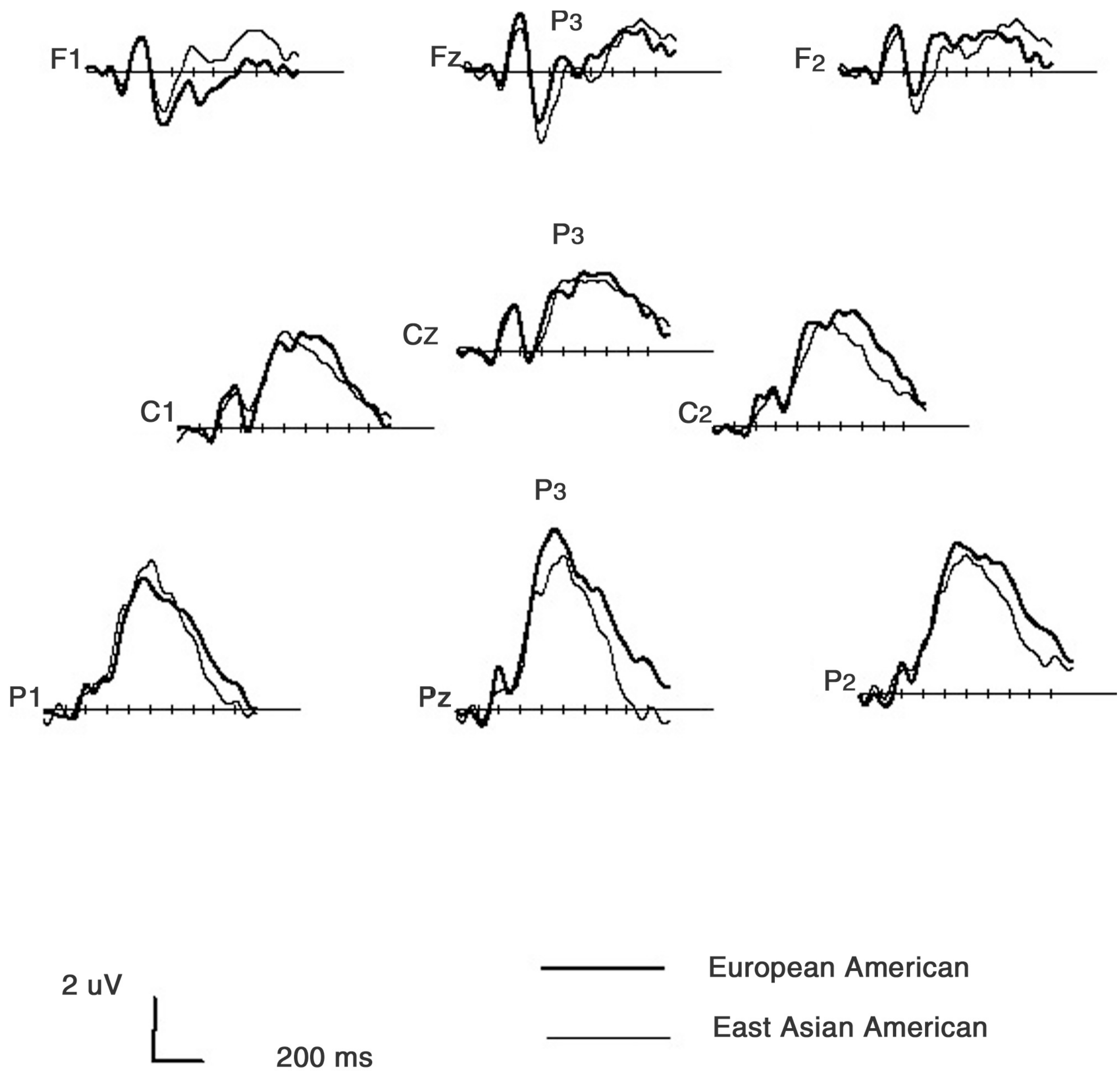

Figure 2 Event-related potentials for Asian American and European American groups during the target condition.
NOTE: Voltage is plotted as a function of time poststimulus onset. European Americans show larger target P3 amplitudes at the posterior electrodes.

was met such that Culture predicted the novelty P3 at Cz. For the third condition, the overall model was significant. There was a nonsignificant trend for self-construal to predict novelty P3 at Cz and the effect of Culture on the novelty P3 at Cz was reduced in magnitude compared to condition 1. Therefore, the pattern of the regression analyses was consistent, with interdependent self-construal mediating the relationship between Culture and novelty P3 at Cz. We tested the significance of this model by using a bootstrap approach to obtain confidence intervals (see Preacher & Hayes, 2004). This method is a nonparametric approach and is particularly well suited to small sample sizes. The resulting analysis resulted in a confidence interval (CI) that did not include 0, indicating that interdependent self-construal is a significant mediator variable of the relationship between culture and the novelty P3 (M = 0.46; 95% CI = .002 to 1.1).

