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Cultural preferences for formal versus intuitive reasoning

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Abstract

The authors examined cultural preferences for formal versus intuitive reasoning among East Asian (Chinese and Korean), Asian American, and European American university students. We investigated categorization (Studies 1 and 2), conceptual structure (Study 3), and deductive reasoning (Studies 3 and 4). In each study a cognitive conflict was activated between formal and intuitive strategies of reasoning. European Americans, more than Chinese and Koreans, set aside intuition in favor of formal reasoning. Conversely, Chinese and Koreans relied on intuitive strategies more than European Americans. Asian Americans' reasoning was either identical to that of European Americans, or intermediate. Differences emerged against a background of similar reasoning tendencies across cultures in the absence of conflict between formal and intuitive strategies.
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1. Introduction

Consider the following problem: is the Pope a bachelor?

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Two approaches suggest themselves to solve this "bachelor" problem, each producing a different answer. One possibility is an intuitive solution: our understanding of "bachelor" reflects similarity relations among people who are known to be bachelors. According to this intuitive approach, the Pope would not be seen as a bachelor. Alternatively, we may represent the concept of "bachelor" as a person who satisfies the rule, "unmarried, adult, male." Under this formal definition, the Pope, contrary to intuition, indeed would be a bachelor.

This "bachelor" problem illustrates an important theoretical distinction in the psychology of reasoning. According to this distinction, human thinking is guided by two separate classes of cognitive strategies that implement different computational principles. One can be described as intuitive, experience-based, or holistic, whereas the other can be described as formal, rule-based, or analytic (Evans & Over, 1996; James, 1890; Neisser, 1963; Smith, Langston, & Nisbett, 1992; Tversky & Kahneman, 1983; for a recent review of the empirical evidence for this distinction, see Sloman, 1996). The former cognitive strategies are associative or similarity-based in nature, and their computations reflect temporal contiguity and statistical regularities among features. The latter strategies recruit symbolic representations, have logical structure and variables, and their computations reflect rule application. In this paper we use the terms *intuitive* and *formal* to refer to these two distinct reasoning systems.

In recent years, a growing number of research programs in psychology have examined these two cognitive systems under the rubric of "dual process" theories of thinking, including deductive reasoning (Evans & Over, 1996), categorization (Rips, 1989; Smith, Patalano, & Jonides, 1998), analogical reasoning (Gentner & Medina, 1998), decision making (Tversky & Kahneman, 1983), belief formation (Gilbert, 1991), and social cognition (Chaiken & Trope, 1999). These two cognitive systems coexist in individuals, interact with each other in interesting ways (e.g., Gentner & Medina, 1998; Sloman, 1996), and occasionally may be in conflict and produce contradictory inferences, as in the above "bachelor" problem. Although the intuitive system tends to dominate, the relative influence of one system versus the other on reasoning has been found to be influenced by the nature of the task, by instructions that emphasize rule-following or deduction (Evans & Over, 1996; Sloman, 1996), by the particular reasoning domain (Atran, 1990; Keil, 1994), as well as by individual differences (Stanovich, 1999).

Little is known about the operation of these two systems of reasoning across diverse cultural groups. People in all cultures are likely to possess both of these reasoning systems, but cultural variation may exist in their relative accessibility and use to the extent that different values are placed on these reasoning systems. Many scholars have documented cultural differences in the intellectual outlooks of East Asian and Western cultures (Fung, 1952; Liu, 1974; Lloyd, 1996; Nakamura, 1960/1988). An *analytic* mode of thought has been held to be more prevalent in Western cultural groups. This mode involves the decoupling of the object from its context, assigning the object to categories based on necessary and sufficient features, and a preference for using rules, including the rules of formal logic, to explain and predict the object's behavior. In contrast, a *holistic* mode of thought has been held to be more prevalent in East Asian cultural groups. This mode involves attention to the context or field as a whole, a concern with relationships among objects and object–field relationships, a preference for intuitive reasoning, and "dialectical" reasoning, which seeks the "middle-way" between conflicting propositions.

Recent evidence indicates that some of these differences in analytic versus holistic outlooks find their counterparts in the thought processes of contemporary Westerners and East Asians (for a review, see Nisbett, Peng, Choi, & Norenzayan, 2001; Nisbett & Norenzayan, 2002). For example, East Asians are more attentive to the situational context of behavior and are less prone to the *fundamental attribution error* (Ross, 1977), or the tendency to overattribute behavior to dispositions despite obvious situational constraints (Choi, Nisbett, & Norenzayan, 1999). East Asians are more *field dependent* (Witkin & Berry, 1975) than Americans, being more influenced by the position of the surrounding frame when judging the position of the rod in the rod-and-frame task (Ji, Peng, & Nisbett, 2000). East Asians have a more holistic sense of causality: they draw on a wider range of factors to explain events. As a result, East Asians show more *hindsight bias* (Fischhoff, 1975), the tendency to view events as having been inevitable in retrospect (Choi & Nisbett, 2000). East Asians also prefer *dialectical* resolutions to apparent contradictions, so that a compromise or "middle-way" solution is sought. Americans respond to contradiction by "polarizing" their opinions—deciding that one proposition is true and the other false (Peng & Nisbett, 1999; Davis, Nisbett, & Schwarz, 2000). In this paper, we examine whether analogous cultural differences can be found in formal and intuitive systems of reasoning.

1.1. Selection of participants

Participants were self-identified European American, Asian American, and East Asian undergraduate students, who were otherwise similar in their demographic background and intellectual ability. In Studies 1 and 2, the East Asians were international students at the University of Michigan who were of Chinese or Korean culture, had lived in the U.S. for less than 4 years, had graduated from a high school in East Asia, and grew up speaking an East Asian language. In Studies 3 and 4, East Asians were Korean students at Yonsei University in Seoul, South Korea. All European Americans were students at the University of Michigan. Asian Americans grew up in the United States, and were of Chinese, Korean, or Japanese ethnic background. The Asian American samples were included to examine acculturation effects. Their thinking was expected to be intermediate between the two other groups, because of their substantial, though probably not complete, socialization into American traditional culture.

1.2. Theoretical rationale for the cultural differences

In each study a simple research strategy was used to measure reasoning preferences. A cognitive conflict was activated such that formal thinking was pitted against intuitive thinking. If European Americans favor formal rules more than intuition, they should be more willing to set aside intuition and follow rules when the two are in conflict. If East Asians favor intuition more than formal rules, they should be less willing to abandon intuition in favor of formal rules.

We had a different prediction for reasoning based on intuition alone or on rules alone, with no cognitive conflict present. In these cases responses are a function of cognitive ability, rather than a function of preference for a particular cognitive strategy. Because we selected our participants in different cultures so that they were similar in cognitive abilities, we expected no cultural differences in their ability to implement a formal strategy or an intuitive strategy in the absence of a conflict between the two.

