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CULTURAL DIFFERENCES IN COGNITION: ROSETTA PHASE I[1, 2]

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Summary.—Cultural differences in cognition are important during multinational commercial, military, and humanitarian operations. The Rosetta Project addresses definition and measurement of key cognitive dimensions. Six potential diagnostic measures related to Analytic–Holistic reasoning were assessed: the Exclusion Task, the Attribution Complexity Scale, the Syllogism Task, Categorization, the Framed Line Test, and the Facial Expression Task. 379 participants' ages ranged from 17 to 24 years (M=19.8, SD=1.4). 64.6% were women; Eastern Asian groups (Japan, Korea, and Taiwan) were assumed to have Holistic reasoning tendencies, and those from a Western group (USA) were assumed to have Analytic tendencies. Participants were recruited from subject pools in psychology using the procedures of each university. Results on the Exclusion and Categorization Tasks confirmed hypothesized differences in Analytic–Holistic reasoning. The Attribution Complexity Scale and the Facial Expression Task identified important differences among the four groups. Outcomes on the final two tasks were confounded by unrelated group differences, making comparisons difficult. Building on this exploratory study, Rosetta Phase II will include additional groups and cognitive tasks. Measures of complex cognition are also incorporated to link findings to the naturalistic contexts.

When commercial, military, and humanitarian activities cross national borders, cultural differences in cognition can alter teamwork, technology transfer, negotiations, and performance (Klein, 2004). Describing these cognitive differences and understanding their roles in international exchanges would allow better target training, support task performance, and design operations for multinational teams and contexts. While cultural differences in cognition complicate naturalistic activities, there is no clear consensus about which differences are critical and the tools which can measure them. There are few systematic data on the relations among the cognitive processes and their role in naturalistic problem identifica-

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tion, sensemaking, decision making, and planning activities. There is even less information available on cultural differences in these critical processes.

Cross-cultural research has potential for describing international interactions, identifying cognitive differences which influence complex naturalistic situations, and suggesting strategies for accommodating these differences. The goal is to understand how various national and regional groups engage in complex cognition needed for problem identification, sensemaking, decision making, and other critical activities. Two directions are important for meeting this goal. First, most cross-cultural research explores differences for Eastern Asian and Western groups. Most research compares one Eastern Asian group with one Western group. While this is a good start, the former may display cognitive variation even when they are from the same geographic region. The present research included three Eastern Asian groups and one Western group for simultaneous comparison. Second, past research used tools which independently measure component processes of Analytic–Holistic reasoning: attention, causal attribution, tolerance for contradiction, and perception of change. The present research included several of these perceptual and verbal measures to allow simultaneous and integrated comparisons.

The Rosetta Project is a research program for addressing cultural differences in cognition. It is an ongoing effort seeking reliable, valid, and easy-to-use measures for cognitive differences found in applied settings and during international interactions. The present report summarizes the results of the initial phase of this project (see Klein, Lin, Radford, Masuda, Choi, Lien, *et al*., 2006, for the full report). It focuses on performance differences in samples from Japan, Korea, and Taiwan, three Eastern Asian groups, reported to be predominately Holistic in reasoning tendencies, and the USA, a Western sample, reported to be predominately Analytic (Nisbett, 2003). While these are general tendencies, there are individual variations within groups.

Analytic and holistic differences can be understood from two perspectives. First, the Ecocultural Model provided a framework for understanding how different ecological constraints relate to perceptual and cognitive differences (Berry, 1976). For example, groups who engaged in hunting and gathering were more likely to exhibit field independent perception while those engaged in farming were more likely to exhibit field dependent perception (Berry, 1986). Second, Analytic and Holistic cognitive differences are consistent with two ancient philosophic traditions, Greek Aristotelian philosophy and Chinese Confucian philosophy, respectively (Nisbett, Peng, Choi, & Norenzayan, 2001; Nisbett, 2003). Each sociopolitical system emerged from and facilitated different cognition.

This research borrowed from recent studies of Holistic-Analytic reasoning. Nisbett's paradigm-shaping book (2003) described Analytic and Holistic differences in attention (i.e., Masuda & Nisbett, 2001), causal attribution (Choi, Dalal, Kim-Prieto, & Park, 2003), categorization (Norenzayan, Smith, Kim, & Nisbett, 2002), tolerance for contradiction (Peng & Nisbett, 1999), and perception of change (Ji, Nisbett, & Su, 2001). These studies suggest that Holistic reasoning is sensitive to background information while Analytic reasoning focuses on target information. If team members focus on different information and attribute causality differently, they may identify and attempt to solve different problems. Differences in Tolerance for Contradiction and Perception of Change suggest different explanations and lead to different plans.