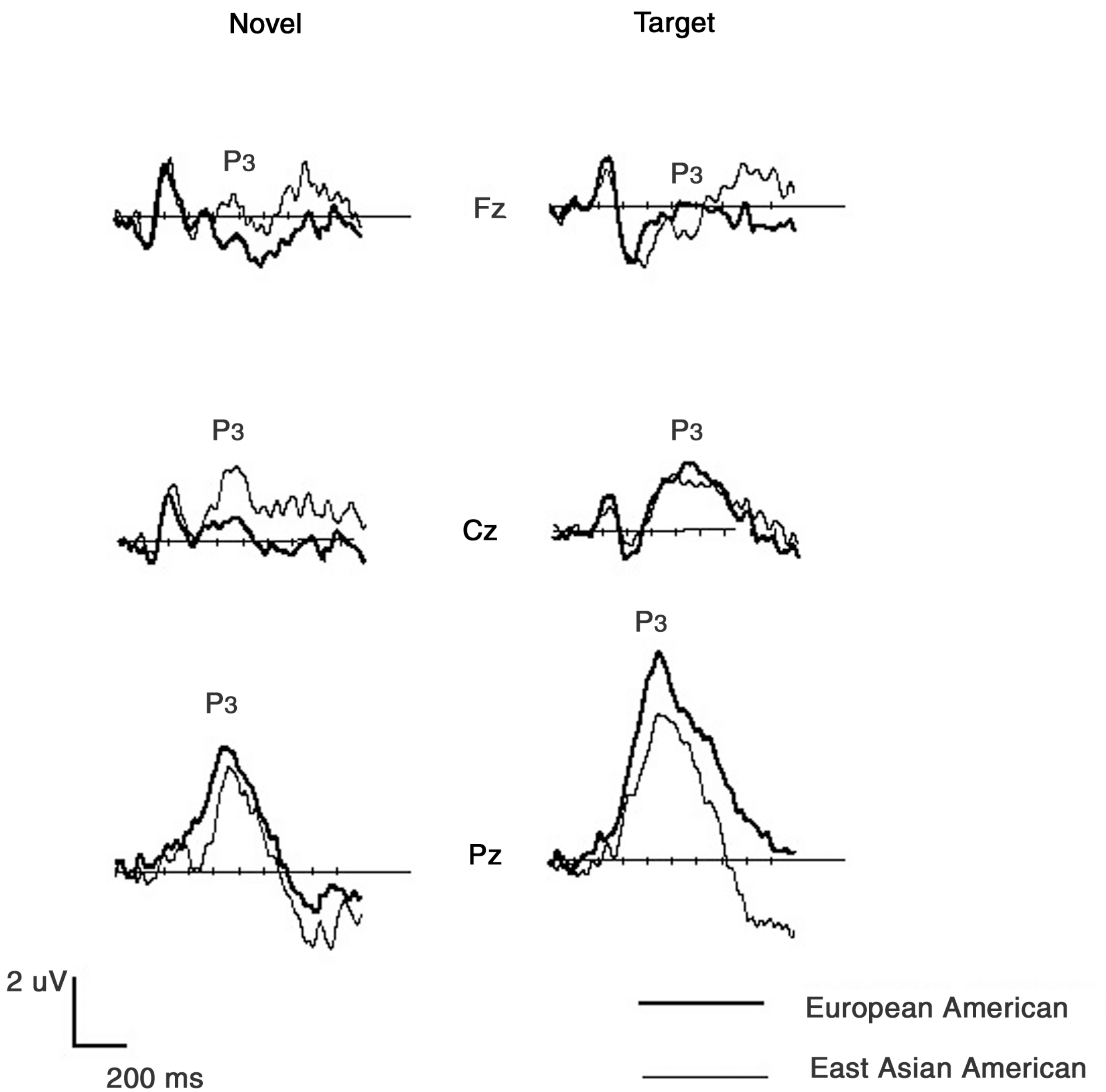

Figure 3 Difference waves for Asian American and European American groups during the novel and target conditions after subtracting the distractor condition.

NOTE: Voltage for the midline electrodes is plotted as a function of time poststimulus onset.