We examined the extent to which cultural differences might be found for a variety of cognitive tasks. In Study 1, we examined category learning. Participants were asked to apply a complex rule as a way of correctly classifying imaginary animals. Their category learning was then tested in a situation in which the complex rule conflicted with memory for previously seen animals. In Study 2, we investigated classification and similarity judgments of drawings (e.g., geometric objects, houses, flowers) that admitted either a rule-based judgment or a judgment based on family resemblance structure. Studies 3 and 4 went beyond immediately perceptible stimuli to examine conceptual processes. In Study 3, participants evaluated the convincingness of deductive arguments when logic conflicted with the typicality of the conclusion. Finally, in Study 4 we investigated deductive reasoning when logical structure was pitted against the believability of the conclusion.

2. Study 1: Rule- versus exemplar-based category learning

If there is a cultural difference between European Americans and East Asians in formal and intuitive thinking, this difference might be apparent when categories have been learned by the formal application of rules, and when subsequent classification by rules conflicts with intuitive knowledge, such as exemplar memory. Rule-based categorization is accomplished by determining whether or not the novel object satisfies a rule that defines the category by its necessary and sufficient features, such as when a new neighbor is categorized as a bachelor if he satisfies the rule, "is an unmarried adult male." Exemplar-based categorization, in contrast, reflects similarity of the novel object to previously stored exemplars retrieved from memory. The more similar the new object and the retrieved exemplars are, the more likely it is that the new object belongs to the same category as the retrieved exemplars. Our new neighbor might be suspected of being a bachelor not because he satisfies some well-articulated rule, but because he is reminiscent of a bachelor relative.

Study 1 was based on a variation of a well-developed paradigm in categorization research (e.g., Allen & Brooks, 1991; Regehr & Brooks, 1993; Smith et al., 1998). Participants viewed imaginary animals on a computer screen and were told that the animals belonged to different categories, some being from Venus and others being from Saturn. In a training phase, participants learned to categorize, with feedback, the set of animals. This was followed by a test phase, in which participants were asked to categorize new animals. Participants in the *rule condition* learned a complex rule, making categorizations based on whether or not the animal had three out of five specific bodily features. Critically, in the test phase of the rule condition, half of the animals were *positive matches*: they belonged to one category by the rule, and also were very similar to a training exemplar from that same category. The other half of the new animals were *negative matches*: they belonged to one category as defined by the rule, but were very similar to a training exemplar from the opposite category (see Fig. 1). Thus, the negative match animals—unlike positive match ones—posed a cognitive conflict between rule-based and exemplar-based categorization.

Unlike the rule condition, participants in the *exemplar-memory condition* were not given a rule. They were asked during the training phase simply to observe a series of the cartoons and

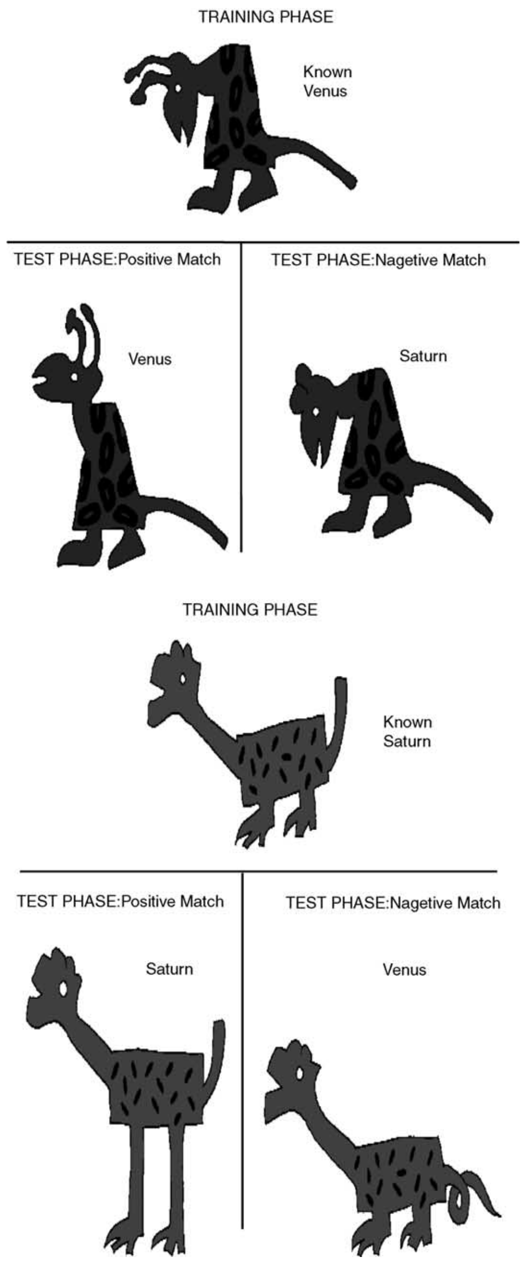

Fig. 1. Examples of stimuli (Study 1). *Rule*: Animal lives on Venus if it has at least three of the following five features: curly tail, hooves, antennae ears, mouth, long neck. Otherwise, it lives on Saturn.

initially make guesses as to which animal belonged to which category. Feedback was given after each guess. As participants repeatedly categorized the same animals, they could rely on their memory of previous exemplars to assign the animals to their appropriate categories. The exemplar-memory condition served as a control, to examine whether the expected cultural differences in rule-based classification are attributable to differences in the sheer tendency to rely on exemplar memory.

Based on past findings (Allen & Brooks, 1991; Smith et al., 1998; Patalano, Smith, Jonides, & Koeppe, 2001), we anticipated that: (1) participants would make fewer classification errors in the rule condition than in the exemplar-memory condition, but take longer because of the necessity to compute the explicit rule, and (2) participants in the rule condition would make more classification errors and show slower reaction times for negative matches than positive matches, that is, when rule and exemplar memory were in conflict than when they were not.

Most importantly, the cultural analysis led to the prediction that the difference in classification errors between positive- and negative-matches would be greater for East Asians than for European Americans, since East Asians would be more inclined to use memory for the exemplars in the rule condition. Similarly, the difference in response times between positive- and negative-matches was expected to be greater for East Asians.

2.1. Method

2.1.1. Participants

Participants were 61 European American (27 men, 34 women), 61 Asian American (32 men, 29 women), and 28 East Asian (12 men, 16 women) undergraduate students at the University of Michigan (age $M = 19$) who received partial course credit for their participation.

2.1.2. Stimuli

The stimuli were color drawings of imaginary animals (from Patalano et al., 2001; see Fig. 1 for example). The animals were constructed out of 10 binary features: ears (antennae ears or regular ears), tail (curly or straight), neck length (long or short), mouth (open mouth or snout), feet (hooves or webbed feet), leg length (short or long), head direction (pointed up or down), body color (red or blue), body marking (spots or stripes), and body shape (round or angular). The animals were categorized as being from Venus or Saturn by a five-feature additive rule that used ears, tail, neck length, mouth, and feet as diagnostic features. An animal was defined as being from Venus if it satisfied at least three of the five diagnostic features; otherwise it was from Saturn. All Venus animals always satisfied exactly three of the five diagnostic features; all Saturn animals satisfied only two of the five diagnostic features. The animals were designed so that the two categories were not easily differentiable, had few members, and had weak prototype structures (see Allen & Brooks, 1991; Patalano et al., 2001), factors that diminish the likelihood that prototypes of Venus and Saturn animals would be formed.