Given the potential importance of Analytic–Holistic differences in naturalistic settings, three verbal measures were included, the Exclusion Task (Choi, *et al*., 2003), the Attribution Complexity Scale (Fletcher, Danilovics, Fernandez, Peterson, & Reeder, 1986), and the Syllogism Task (Norenzayan, *et al*., 2002). Three visual tasks which measure cognition were also included, the Categorization Task (Norenzayan, *et al*., 2002), the Framed Lined Test (Kitayama, Duffy, Kawamura, & Larsen, 2003), and the Facial Expression Task (Masuda, Ellsworth, Mesquita, Leu, Tanida, & Van de Veerdonk, 2008). The visual tasks, low in language requirement, are potentially useful for people with less literacy. They also can be used without translation. While these measures appear in the research literature, they have not been compared with each other and across Eastern Asian groups. The six measures of Analytic–Holistic Reasoning together with the expectation for analytic–holistic performance differences between national groups are outlined briefly below.

The Exclusion Task (Choi, *et al*., 2003) presents a brief mystery scenario along with a list of potential causal factors. The goal is to assess the amount of information excluded when attributing cause. Each of the Eastern Asian groups was hypothesized to have fewer pieces of information excluded as irrelevant than would the USA group. This is consistent with their tendency toward a broader, less focused view.

The Attribution Complexity Scale (ACS; Fletcher, *et al*., 1986) measures cognitive complexity. Participants rate their agreement with statements about attribution. Based on Nisbett's theoretical framework (2003), each of the Eastern Asian groups was hypothesized to have a higher mean score on the Attribution Complexity Scale than would the USA group. This is because Holistic thinkers look for interconnectedness, while Analytic thinkers focus on salient elements reflecting lower complexity.

The Syllogism Task (Norenzayan, *et al*., 2002) measures the interaction of logic and believability. Analytic–Holistic reasoning influences how individuals weigh logical structure versus empirical plausibility in evalu-

ating the truth of syllogisms (Norenzayan, *et al*., 2002). Analytic reasoning favors formal logic over plausibility because it allows "decontextualizing," i.e., ignoring content and responding to logical structure alone. Holistic reasoning is more swayed by plausible arguments, a more intuitive approach to making decisions. It was hypothesized that plausible arguments would be more convincing among participants from groups tending to use Holistic reasoning than those from groups reported to be more Analytic.

The Categorization Task (Norenzayan, *et al*., 2002) assesses analytic or rule-based versus holistic or resemblance strategies for categorization of visual stimuli. Participants are asked to judge "belongs to" to tap an analytic strategy or to judge "similarity" to tap their use of a holistic strategy. Consistent with earlier research, it was hypothesized that participants from the three Eastern Asian groups would show more resemblance judgments and U.S. participants more rule-based judgment in the "similarity" condition. It was expected there would be comparable performance in the "belongs to" condition (Kemler-Nelson, 1984; Norenzayan, *et al*., 2002).

The Framed Line Test measures the influence of background information on the reproduction of a line length (Kitayama, *et al*., 2003). Kitayama and colleagues (2003) reported that Analytic thinkers, more focused on target information, were better able to reproduce the absolute length than were Holistic thinkers. In contrast, Holistic thinkers, more sensitive to background information, were more accurate in relative judgments. These same relationships were hypothesized.

The Facial Expression Task (Masuda, *et al*., 2008) assesses the inclusion of background information in a social context. The affect of a cartoon figure is judged in the context of peripheral figures with the same or different affect. This task measures the effect of peripheral faces on the judgment of the central figure's affect. Consistent with Masuda and colleagues (2008), it was hypothesized that participants from the three Eastern Asian groups would be more sensitive to the affect of the peripheral faces, reflecting more Holistic reasoning. The more analytic USA participants were hypothesized to incorporate less contextual information in their judgment of the central figure.

In summary, the six measures were hypothesized to show responses more consistent with holistic tendencies for each of the three Eastern Asian groups than for the Western group.

Method

Settings and Participants

This study included three Eastern Asian groups, reported to be predominately holistic in response tendencies, and one Western group, re-

ported to be predominantly analytic in response tendencies. Past research has compared each of these Eastern Asian groups with a USA group independently. These three were included simultaneously to explore possible differences among groups. Participants were undergraduates, ages 17 to 24 years ($M = 19.8$, $SD = 1.4$), from Hokkaido University, Japan; Seoul National University, Korea; National Taiwan University, Taiwan; or Wright State University, USA. Each was enrolled in an introductory course in psychology. Those who reported that they or their parents had been born in a foreign country or that they had lived outside their country of birth for over 1 yr. were excluded. Recruiting followed the practices of the individual universities, with some participants receiving course credit and others receiving a small payment. Each of two sessions lasted less than 1 hr. In the first session, the verbal tasks were administered to groups; in the second session, the visual tasks were administered individually.