DISCUSSION

In the current experiment, differences between European Americans' and East Asian Americans' neural responses to target objects and perceptually discrepant stimuli were demonstrated. An interaction was found such that European Americans responded to target objects with relatively greater P3 amplitudes, whereas the East Asian Americans tended to respond to perceptually discrepant events with relatively greater P3 amplitudes. These data support and extend previous findings of differential attention to object and context between European Americans and those of East Asian descent.

Finding that the European Americans allocated relatively greater attention to the target objects during the oddball task is consistent with a growing body of literature that European Americans allocate greater attention to focal objects (Chua et al., 2005; Fiske et al.,

TABLE 1: Correlations Between the Triandis Individualism and Collectivism Subscales and the Amplitude of the Novelty P3 (Novel Condition P3 Event-Related Potential [ERP] Minus Standard Condition ERP) and Target P3 (Target Condition P3 ERP Minus Standard Condition ERP) Components

Electrode	*Collectivism*	*Individualism*
Novelty P3		
Fz	.30*	–.12
Cz	.38**	.10
Pz	–.10	–.20
Target P3		
Fz	.16	–.20
Cz	.20	–.05
Pz	–.12	.06

$^*p < .1$. $^{**}p < .05$.

TABLE 2: Regression Analyses Testing Interdependent Self-Construal as Mediator of Culture and Novelty P3

Variable	B	SEB	β	R^2
Mediator variable: Collectivism				.20***
Culture (dummy code)	0.88	.45	.44	
Dependent variable: Novelty P3				.15**
Culture (dummy code)	1.6	.60	.39	
Dependent variable: Novelty P3				.16**
Culture (dummy code)	0.58	.75	.27	
Collectivism	0.53	.33	.26*	

$^*p < .1$. $^{**}p < .05$. $^{***}p = .01$.

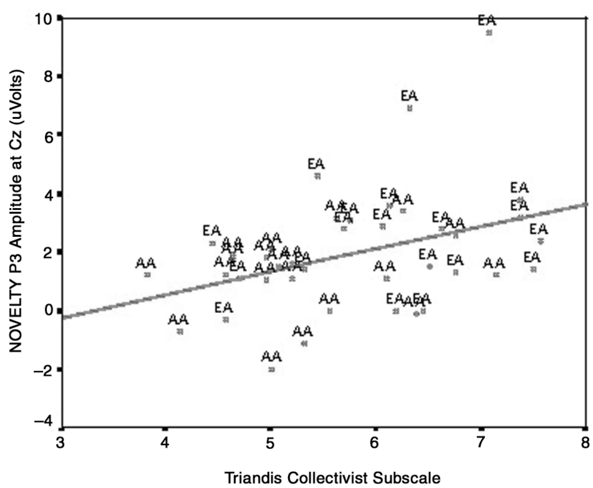

Figure 4 Scatterplot of the relationship between interdependent self-construal, as measured by the Triandis Collectivism subscale and the novelty P3 amplitude (difference between novelty and standard conditions at electrode Cz electrode).
NOTE: EA = European American; subject AA = Asian American subject. The scatterplot shows that as interdependent self-construal increases, there is an associated increase in the novelty P3 amplitude.

1998; Gutchess et al., 2006; Nisbett et al., 2001; Nisbett & Masuda, 2003), and supported our first hypothesis. The posterior target P3 has been associated with a posterior cortical stimulus classification and template memory system (Daffner et al., 2003; Dien, Spencer, & Donchin, 2003; Soltani & Knight, 2003) and is consistent with the notion that European Americans tend to categorize events to a greater degree than Asians (Fiske et al., 1998; Nisbett et al., 2001; Nisbett & Masuda, 2003). The posterior location of the ERP difference in response to target objects is also consistent with the posterior cortical location of the greater hemodynamic response to focal objects that Gutchess et al. (2006) found in Americans.