Ten different animals were presented four different times in the training phase, followed by 20 new animals in the test phase, consisting of a positive match and a negative match to each animal in the training phase. The design was counterbalanced, such that half of the animals were from Venus, and the other half were from Saturn. As can be seen in Fig. 1, a positive match was very similar to its corresponding training exemplar, varying only on one of the irrelevant features (e.g., head pointed up or down). In contrast, a negative match was also very similar to its corresponding training exemplar, but varying this time only on one of the features diagnostic of the rule (e.g., antennae or regular ears). This made it possible for animals to change categories, yet remain similar to an item in the opposite category. The values of the irrelevant features appeared equally often in each category, and thus were not diagnostic of category membership.

2.1.3. Procedure

Participants were tested individually on a computer. All the instructions and materials were in English, as all participants, including the East Asian students, were enrolled at an American university and were fluent in English.

Participants from the three cultural groups were randomly assigned to either the rule condition or the exemplar-memory condition, which served as an experimental control. Participants in the rule condition were given the rule at the beginning of training, and they memorized it before beginning the study (post-study interviews indicated that all participants in the rule group had successfully memorized the rule). Those in the exemplar-memory condition were never given a rule. They were instructed to guess whether the animal was from Venus or Saturn the first time they saw an animal, and subsequently categorize new ones by using their knowledge of previously studied animals. Prior to being presented with the actual animals, participants practiced with one sample animal as a way to familiarize themselves with the task.

In the training phase participants were given a total of 40 trials, consisting of 10 different animals categorized four times each, one animal at a time, each participant receiving them in one of four different random orders. Participants were instructed to categorize the animals as quickly as they could, without sacrificing accuracy. They made each categorization decision by pressing a designated button on the keyboard. Then participants received automated feedback indicating if the decision was correct or incorrect. They then pressed another designated button to go to the next stimulus screen. The training phase was identical in the rule and exemplar-memory conditions, except that rule participants used the rule.

The test phase was also identical for both experimental groups, with the same exception that rule participants continued to use the rule. Each training animal corresponded to one positive match and one negative match animal in the test phase. Unlike in the training phase, no feedback was given in the test phase. Otherwise, the procedures in both phases were identical.

The dependent measures were: the percentage of classification errors, and the reaction times for accurate responses in the training and test phases.

2.2. Results

2.2.1. Training phase

The data in the training phase established that all participants in both the rule and exemplar-memory conditions learned to categorize the animals, the learning curves being similar for the three cultural groups. In the rule condition, a culture by trials analysis of variance (ANOVA) revealed a linear decrease of classification errors across the four trials, $F(3, 201) = 6.43$, $p < .001$, with no main effect of culture, $F(2, 67) = 1.79$, ns, or learning by culture interaction, $F(6, 201) = 1.35$, ns. Misclassifications, averaged across the three cultural groups, decreased from 20.7% (first trial) to 11.3% (last trial). Similarly, reaction times decreased linearly across the four trials, $F(3, 201) = 42.30$, $p < .001$ ($M = 5{,}586$ ms for first trial vs. $M = 3{,}294$ ms for last trial). There was no main effect of culture, $F < 1$, or learning by culture interaction, $F < 1$.

Results were similar in the exemplar-memory condition. Classification errors decreased linearly across the four trials, $F(3, 231) = 10.49$, $p < .001$, down from 51.9% (first trial), to 39.9% (last trial), which was significantly better than chance (50%), $t(79) = 4.62$, $p < .001$. There was no main effect of culture, $F < 1$, or culture by learning interaction, $F < 1$. Reaction times also revealed a main effect of learning across the four trials, $F(3, 231) = 7.88$, $p < .001$, down from $M = 1{,}883$ ms (first trial), to $M = 1{,}431$ ms (last trial), with no main effect of culture, $F < 1$, or learning by culture interaction, $F < 1$.

2.2.2. Test phase: rule group versus exemplar-memory group

Thus, the three cultural groups in each condition learned to categorize successfully and entered the test phase on similar footing. Based on prior research, we expected that participants in the rule condition would make fewer classification errors and have slower reaction times than participants who instead had to rely on exemplar memory. An instruction (rule vs. exemplar memory) by culture (European American, Asian American, East Asian) by match (positive vs. negative, repeated measure) ANOVA indicated that this was indeed the case, with a main effect of the instructions on classification errors, $F(1, 144) = 507$, $p < .001$, and on reaction times, $F(1, 144) = 124.30$, $p < .001$.

2.2.3. Test phase: exemplar-memory group

Categorization decisions were analyzed separately for participants who were given the rule and for those who had to rely on exemplar memory, the latter serving as an experimental control for the cultural predictions in the rule condition. The results for the exemplar-memory condition for classification errors and reaction times are shown in Fig. 2. For the negative match items the classification error rate was reverse-scored, since in the absence of the rule the only correct response would be to categorize based on similarity to past exemplars. As can be seen, participants' categorization was significantly better than chance (i.e., 50%) for positive matches, $t(79) = 6.58$, $p < .001$, and for negative matches $t(79) = 8.16$, $p < .001$. No cultural differences emerged for either classification errors or reaction times, $F(2, 77) = 1.18$, ns, and $F < 1$, respectively. All cultural groups learned the categories using exemplar memory equally well.

2.2.4. Test-phase: rule group

Consistent with prior research, a repeated-measures ANOVA for the rule group indicated that participants overall made more classification errors when the rule was in conflict with exemplar memory (negative matches), than when there was no such conflict (positive matches), $F(1, 67) = 20.04$, $p < .001$. A similar main effect emerged for reaction times, with slower reaction times for negative than positive matches, $F(1, 67) = 16.57$, $p < .001$ (see Fig. 3).

Most interestingly, the predicted cultural differences in the degree of classification errors for negative as opposed to positive matches was obtained: there was a significant culture by item type interaction, $F(2, 67) = 3.81$, $p < .05$. Analyses of partial interactions indicated that, as expected, the negative–positive difference was larger for East Asians than European Americans, $F(1, 67) = 4.97$, $p < .05$, and it was also larger for East Asians than Asian Americans, $F(1, 43) = 7.49$, $p < .01$ (see top panel of Fig. 3). As to reaction times, there was a main effect of culture, $F(2, 67) = 3.43$, $p < .05$, but no culture by item type interaction,