Measures

The order of the six measures, validated in earlier studies, was counterbalanced within each of the two sessions. The verbal measures, paper-and-pencil tasks, were prepared using standard back-translation procedures as needed (Brislin, 1980). The nonverbal measures asked participants to draw inferences from visual displays. Starting with English-language research material, bilingual Chinese, Japanese, and Korean speakers first translated the material from English to Chinese, Japanese, or Korean, respectively. For each language, the different bilingual speakers then translated the material back into English. The back translations were then compared with the original English material for discrepancies. Institutional Review Boards at each participating university approved the research protocol.

In the Exclusion Task (Choi, *et al*., 2003), the first scenario was presented to participants: "Suppose that you are the police officer in charge of a case involving a graduate student who murdered a professor (the dead professor was the graduate student's advisor). Why would the graduate student possibly murder an advisor? As a police officer, you must establish the motive." Participants were then asked to evaluate 97 statements and mark those they judged to be irrelevant for specifying a motive. Items included, "Whether the professor liked to attend parties," "Whether the professor behaved unreasonably toward the graduate student," and "The graduate student's history of mental disorders." A marked statement indicated exclusion of the statement. Fewer statements excluded as irrelevant indicated a higher holistic tendency (Choi, *et al*., 2003). Possible scores range from 0 to 97.

In the Attribution Complexity Scale (Fletcher, *et al*., 1986), participants rated 28 statements, representing seven constructs of attribution, on

a 7-point scale using anchors of 1: Strongly disagree and 7: Strongly agree. Half of the items were reverse scored. Higher ratings indicated more complex attribution. Examples for the construct were Level of Interest or Motivation (MOT), "I really enjoy analyzing the reasons or causes for people's behavior," Preference for Complex Explanation (PCE), "I have found that the causes for people's behavior are usually complex rather than simple," Presence of Metacognition Concerning Explanation (MET), "I believe it is important to analyze and understand our own thinking processes," Behavior as a Function of Interaction (BFI), "I think a lot about the influence I have on other people's behavior," Complex Internal Explanation (CIE), "I tend to take people's behavior at face value and not worry about the inner causes for their behavior (e.g., attitudes, beliefs, etc.)," Complex Contemporary External Explanation (CCE), "I think a lot about the influence that society has on other people," and Tendency to Infer External Causes Operating from the Past (TEM), "I have often found that the basic cause for a person's behavior is located far back in time." Scores can range from 28 to 196.

Fletcher and colleagues (1986) reported an internal reliability coefficient of .85 and a test-retest correlation measured over 18 days of .80. In the present study, the reliability coefficient was .86 for the overall sample. All four samples had high reliability coefficients (α), Japan (.88), Korea (.84), Taiwan (.86), and the USA (.89), indicating internal consistency of the Attribution Complexity Scale. Scores for each construct reflect its complexity; the composite score reflects overall complexity.

In the Syllogism Task (Norenzayan, *et al*., 2002), there were 16 syllogisms with orthogonal variations for both the logical structure of deductive arguments and the empirical plausibility of conclusions. For example, a nonvalid–believable syllogism was Premise 1: If someone is a leader of a country, he is permitted to visit the Royal Family in England. Premise 2: The President of Nigeria is not permitted to visit the Royal Family in England. Conclusion: The President of Nigeria is a leader of a country.

In addition, abstract syllogisms and ratings of the empirical plausibility of conclusions were included as controls. The task booklet first presented 16 meaningful syllogisms and then the eight abstract syllogisms. Participants read the premises and the conclusions and circled "yes" or "no" to indicate whether the conclusions following the premises were logical. Finally, the conclusions for each of the 16 meaningful syllogisms were rated for their empirical plausibility. Ratings were from –3 (Definitely false) to +3 (Definitely true).

For each of the four conditions of meaningful syllogisms, 2 (Valid, Invalid) × 2 (Believable, Nonbelievable), the percent of "yes" responses for the four exemplars was the response measure. Scores could range from 0 to 16. For the eight abstract syllogisms, the "yes" responses to logical syl-

logisms were scored as hit rate and "yes" responses to the nonlogical syllogism were scored as false alarm rate. An accuracy score was obtained using these hit rates and false alarm rates. This score taps logical thinking of a participant. Scores can range from 0 to 8. Mean ratings for the plausibility of conclusions were calculated. Scores could range from –3 to +3.