Finding that East Asian Americans allocated greater attention to the contextually novel events in the oddball task is consistent with a growing body of literature indicating that East Asians, in contrast with European Americans, are more sensitive to stimulus context (Chua et al., 2005; Fiske et al., 1998; Kim & Markus, 1999; Kitayama et al., 2003; Nisbett et al., 2001; Nisbett & Masuda, 2003), and supported our second hypothesis. In the culture and cognition literature, increased attention to context generally refers to East Asians' focus on background stimuli when viewing complex pictures. In the present experiment, East Asian Americans' increased P3 amplitudes to perceptually discrepant nontargets extends the concept of context to include events that are deviations from stimulus context defined across time by the standard and the target. We have found that East Asian Americans respond more strongly to stimuli that are "out of context," and this seems to be related to interdependent self-construal. Although Gutchess et al. (2006) did not find evidence that East Asians showed an increase in neural activation when viewing background images in comparison to European Americans, our findings should not necessarily be interpreted as inconsistent with their findings. It should be noted that Gutchess et al. did report that East Asians showed greater activation than the European Americans in the left occipital fusiform gyrus during presentation of background images. However, the activation did not reach their voxel cluster threshold for statistical significance. There are also significant differences in methodology between the two studies that may explain apparent discrepancies, including definition of context, the neural activity being measured (i.e., slow hemodynamic response vs. fast electrical response), and the nationality of the Asian participants.

The anterior novelty P3 ERP has been associated with a distributed executive attentional network (Daffner et al., 2003; Friedman et al., 2001; Herrmann & Knight, 2001; Ranganath & Rainer, 2003) involving the frontal lobe and anterior cingulate gyrus (Clark, Fannon, Lai, Benson, & Bauer, 2000; Dien et al., 2003; Opitz, Mecklinger, Friederici, & von Cramon, 1999) and has been associated with working memory (Friedman et al., 2001). This suggests that East Asian Americans are utilizing an anterior executive attentional system to process perceptually discrepant events to a greater degree than are European Americans.

Additionally, we found that the greater allocation of attention to contextually novel events by Asian Americans, as measured by the novelty P3, was associated with their greater degree of interdependent self-construal. This is supported by the greater interdependent self-construal scores by the Asian Americans in our study and is consistent with Nisbett and Masuda's (2003) emphasis on the importance of attending to context in Asian culture. In addition, a linear relationship was also found across all subjects between novelty P3 amplitude and degree of interdependent self-construal. This suggests that how one sees oneself with respect to others, independently of their cultural group, is related to allocation of attention to perceptually discrepant events. Furthermore, a mediational analysis indicated that the relationship between culture and novelty P3 was mediated by interdependent self-construal. This suggests a mechanism by which neural components of attention to stimulus context are associated with culture. In other words, culture influences interdependent self-construal, which influences attention to stimulus context, as measured by the novelty P3. This relationship, while promising, should be replicated through additional research.

In contrast to the novelty P3 findings, we did not find evidence that the difference in target P3 amplitudes between the European and East Asian Americans was related to self-construal. One factor that may have obscured finding a relationship between self-construal and the target P3 magnitude was a limited range of independent self-construal scores. The European Americans did not score higher on the independence subscale than the East Asian Americans in this sample. Future studies might reinvestigate the relationship between independent self-construal and target P3 amplitudes using samples with a wider range of independent self-construal. It is also possible that factors other than self-construal may account for the difference in processing targets between European and Asian Americans.

Using ERPs, we have measured differences in brain activity between East Asian Americans and European Americans at a specific stage of cognitive processing. Specifically, we found differences in processing information between European and Asian Americans that occurred around 400 ms after the onset of the stimulus. The timing of these differences in processing information is consistent with processing of information by relatively late attentional systems (Herrmann & Knight, 2001). This is consistent with anterior executive attention in the case of processing the contextually novel events and posterior stimulus classification in the case of processing the target events. This suggests that the greater contextual dependence found in some cultures (e.g., Chua et al., 2005; Fiske et al., 1998; Leung & Bond, 1984; Matsumoto, 1989; Nisbett et al., 2001) may be driven by differences in higher order executive attention. Identifying specific temporal differences in brain activity across cultures should contribute additional insight into the *process* of cross-cultural differences in cognition and behavior.

Although the present study was able to temporally localize the cultural effects as occurring several hundred milliseconds after the onset of the stimulus, we did not investigate other time frames of cognition. For example, future research should explore how early culturally related differences occur, since it has been hypothesized that culture may affect "low-level" perceptual encoding (see Gutchess et al., 2006).

In the current experiment, contextually novel stimuli differed from the standard and target in a number of ways including expectation, category type, and number of characters. Previous research has indicated that many stimulus factors may contribute to the novelty P3 response including unusualness (Daffner et al., 2000), familiarity (Cycowicz & Friedman, 1998), relative brightness (Courchesne et al., 1978), relative size (Polich & Comerchero, 2003), change in category type (Courchesne et al., 1978; Polich & Comerchero, 2003), and perceptual similarity of the standard and target (Katayama & Polich, 1998; Polich & Comerchero, 2003). Based on the literature, the more perceptually discrepant the event is from those expected, the greater the novelty P3. These findings are consistent with the notion that the novelty P3 represents part of a relatively automatic orienting system that draws one's attention to events that deviate from expectations independent of sensory modality, and perhaps independent of the particular dimension that defines expectation and deviations of events (Friedman et al., 2001). Future research may want to address to which aspects of deviation from expectation East Asians are most sensitive.