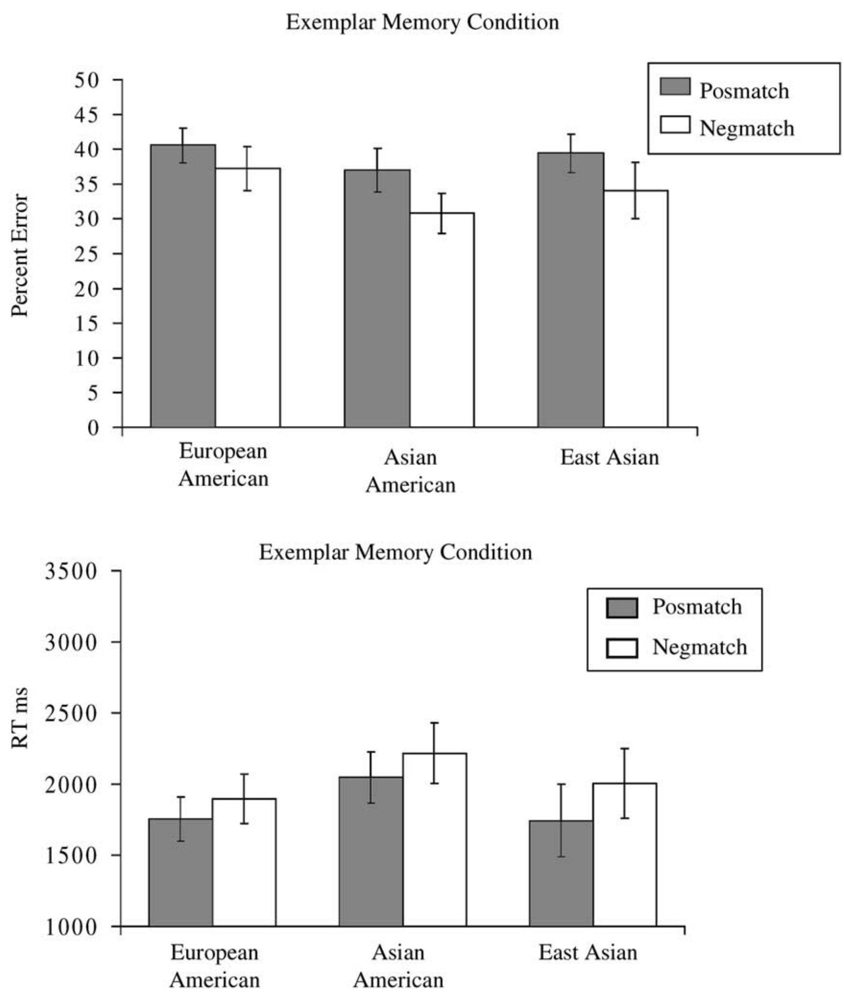

Fig. 2. Category learning (Study 1): classification error rates and reaction times for the exemplar-memory group.

$F < 1$. Analyses of simple effects revealed that East Asians had slower reaction times than European Americans, $F(1, 67) = 6.15$, $p < .02$, and Asian Americans, $F(1, 67) = 3.86$, $p = .05$ (see bottom panel of Fig. 3).

Finally, two analyses were conducted to determine whether differences in English language fluency could account for the cultural differences in category learning. Because most East Asians were not native English speakers, and the study was conducted in English, it is conceivable that their lesser fluency could have contributed to a weaker tendency to apply the rule, especially when the rule was in conflict with exemplar memory. This idea was tested in two ways: (1) the rule group's reported verbal SAT scores were correlated with their performance on the negative match items, and (2) East Asian and Asian American participants in the rule condition were pooled into a single sample (European Americans were excluded, because they were all native English speakers), and separated by their reported native language (whether or

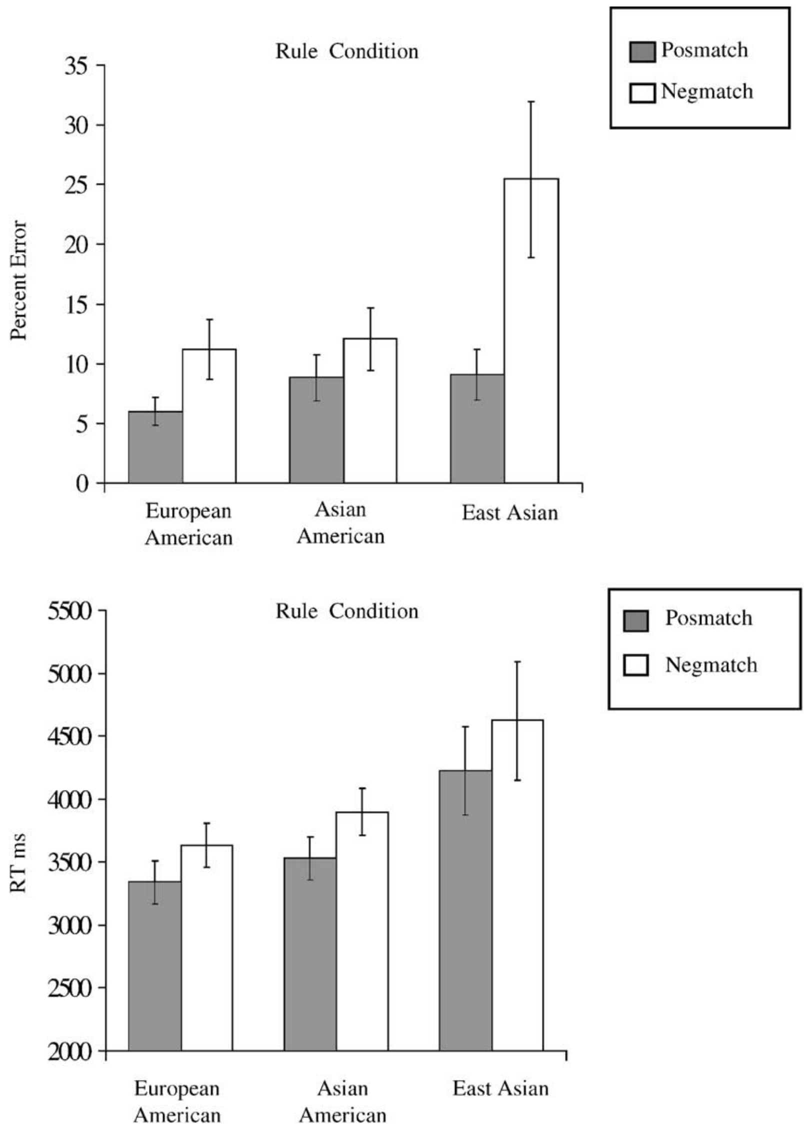

Fig. 3. Category learning (Study 1): classification error rates and reaction times for the rule group.

not they grew up speaking English or an East Asian language). If language fluency was a factor in their performance, those who reported an East Asian language to be their native language should have had higher error rates and slower reaction times for negative matches.

There was no evidence that the category learning results were influenced by English language fluency. The correlations between verbal SATs and performance on negative match items for the rule group were no different from 0, either for classification errors, $r(58) = -.07$, or for reaction times, $r(58) = .04$ (11 participants failed to report their SAT scores). Nor did reported native language matter. Participants who grew up speaking an East Asian language made no more classification errors than native English speakers ($M = 16.25$ vs. $M = 17.14$), $t < 1$, nor did they have slower reaction times ($M = 3{,}806$ vs. $M = 4{,}207$), $t(35) = 1.08$, ns.

2.3. Discussion

Our central prediction was that a cultural difference would emerge in the extent to which memory for exemplars would interfere with rule application when the two processes were in conflict. The results supported this prediction. East Asians and European Americans categorized equally well in the exemplar-memory condition. In the rule condition, however, European Americans and Asian Americans made fewer classification errors than East Asians for negative matches—for which a conflict existed between rule- and exemplar-based categorization. No differences emerged for the positive matches—for which no such conflict existed.