In the Categorization Task (Norenzayan, *et al*., 2002), participants reviewed 20 stimuli each displaying a target drawing and two arrays of four drawings each (see Fig. 1). Each of the drawings had four binary features. In Fig. 1, these were leaf, petals, stem, and inner circle. The four drawings in one of the arrays were rule-based: one binary feature appeared in all four drawings, i.e., all straight stems. This feature also appeared in the target object. The four drawings of the other array showed family resemblance or similarity with target object: each of the four drawings shared three of the four binary features but had one dissimilar feature. The target array also shared three features. Half of the participants were asked to indicate the array that was "similar" to the target object, the holistic solution, while the other half were asked to report the array that the target drawing "belonged to," a rule-based solution (Norenzayan, *et al*., 2002). The number of similarity and rule-based categorizations was summed for each participant and time to completion was noted. Scores can range from 0 to 20 for each type of response.

In the Framed Line Test (Kitayama, *et al*., 2003), this paper-and-pencil task permitted recording of absolute and relative judgments. Participants viewed a sequence of five square frames of varying size. Each had vertical lines, varying in length, extending down from the top of the frame. For

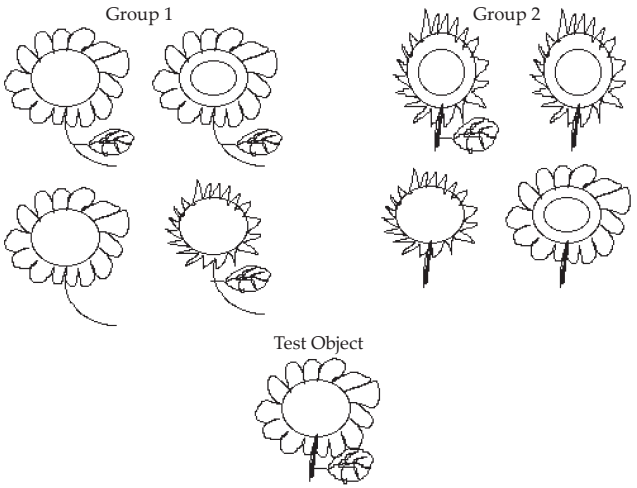

Fig. 1. Categorization Task

each frame, participants were asked to remember and reproduce the vertical line in a second frame. In the absolute condition, participants were asked to draw a line that was the same length as the original line. In the relative condition, the line was to be in the same proportion or ratio to the second frame as the first line was to the first frame. The absolute difference between the length drawn and the correct length was the dependent measure. The same test material was used for the absolute and the relative tasks. All participants completed both absolute and relative tasks. Half completed the absolute condition first and the other half the relative condition first.

In the Facial Expressions Task (Masuda, *et al*., 2008), each of 18 stimuli presented a cartoon central figure and four cartoon background figures (see Fig. 2). Each central figure had either a happy, neutral, or sad facial expression and was either the same (happy, neutral, or sad) or different from its surrounding background figures. Six stimuli had consistent central and background figures, i.e., happy and happy, while 12 stimuli had differing central and background figures, i.e., sad and neutral. Participants rated the central figure's facial expression on two 10-point scales from 0 to 9, one for Happiness/Joy and one for Sadness. Scores could range from 0 to 9.

A "Shakiness" score was computed to tap the influence of side figures' emotion on the target figure. This measure quantified the overall effect of the side figures' emotions (Happy, Neutral, and Sad) on the judgment of each of the central figures (Happy, Neutral, or Sad) for the Happiness and the Sadness scales. For example, the Shakiness score for the Happiness Scale when the central face was Happy (HH) is the sum of squared deviation of the central face judgment with each of the three side figure emotions: $VARHH = HH^2 + HN^2 + HS^2$. Here, HH = mean judgments for Happy Central–judgment for Happy Central with Happy side figures, HN = mean judgments for Happy Central–judgment for Happy Central with Neutral side figures, and HD = mean judgments for Happy Central–judgment for Happy Central with Sad side figures. The higher the VARHH score, the more judgment was affected by the side figure emotions.

Demographic questionnaire.—The questionnaire queried age, sex, academic major, years in school, primary language, language spoken with parents, country of birth, parents' birthplace, and parents' education. The responses allowed exclusion of those who did not meet the selection criterion, the identification of sample differences, and the evaluation of demographic correlates of performance.

Participants were from Japan ($n = 94$), Korea ($n = 92$), Taiwan ($n = 99$), and the USA ($n = 94$). Mean ages differed significantly ($F_{3,375} = 48.61$, $p < .001$; see Table 1 for mean ages of samples). The Taiwan sample included more advanced students. Men comprised 60.6, 42.4, 22.2, and 21.3% of the samples, respectively, a significant difference ($\chi^2_3 = 43.16$, $p < .001$). Parents' ed-

FIG. 2. Facial Expression Task

ucation, academic majors, and years in school differed, with mothers in Korea and fathers in the USA having had less time in college than other groups. There were more Korean science majors and fewer Japanese science majors than in other samples.