Some studies have found that extraversion was inversely related to the target P3 amplitude (Brocke, Tasche, & Beauducel, 1996; Daruna, Karrer, & Rosen, 1985; Wilson & Languis, 1990), raising the possibility that this specific personality characteristic might account for the present findings. Indeed, some studies have found cultural differences in extraversion (see, e.g., Lucas, Diener, Grob, Suh, & Shao, 2000). However, the extraversion-target P3 relationship has been brought into question due to the inconsistencies in the findings between extraversion/introversion and the target P3 (see Cahill & Polich, 1992; Ditraglia & Polich, 1991; Pritchard, 1989) and the failure to find a correlational relationship between extraversion and the target P3 (see Polich & Martin, 1992; Stelmack & Houlihan, 1995). Perhaps most important, since the European Americans were found to exhibit higher target P3 amplitudes than the East Asian Americans, we would have to hypothesize that the European Americans were *more* introverted than the Asian Americans. To the contrary, some research has found Asian Americans to be more introverted on personality tests (e.g., Lucas et al., 2000).

Personality is a function of genetic and sociocultural factors (see, e.g., Brody & Crowley, 1995; Triandis & Suh, 2002), so the role of each warrants further investigation. Our findings suggest that the differences between East Asian Americans and European Americans in attention to contextually novel stimuli may be due to differences in interdependent self-construal. This suggestion seems reasonable given its consistency with the extant theoretical and empirical literatures. Future studies should investigate whether other personality traits or cultural constructs account for the differences in target and novelty P3 amplitudes among European Americans and East Asian Americans.

Although ERP measures provide good temporal resolution, they provide limited spatial information about brain generators of activity. The East Asian Americans' contextually novel effect was more pronounced at the frontocentral scalp sites, whereas the target object effect was more pronounced at posterior scalp site. Being able to verify the anterior effect for the novelty P3 and the posterior effect for the target P3 is essential for interpreting the functional significance of these findings. However, it would be highly desirable to obtain more precise anatomical localization of the brain generators of the effects observed in the present study. Therefore, future studies should use other neuroimaging methods, for example fMRI, in order to better localize the activity that differentiates cultural aspects of cognition.

Furthermore, the present study demonstrates differences in neural processing of information between individuals of European and East Asian descent in America. Other studies looking at culture and cognition have used similar samples (e.g., Kim, 2002). However, it is important to replicate these effects using samples of European Americans and East Asians to obtain a wider range of independent self-construal scores. Extending the range of independent self-construal may also illuminate the potential influence of independent self-construal on attention to target objects. These findings should also be extended to other cross-national studies of culture. Understanding the process by which East Asian–descent Americans learn cognitive styles like East Asians despite living in a North American context is in itself important to understand. Others have speculated that individuals are socialized for attention-based strategies (Kitayama & Duffy, 2004; Nisbett et al., 2001). Based on our mediational analyses, we speculate that through the socializion of interdependence, particular ways of thinking are adopted. Interdependence can exist within a larger culture that values collectivism (e.g., Oyserman et al., 2002).

The current study extends our understanding of culture and cognition by identifying a specific stage of neurocognitive activity related to the increased processing of stimulus context by East Asian Americans and increased processing of target objects by European Americans. Furthermore, interdependent self-construal was found to mediate the relationship between culture and the novelty P3, suggesting a specific mechanism by which culture influences attention to the environment. These neurocognitive processes may underlie the more global findings of social and cognitive differences between European and East Asian cultures (Nisbett et al., 2001; Nisbett & Masuda, 2003). To be certain, understanding the neural mechanisms by which culture, emotion, cognition, and behavior are interrelated promises to provide fresh insights into the nature of these phenomena.

NOTE

1. The Triandis scale was chosen over Singelis's (1994) Self-Construal Scale because it permitted more flexibility in terms of horizontal and vertical aspects of collectivism (not discussed in this article). Interdependent and independent self-construal are conceptualized as individual-level variables, and individualism and collectivism as corresponding cultural-level variables. Nonetheless, many of the items across the two scales share strong face validity (e.g., six items use exact same wording and three are substantially similar in wording). Across studies in our lab, the two scales have been highly correlated.

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