Similarly, no cultural differences in response times emerged in the exemplar-memory condition. The overall lack of cultural differences in the exemplar-memory condition suggests that the cultural differences in the rule condition are difficult to explain in terms of cultural differences in the sheer tendency to rely on exemplar memory in the absence of a rule.

East Asians' response times in the rule condition were overall slower than those of European Americans. One possible explanation for this finding is that there might be an important difference between classification errors and reaction times. Since positive matches were randomly intermixed with negative matches, participants who were particularly sensitive to exemplar-memory might have expected a conflict at any trial. Thus, rule application might have been harder for East Asians, in a context where the rule could conflict with exemplar-based categorization for any given trial. Finally, Asian Americans responded identically to European Americans in all respects.

3. Study 2: Rule- versus family resemblance-based classification and similarity judgments

Study 1 demonstrated that category learning based on the application of a formal rule was easier for Americans than for East Asians when the rule conflicted with exemplar-memory. However, exemplar-based reasoning is only one strategy among many intuitive strategies, another being family resemblance. This strategy draws on knowledge of graded membership of exemplars within a category, such that some are believed to be more similar to the category than others (Rosch, 1978; Rosch & Mervis, 1975; Wittgenstein, 1953).

If Western thinking is more rule-governed and less intuitive than East Asian thinking, Westerners may be more tempted to spontaneously locate objects in novel categories based on a simple rule, and less willing to rely on family resemblance, whereas the reverse might be true for East Asians. Study 2 tested this hypothesis.

Participants placed objects in one of two categories that could be defined on the basis of a unidimensional rule or overall similarity (Kemler-Nelson, 1984). They saw a series of presentations, each consisting of a "target" object beneath two groups or categories of four similar objects, as illustrated in Fig. 4. In one condition, participants were asked to decide which category the target object belonged to (*the classification condition*). Such free classification

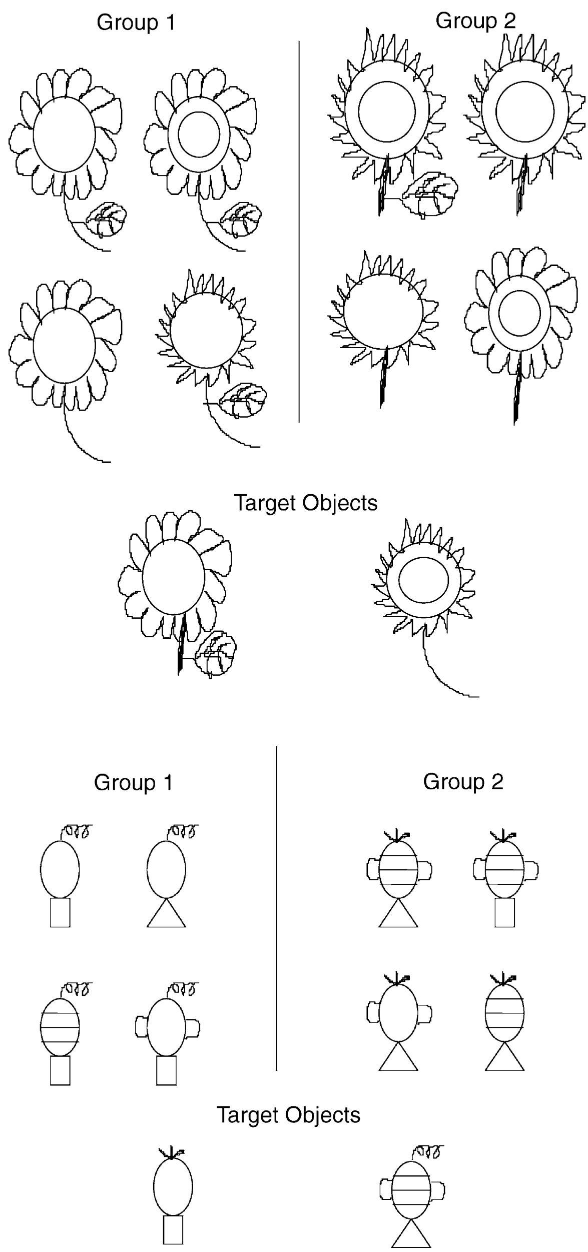

Fig. 4. Examples of stimuli (Study 2). Each of the two target objects was presented separately with the two groups to achieve a counterbalanced design. For the flowers, the defining feature is the stem length; for the geometric figures, it is the topmost string.

has been shown to be unidimensional, as long as the stimuli allow scanning of an array of dimensionalized objects, as was the case in this study (Ahn & Medin, 1992; Medin, Wattenmaker, & Hampson, 1987). However, unlike Medin et al. (1987) where participants received items and sorted them into groups, in this study participants were given two groups and then assigned an item to one of them. To encourage more strongly the use of an alternate family resemblance strategy, other participants were instructed to judge which category the target object was most similar to (*the similarity judgment condition*). The stimuli were constructed such that the responses driven by the rule versus family resemblance criterion led to different decisions. Participants could rely on a unidimensional rule, deciding whether or not the target object shared a single feature with all category members. Alternatively, they could rely on family resemblance, judging the target object to be holistically similar to all members of a category because it shared a large number of features with them, even though no one feature characterized all members of the category. The anticipation was that East Asians would make less use of rules and more use of family resemblance than would European Americans in both conditions. As to response times, it was expected that the similarity instructions would produce faster response times than the classification instructions. However, because making judgments based on a unidimensional rule or on family resemblance are equally fast, there was no reason to expect cultural differences in reaction times in this study.

3.1. Method

3.1.1. Participants

Participants were undergraduate students at the University of Michigan (age $M = 19$). The sample consisted of 52 European Americans (27 men, 25 women), 52 Asian Americans (28 men, 24 women), and 53 East Asians of Chinese and Korean ethnic background (27 men, 26 women).

3.1.2. Stimuli

Fig. 4 shows examples of the stimulus sets used. Each one had an abstract structure, described in Table 1, constructed from a set of four binary features. Each stimulus set corresponded to one item (e.g., flower, house), and was composed of a target object and two categories (Group 1 and Group 2), instantiated as four objects belonging to each category. The two categories and the target object for each stimulus set were designed so that two alternative solutions were possible. One of the four binary features always defined each category (e.g., all four instantiations of the flower in one group had a short stem and all four in the other had a long stem). The other three,

Table 1
Category structures in Study 2

Group 1	Group 2	Target objects
0000	1111	0111
0100	1011	1000
0010	1101	
0001	1110	

Note. The two categories (groups) in each stimulus set were instantiated in four exemplars per group, varying on four binary features. The value of each binary feature is represented as 0 or 1. Each row represents one exemplar, and each column represents the distribution of values for one feature. The first and last column corresponds to the defining rule.

non-deterministic features took on a different value for each category, such that each of the four objects in each category contained three out of the four values, which together produced a strong family resemblance structure that separated the two categories based on overall similarity. A rule-based solution would select the deterministic feature that the target object shared with one of the categories; a family-resemblance solution would select overall similarity of the target object to the category members. Ten category pairs were used, each pair shown with only one of the two alternative targets, counterbalancing the design, and yielding a total of 20 stimulus sets.