RESULTS

The Exclusion Task

The mean information exclusion rates for the Japanese, Korean, Taiwanese, and USA samples were significantly different ($F_{3,375} = 11.56$, $p < .001$; see Table 1 for task descriptive). The USA sample excluded more items than Japanese ($t_{186} = 3.74$, $p < .001$), Korean ($t_{184} = 5.44$, $p < .001$), and Taiwanese samples ($t_{191} = 4.89$, $p < .001$). The lower exclusion rates for the Eastern Asian samples compared to the USA sample are consistent with Choi and colleagues (2003) and with the research hypothesis.

Attribution Complexity Scale

The mean composite scores for Japan, Korea, Taiwan, and the USA were not significantly different (see Table 1 for task descriptions). Six of the seven subscales showed significant group differences: Level of Interest or Motivation ($F_{3,375} = 5.23$, $p < .01$); Preference for Complex Explanation ($F_{3,375} = 8.03$, $p < .001$); Presence of Metacognition Concerning Explanation ($F_{3,375} = 4.85$, $p < .01$); Behavior as a Function of Interaction ($F_{3,375} = 5.16$, $p < .01$); Complex Internal Explanation ($F_{3,375} = 10.17$, $p < .001$); and Tendency to Infer External Causes Operating from the Past ($F_{3,375} = 4.44$, $p < .01$). The Korea group scored lower than the USA sample ($M_{diff} = -1.8$, $p < .05$) and the Taiwan sample ($M_{diff} = -2.2$, $p < .01$) on Level of Interest or Motivation. The Taiwan group scored lower than the USA sample ($M_{diff} = -1.9$, $p < .01$) and the Korean sample ($M_{diff} = -2.6$, $p < .001$) on Preference for Complex Explanation. The Japanese sample scored lower than the USA sam-

TABLE 1
MEANS AND STANDARD DEVIATIONS OF SAMPLES ON AGE AND TASK

	Japan $n=94$		Korea $n=92$		Taiwan $n=99$		USA $n=94$	
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Age, yr.	19.5	1.0	21.0	1.4	19.8	1.3	18.9	1.1
The Exclusion Task	42.3	16.6	39.0	14.6	40.2	15.4	51.1	15.6
Attribution Complexity Scale								
Overall	141.1	19.6	144.5	15.3	144.0	17.1	144.5	20.0
Level of Interest or Motivation	20.3	4.0	18.8	4.4	21.0	3.8	20.6	4.4
Pref. for Complex Explanation	18.4	3.7	19.8	3.6	17.2	4.3	19.1	3.8
Presence of Metacognition Concerning Explanation	19.6	4.4	21.1	3.4	21.0	3.4	21.6	3.4
Behavior as a Function of Interaction	21.3	3.5	20.9	2.3	22.6	2.8	21.5	4.2
Complex Internal Explanation	22.4	2.9	22.4	2.8	20.9	3.1	20.5	3.3
Complex Contemporary External Explanation	19.7	3.9	20.4	3.4	20.5	3.4	21.1	3.6
Tendency to Infer External Causes Operating from the Past	19.5	4.0	21.3	3.3	20.7	3.6	20.1	3.8
Syllogism Task								
Valid Believable	91.8	12.9	84.0	18.4	94.4	12.7	93.1	14.4
Nonbelievable	88.6	23.7	82.1	19.7	77.8	26.6	66.5	35.1
Invalid Believable	20.5	19.0	13.3	15.5	17.9	18.3	46.3	22.9
Nonbelievable	7.7	12.7	7.9	15.2	2.3	8.1	26.9	19.8
Accuracy	59.7	13.6	54.3	12.4	58.5	13.8	61.2	17.1
Categorization Task								
"Similar" responses	10.2	4.8	10.7	4.6	12.0	2.8	11.5	3.5
Completion time, sec.	171.5	51.2	176.7	65.6	184.2	80.3	229.1	64.5
Framed Line Test, mm								
Relative Condition	25.7	18.6	21.2	9.5	25.1	10.7	38.7	27.2
Absolute Condition	39.7	21.4	38.7	16.4	37.7	17.9	60.3	37.2

ple ($M_{diff}=-1.9$, $p<.01$) and the Korean sample ($M_{diff}=-1.5$, $p<.05$) on Presence of Metacognition Concerning Explanation. The Taiwanese group scored higher than the Japanese ($M_{diff}=1.3$, $p<.05$) and the Korean samples ($M_{diff}=1.8$, $p<.01$) on Behavior as a Function of Interaction. The USA sample scored lower than the Japanese ($M_{diff}=-1.9$, $p<.001$) and Korean samples ($M_{diff}=-2.0$, $p<.001$) on Complex Internal Explanation. The Korean sample scored higher than the Japanese ($M_{diff}=1.9$, $p<.01$) on Tendency to Infer External Causes Operating from the Past. Sample differences call for more detailed study of these attribution subscales.