3.1.3. Procedure

Participants were tested individually on a computer. All the instructions and materials were in English, as all participants, including the East Asian students, were enrolled at an American university and were fluent in English. Participants were randomly assigned to the classification or the similarity judgment condition. In the classification condition, participants were asked, for each stimulus set, to decide “which group the target object belongs to.” In the similarity judgment condition, other participants were instructed to decide “which group the target object is most similar to.” Before seeing the actual stimuli, participants practiced with one sample stimulus set as a way to be familiarized to the task. At this point the experimenter verified that the participant understood the instructions and was ready to begin. The stimulus sets were then presented to participants in a random order. The computer program automatically moved to the next screen as soon as a response was made. Participants were asked “to take their time while responding, but not spend too much time on any single item.”

For each stimulus set, participants indicated their classification or similarity judgment decision by pressing a designated button. The dependent measure was the percentage of rule and family resemblance solutions for each participant, averaged across the 20 trials. Reaction times (RT) were also recorded. Participants who were instructed to make categorization decisions were expected to be slower than those who were asked to judge overall similarity (Smith et al., 1998).

3.2. Results

The results are shown separately for the classification condition and the similarity judgment condition. As seen in the top panel of Fig. 5, participants overwhelmingly preferred to classify based on the unidimensional rule rather than family resemblance, replicating past research (e.g., Medin et al., 1987), $F(1, 100) = 44.40$, $p < .001$ ($M = 67\%$ vs. $M = 33\%$). Contrary to predictions, there was no culture by response type interaction, $F(2, 100) = 1.25$, ns. All three cultures substantially preferred rule-based over family resemblance classification, $t(33) = 4.23$, $p < .001$ for European Americans, $t(33) = 2.48$, $p < .02$ for Asian Americans, and $t(34) = 4.94$, $p < .001$ for East Asians.

Matters were different when participants were asked to judge the similarity of the target object to the categories, as may be seen in the bottom panel of Fig. 5. Under these instructions, a marked cultural difference emerged. There was a significant culture by response type interaction, $F(2, 51) = 8.01$, $p < .005$, and no main effect of response type, $F < 1$. European Americans gave many more responses based on the unidimensional rule than on family resemblance ($M = 69\%$ vs. $M = 31\%$), $t(17) = 3.68$, $p < .005$. (Indeed, they preferred

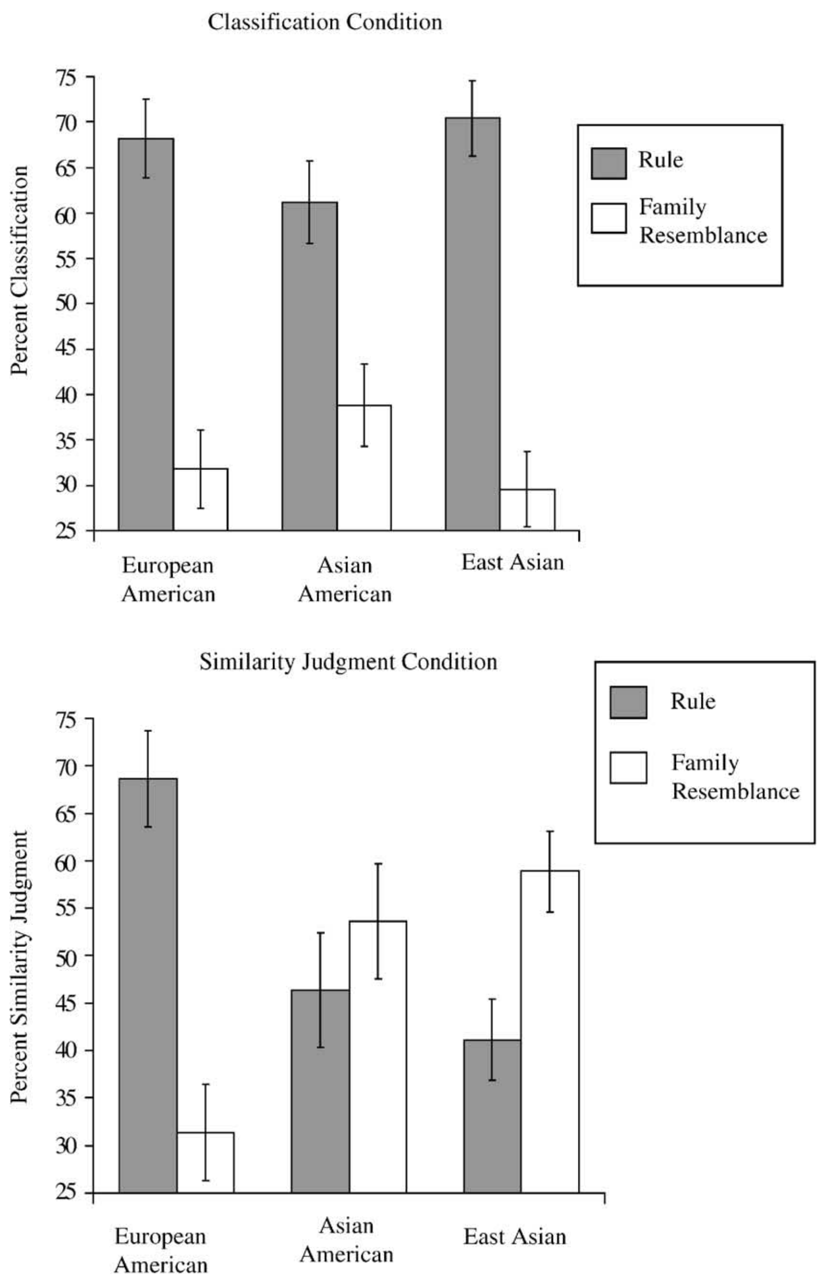

Fig. 5. Classification and similarity judgments by rule versus family resemblance (Study 2).

the unidimensional rule precisely to the same extent as when making classification decisions.) East Asians, in contrast, gave fewer rule-based responses than family resemblance responses ($M = 41\%$ vs. $M = 59\%$), $t(17) = 2.09$, $p = .05$. Asian Americans were intermediate, having no preference for rule versus family resemblance responses ($M = 46\%$ vs. $M = 54\%$), $t < 1$.

Reaction times were submitted to a culture by instruction condition (classification vs. similarity judgment) ANOVA. Only a main effect of judgment condition emerged, indicating that participants overall were slower when classifying than when judging similarity (in ms: $M = 7{,}516$ and $SD = 3{,}160$ vs. $M = 6{,}260$ and $SD = 4{,}379$), $F(1, 151) = 4.25$, $p < .05$. There were no main effects of culture, $F < 1$, or culture by judgment condition interaction, $F < 1$.

4. Study 3: Conceptual structure based on logic versus typicality

The first two studies probed categorization and similarity judgments of artificially constructed categories. In contrast, in Study 3 we examined the extent to which people spontaneously rely on formal rules versus intuition to mentally represent naturally occurring categories. This was done by setting logic against the typicality of category exemplars. Typicality-based reasoning relies on the similarity relations among particular exemplars of a category, with typicality judgments usually (but not always) being a function of the number of features shared by other category members (Rosch & Mervis, 1975; Smith & Medin, 1981). For example, penguins are atypical birds because of their perceptual peculiarities—large body, small wings, inability to fly—that set them apart from other members of the category “bird.”[1] This type of reasoning is intuitive in that it relies on the perceptual features of actual category members, or on second-hand knowledge of the perceptual features of exemplars of a category.

In Study 3, we assessed reasoning preferences based on logic versus typicality. We investigated how people project fictitious or unknown features from a *superordinate* category (e.g., bird) to *subordinate* categories of varying typicality (e.g., eagle, penguin) (Sloman, 1993). Participants rated how convincing they found deductive categorical arguments such as:

1 All birds have ulnar arteries
Therefore, all eagles have ulnar arteries

2 All birds have ulnar arteries
Therefore, all penguins have ulnar arteries

There are two known strategies one can recruit to reason about these arguments. Reasoners following logic would “discover” the hidden premise in each argument, that “All eagles are birds,” and “All penguins are birds.” Once these hidden premises are exploited, the argument becomes a standard valid deductive argument. Armed with this knowledge, participants should be equally convinced by the typical and atypical arguments.

But the typicality of the conclusion category can make the arguments more convincing to the extent that reasoning is guided by intuitive strategies rather than logic. When participants evaluate both typical and atypical arguments, a *typicality effect* is found, that is, participants are less convinced of atypical arguments than typical ones (Sloman, 1993).

Study 3 examined this typicality effect cross-culturally. The phenomenon was evaluated both within-groups (when typicality is salient), and between-groups (when typicality is not salient). If East Asians rely on intuition more than European Americans, the typicality effect should be stronger for East Asians, particularly when typicality is not salient.

4.1. Method

4.1.1. Participants

Ninety-two European American students (40 men, 52 women, age $M = 19$) and 74 Asian American students at the University of Michigan (35 men, 39 women, age $M = 19$), as well as 93 Korean students at Yonsei University in Seoul, South Korea (49 men, 44 women, age $M = 23$) participated for partial course credit. In addition, a separate group of 42 European American students at Michigan (16 men, 26 women, age $M = 19$) and 42 Korean students at Yonsei (26 men, 16 women, age $M = 22$) rated the typicality of the conclusions as a manipulation check.

4.1.2. Materials

Two bilingual Korean researchers generated the categories to ensure the cross-cultural equivalence of the materials. Care was taken to ensure that the categories were equally familiar, and equally typical or atypical in these cultures. Ten pairs of arguments were constructed using this procedure. For each argument pair, the superordinate category (premise) was held constant, and the typicality of the subordinate category (conclusion) was varied, with an unknown or a fictitious feature being projected from the former to the latter category. Half of the arguments had typical conclusions and the other half had atypical ones (see Table 2 for examples).

Table 2
Selected arguments in Study 3

Arguments with typical conclusions	
1	All birds have an ulnar artery Therefore, all eagles have an ulnar artery
2	All professionals do community service in Tahiti Therefore, all doctors do community service in Tahiti
3	All clothing is made of Supsa leaves in the Island of Pago–Pago Therefore, all shirts are made of Supsa leaves in the Island of Pago–Pago
4	All diseases can be understood in terms of the Shawinigan principle Therefore, all cancer can be understood in terms of the Shawinigan principle
Arguments with atypical conclusions	
1	All birds have an ulnar artery Therefore, all penguins have an ulnar artery
2	All professionals do community service in Tahiti Therefore, all bankers do community service in Tahiti
3	All clothing is made of Supsa leaves in the Island of Pago–Pago Therefore, all raincoats are made of Supsa leaves in the Island of Pago–Pago
4	All diseases can be understood in terms of the Shawinigan principle Therefore, all cholera can be understood in terms of the Shawinigan principle

4.1.3. Procedure

The study was conducted in a classroom setting. Participants received a questionnaire packet containing all the instructions and materials. They were instructed to evaluate the convincingness of each argument on an 11-point scale:

0--------1--------2--------3--------4--------5--------6--------7--------8--------9--------10

Very Unconvincing/Very Weak Very Convincing/Very Strong

Because Study 3 was concerned with the spontaneous reliance on logic versus conclusion typicality, the instructions did not provide any clues to respond logically to the arguments; instead, participants were asked to "read each argument, assume that the facts given to you are true, and using the scale, evaluate how convincing you believe each argument is."

After responding to all 20 arguments, participants completed a brief demographic questionnaire. They were given as much time as they needed, with all participants completing the questionnaire within 10 min. For Korean participants, all materials were translated into Korean using the back-translation method (Brislin, 1970).

4.1.4. Salience of typicality manipulation

In contrast to previous studies of this phenomenon which have relied on an exclusively within-groups methodology which makes typicality a salient feature of the task, the present study manipulated the salience of typicality by counterbalancing the order of presentation of the typical and atypical arguments. Half of the participants in each cultural group were randomly assigned to evaluate all 10 typical arguments first, followed by all 10 atypical arguments (*typical first condition*). The other half was randomly assigned to evaluate all 10 atypical arguments first, followed by all 10 typical arguments (*atypical first condition*). Thus, the typicality effect was evaluated in two ways: as a between-groups comparison of the *first* 10 typical versus atypical arguments (*low salience of typicality*). The typicality effect was also measured as a between-groups comparison of the *last* 10 typical and atypical arguments (*high salience of typicality*).

4.1.5. Manipulation check

A separate group of European American and Korean students rated the typicality of the conclusion categories to establish the effectiveness of the typicality manipulation and the functional equivalence of the typicality information across cultures. Participants rated the typicality of the conclusions for each of the 20 arguments (for example, "how typical are eagles of birds?") on a scale anchored between 0 (Not at all typical) and 10 (Very typical). The items were counterbalanced so that half rated typical ones first, and half rated atypical ones first.

4.2. Results

4.2.1. Manipulation check

The typicality manipulation was successful. All typical conclusions were rated as more typical than their atypical counterparts, for both European Americans and Koreans. Averaging across the 10 typical and 10 atypical conclusions, the effect was highly reliable, for European Americans: $t(42) = 12.71$, $p < .001$, typical $M = 8.32$, $SD = 1.69$, atypical $M = 5.24$, $SD = 2.15$, and for Koreans: $t(42) = 17.18$, $p < .001$, typical $M = 8.49$, $SD = 1.18$, atypical $M = 5.00$, $SD = 1.45$. There was no culture by conclusion typicality interaction, $F(1, 82) = 1.61$, ns.

4.2.2. Convincingness of arguments

We examined the results in a between-groups design separately where there was (1) low salience of typicality (the mean of the first 10 arguments), and (2) high salience of typicality (the mean of the last 10 arguments).