Syllogism Task

Based on differences in Analytic–Holistic reasoning, it was hypothesized that Eastern Asians, relative to the USA sample, would be more susceptible to belief bias; they would be more likely to evaluate arguments as valid when the conclusion was believable and less likely to do so when the conclusion was not believable (see Table 1 for task description). A complex

analysis of variance was performed, but the three-way interaction was the main interest for understanding susceptibility-to-belief bias. There was a significant three-way interaction among sample, validity of argument in conclusions, and believability, ($F_{3,374} = 5.35$, $p < .001$), with the USA sample showing larger differences between valid-believable and valid-nonbelievable syllogisms, as well as between invalid-believable and invalid-nonbelievable items. The direction of this effect, however, refutes rather than supports the expectation of greater belief bias in Eastern Asians.

To assess possible reasons for this, response accuracy was used for the abstract syllogisms described earlier to gauge participants' attending to logic in the absence of competing factual information (see Table 1 for mean accuracy scores of samples). These differences in accuracy are significant ($F_{3,375} = 3.88$, $p < .01$). *Post hoc* analysis showed that the Japanese, Korean, and Taiwanese samples were more accurate than the USA sample ($t_{186} = 7.06$, $p < .001$; $t_{177.90} = 9.99$, $p < .001$; and $t_{191} = 6.96$, $p < .001$, respectively, when equal variance was not assumed between the Korean and USA samples). The Korean sample was also more accurate than the Japanese and Taiwanese samples ($t_{186} = 2.80$, $p < .01$ and $t_{184.02} = 2.34$, $p < .05$, respectively, when equal variance was not assumed between the Korean and Taiwanese samples). The samples differ in accuracy thereby complicating interpretations of the concrete arguments.

Categorization Task

The Similar condition included 45, 44, 50, and 46 participants from Japan, Korea, Taiwan, and the USA, respectively. The average number of holistic responses over all samples was 11.1 ($SD = 4.0$). The mean completion time was 190.5 sec. ($SD = 69.9$; see Table 1 for task description). While Similarity-based judgments did not different across samples ($F_{3,181} = 2.01$, $p > .05$), completion time did differ ($F_{3,181} = 7.14$, $p < .001$). USA participants took longer than the Japanese, Korean, and Taiwanese groups ($t_{89} = 4.71$, $p < .001$; $t_{89} = 3.57$, $p < .01$; $t_{94} = 3.00$, $p < .01$, respectively). USA participants could make similarity-based judgments but took longer to do so, supporting the hypothesized differences. Consistent with previous findings, no differences were found for the Rule-based condition's analytic responses and time of completion across samples (Norenzayan, *et al*., 2002).

Framed Line Test

Performance on absolute and relative conditions was compared for the samples. In the relative condition, the mean total errors were significantly different, ($F_{3,375} = 16.92$, $p < .001$; see Table 1 for task description). The USA sample was significantly less accurate than the Japanese ($t_{164.16} = -3.80$, $p < .001$), Korean ($t_{115.51} = -5.88$, $p < .001$), and Taiwanese ($t_{119.56} = -4.52$, $p < .001$) samples (when equal variance was not assumed). In the absolute condition, the mean total errors were significantly different ($F_{3,375} = 18.26$,

$p < .001$; see Table 1 for task description). The USA mean was significantly less accurate than the Japanese ($t_{148.45} = -4.65$, $p < .001$), Korean ($t_{128.29} = -5.15$, $p < .001$), and Taiwanese ($t_{132.27} = -5.32$, $p < .001$) values (when equal variance was not assumed). The three Eastern Asian samples were not significantly different from each other in either condition. For both Relative and Absolute judgment conditions, the three Eastern Asian groups were superior in performance to the USA sample. While this was expected in the Relative judgment condition, it is contrary to past findings for the Absolute judgment condition (Kitayama, *et al*., 2003).

Facial Expression

In a 4 (Sample: Japan, Korea, Taiwan, USA) × 3 (Central Figure Affect: Happy, Neutral, Sad) × 3 (Background Figure Affect: Happy, Neutral, Sad) analysis of variance of Happiness Judgments, the three-way interaction was significant ($F_{12,1496} = 2.82$, $p < .01$; see Table 2 for task description). This

TABLE 2

Means and Standard Deviations of the Facial Expression Task

Measure	Japan $n = 94$		Korea $n = 92$		Taiwan $n = 99$		USA $n = 94$	
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Happiness Judgment								
CF: Happy BG: Happy	7.0	1.2	6.4	1.2	6.0	1.2	7.1	1.3
CF: Happy BG: Sad	6.9	1.5	6.4	1.4	6.0	1.7	7.5	1.2
CF: Happy BG: Neutral	6.8	1.2	6.6	1.1	6.1	1.4	7.3	1.3
CF: Sad BG: Happy	0.7	1.3	1.4	1.3	0.7	1.1	0.6	1.2
CF: Sad BG: Sad	0.3	0.5	1.1	1.3	0.4	0.6	0.4	0.6
CF: Sad BG: Neutral	0.6	0.9	1.2	1.1	0.6	0.8	0.7	1.0
CF: Neutral BG: Happy	3.2	1.9	3.6	1.6	2.8	1.6	3.4	1.5
CF: Neutral BG: Sad	1.9	1.6	3.1	1.6	2.4	1.6	3.1	1.6
CF: Neutral BG: Neutral	2.3	1.7	3.2	1.5	2.6	1.6	2.9	1.6
Sadness Judgment								
CF: Happy BG: Happy	0.8	1.0	1.9	1.3	0.8	0.9	0.8	1.0
CF: Happy BG: Sad	1.3	1.5	2.3	1.5	1.2	1.4	1.0	1.6
CF: Happy BG: Neutral	1.1	1.1	2.0	1.4	1.1	1.1	1.1	1.4
CF: Sad BG: Happy	7.0	1.7	7.1	1.2	5.9	1.7	7.7	1.5
CF: Sad BG: Sad	7.5	1.5	7.4	1.1	6.4	1.4	7.9	1.0
CF: Sad BG: Neutral	6.9	1.3	7.3	1.1	6.3	1.5	7.7	1.4
CF: Neutral BG: Happy	2.1	1.6	3.3	1.6	2.7	1.6	4.5	1.5
CF: Neutral BG: Sad	3.0	2.1	3.7	1.8	3.1	2.1	4.7	1.7
CF: Neutral BG: Neutral	2.0	1.6	3.2	1.7	2.4	1.7	4.7	1.7
"Shakiness" Score								
VARHH	1.7	2.2	1.3	2.8	1.6	3.1	1.3	2.4
VARHN	3.0	4.3	1.7	3.1	1.4	2.7	1.2	1.8
VARHS	1.4	5.1	1.0	1.9	0.8	2.2	1.0	3.6
VARSH	1.7	3.3	1.4	2.2	1.6	4.1	1.8	5.9
VARSN	3.0	4.0	1.8	2.2	2.2	4.4	1.7	3.2
VARSS	2.4	4.5	1.1	2.2	1.5	2.4	1.5	4.3

supports the hypothesis that sample differences in Happiness Judgments of the central figure vary as a function of the background facial expressions. Similarly, in a 4 (Sample: Japan, Korea, Taiwan, USA) × 3 (Central Figure Affect: Happy, Neutral, Sad) × 3 (Background Figure Affect: Happy, Neutral, Sad) analysis of variance of Sadness Judgments, the three-way interaction was significant ($F_{12,1496} = 3.04$, $p < .001$). This supports the hypothesis that sample differences for Sadness Judgments of the central figure are dependent on background facial expressions.

To address the hypothesis that the Holistic groups would be more influenced by the side figures' emotion, the "Shakiness" measure was used. One-way analyses of variance showed significant differences on "Shakiness" scores when the Central figure was Neutral for only happiness judgment (VARHN; $F_{3,375} = 6.62$, $p < .001$) and approached significance for the sadness judgment (VARSN; $F_{3,374} = 2.60$, $p > .05$). In both cases, the Japanese sample showed the most "Shakiness" or sensitivity to the background figures. The results partially supported the hypothesis.

Relations Among Measures

The two verbal measures of Analytic–Holistic reasoning were significantly correlated ($r = -.14$, $p < .001$); higher Attribution Complexity scores were related to fewer excluded items on the Exclusion Task (see Table 3). The Facial Expression magnitude scores, representing how perception was affected by background, were negatively related to Exclusion Task performance ($r = -.11$, $p > .05$), supporting the relatedness of these verbal and perceptual measures of Holistic–Analytic reasoning.

TABLE 3
PEARSON CORRELATION MATRIX

	1	2	3
1. Attribution Complexity Scores			
2. Exclusion Task	–.14*		
3. Facial Expression Task	–.08	–.11*	

*$p < .05$.

DISCUSSION

This research brings together several different research measures to assess relationships' potential as diagnostic tools. Outcomes confirm some of the Analytic–Holistic reasoning differences identified in earlier research with Western and Eastern Asian groups (Norenzayan, *et al*., 2002; Choi, *et al*., 2003; Nisbett, 2003). On the Exclusion Task, Eastern Asian participants excluded significantly fewer items than did the Westerners, supporting the hypothesis that their reasoning was more Holistic. While the number of Holistic responses on the Categorization Task did not vary over groups, the Western participants needed a longer time to complete the task than the Eastern Asian participants, providing partial support for the hypothe-

sis. These differences tend to support the prediction that USA participants showed more Analytic reasoning and Japanese, Korean, and Taiwanese participants showed more Holistic reasoning.

The research also suggested important distinctions among the groups. While the Attribution Complexity composite score did not show significant differences among groups, there were significant differences for most of the subscales, suggesting different cultural patterns of complexity. A further examination of these differences may provide important information about distinctions among the four groups. Similarly, the Facial Expression Task did not show Eastern Asian–Western differences as hypothesized but did show significantly more Shakiness for the Japanese participants than for the other Eastern Asian participants. This suggests that the Japanese participants may be particularly sensitive to social context. Taken together, these findings point to the need to measure differences as well as commonalities among Eastern Asian groups.

Further, this study did not find the hypothesized relations for the Syllogism Task. The performance of USA participants on the abstract items was significantly lower than that of each of the Eastern Asian groups. This difference made it difficult to evaluate the hypothesis related to the concrete syllogisms. Similarly, with the Framed Line Test performance, the overall judgment accuracy of USA participants was significantly different, so it was difficult to evaluate the hypothesized differences between absolute and relative judgments. Cross-cultural research is vulnerable to distortions introduced by the selection of participants, the translation of material, and the execution of procedures. While translations and procedures were designed to minimize errors, differences among participants over the data collection sites appear to have introduced errors of measurement.

Finally, this research looked at commonality among measures. Performance on the Attribution Complexity Task and Exclusion Task was related. In the search for simple perceptual measures that might predict verbal indicators of Analytic–Holistic reasoning, the Facial Expression Task predicted Exclusion Task performance. The identification of this relation supports the possibility of perceptual predictors and supports the potential value of these predictors of Analytic–Holistic reasoning.

The goal of this study was to understand how national and regional groups may differ in their cognition. There was support and also some discrepancies from past research. Four directions may be important for research.

First, most cross-cultural research, like the research reported here, explores differences for Eastern Asian and Western groups. While this is a good start, these two regions alone may not capture the cognitive variation noted globally. Theoretical advances in cultural cognition as well as practical needs of commerce, communication, and diplomacy demand

broad regional coverage. Researchers would be wise to include less studied regions such as the Indian subcontinent, the Arab Middle East, South America, and subSaharan Africa. Data from such regions may yield dimensions different from those identified in eastern Asia and the Western region. These regions are also key ones for many practitioners.

Second, the present research has explored differences in the general domain of Analytic–Holistic reasoning. Recent advances have identified component processes of Analytic–Holistic reasoning: attention, causal attribution, tolerance for contradiction, and perception of change (Choi, Koo, & Choi, 2007). These processes influence the information to which people attend, the causes they assign to events, the way they evaluate contradictions, and their expectations about future events. Research could benefit from focus on such components given their potential disruptive role during international interchanges.

Third, the present study selected groups which have been related historically and philosophically to Analytic and Holistic reasoning. The groups have also displayed these differences in past research. Research using tools to tap individual variations in Analytic and Holistic reasoning would likely delineate group differences.

Finally, cultural differences in cognition are critical given their influence on demands typical in naturalistic contexts. People must identify ill-defined problems, make sense of complex and sometimes contradictory information, make decisions under high risk and time pressure, and plan as situations evolve. Measures must be standardized and validated against these naturalistic performance criteria to anchor research to applied needs (Lin & Klein, 2008).

Rosetta Phase II will explore the four directions. Additional national groups from Southeast and South Asia will be included to extend generality. The number and range of the components of Analytic–Holistic reasoning will be expanded and the Analysis-Holism Scale (Choi, *et al*., 2007) and Dialectical Thinking Inventory (Chan, 2004) included, in addition to the Exclusion Task from the present study. Finally, two unpublished scales of complex cognition, Dynamic Cognition (Klein & Lin, 2006b) and Cognition in Context (Klein & Lin, 2006a), which tap more complex cognition, will be added. The goal is to identify and measure the mechanisms by which cultural differences in cognition are translated into the complexities which vex multinational interchanges.

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