4.2.2.1. Low salience of typicality condition. The top panel of Fig. 6 shows the convincingness ratings when typicality salience was low (the first 10 arguments), allowing participants elbow room to set aside typicality and follow logic. A culture (European American, Asian American, Korean) by argument type (typical, atypical) between-groups ANOVA revealed a main effect of argument type, as an indicator of the typicality effect, $F(1, 253) = 25.76$, $p < .001$. As predicted, a culture by argument type interaction emerged, reflecting differing strengths of the typicality effect for Koreans, European Americans, and Asian Americans, $F(2, 253) = 4.67$, $p < .01$. Analysis of partial interactions indicated that, as predicted, the typicality effect was stronger for Koreans than European Americans, $F(1, 253) = 9.09$, $p < .005$, and it was marginally stronger for Koreans than Asian Americans, $F(1, 253) = 3.46$, $p = .06$. European Americans and Asian Americans did not differ, $F < 1$.

The cultural differences were most revealing when the typicality effect was evaluated separately for each cultural group. As expected, a large typicality effect emerged for Koreans, $t(91) = 5.98$, $p < .001$. It was marginally significant for Asian Americans, $t(72) = 1.92$, $p = .06$. Most tellingly, European Americans did not show the typicality effect, $t(90) = 1.16$, ns. Instead, their responses were consistent with logic, being equally convinced by both arguments.

4.2.2.2. High salience of typicality condition. The bottom panel of Fig. 6 presents the results when salience of typicality was high (last 10 arguments). Reflecting the typicality effect, a culture (European American, Asian American, Korean) by argument type (typical, atypical) between-groups ANOVA revealed a main effect of argument type, with typical arguments being more convincing than atypical ones, $F(1, 253) = 94.59$, $p < .001$. There was no culture by argument type interaction, $F < 1$. Thus, all three groups showed the typicality effect to the same extent when the salience of typicality was high.

Finally, the results were reexamined with typicality as a within-groups manipulation. In this design, the expected cultural difference in the typicality effect emerged again, culture (European American, Asian American, Korean) by argument type (typical, atypical) interaction, $F(2, 256) = 5.49$, $p < .005$. An analysis of partial interactions revealed that the typicality effect was larger for Koreans than for European Americans, $F(1, 256) = 10.82$, $p < .005$; it was (marginally) larger for Asian Americans than European Americans, $F(1, 256) = 3.62$, $p = .06$; but did not differ in magnitude between Koreans and Asian Americans, $F(1, 256) = 1.44$, $p > .20$.

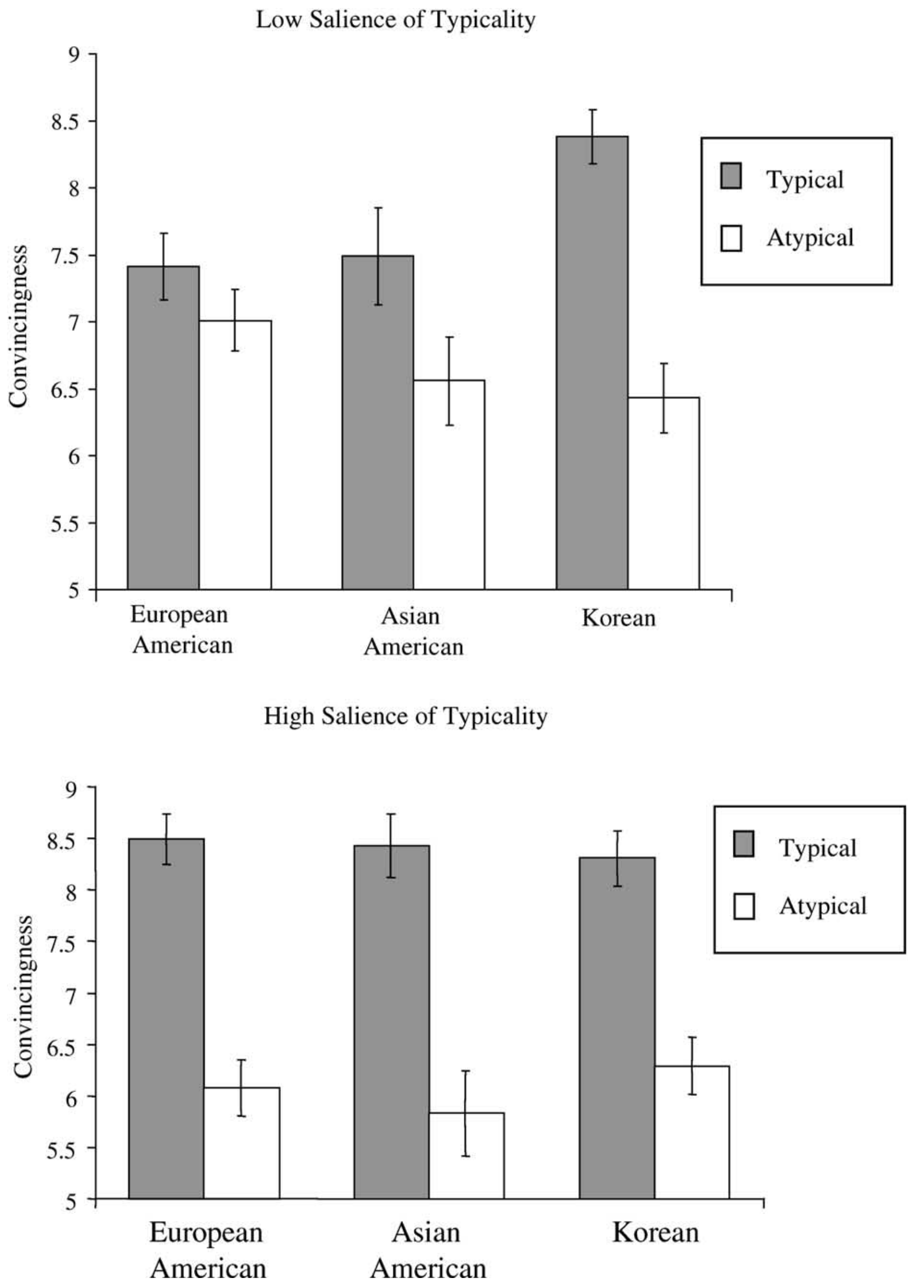

Fig. 6. Convincingness of deductive arguments with typical versus atypical conclusions (Study 3).

5. Study 4: Logic versus belief in deductive reasoning

Evidence presented in Studies 1–3 indicates that there are cultural differences in the ways contemporary East Asians and Westerners categorize and organize concepts. In Study 4 we examined the consequences of this cultural difference for reasoning based on logical structure versus empirical belief. Unlike Study 3, which did not directly manipulate the logical structure of arguments, Study 4 included an orthogonal variation of both the logical structure of arguments and the intuitive content of the conclusions.

In Study 4, such a cognitive conflict was created between the logical structure of a deductive argument and the empirical plausibility of the argument's conclusion. Participants evaluated the logical validity of a series of categorical syllogisms and conditional arguments that were either valid or invalid and that had conclusions that were either believable or nonbelievable. Moreover, at the end of the task, the same argument forms were presented in an abstract version so as to assess logical reasoning independent of content. Finally a separate group of participants rated the believability of each conclusion as a manipulation check and in order to establish the functional equivalence of the believability manipulation across cultures.

To the extent that one's reasoning is guided by intuitive knowledge, the believability of the conclusion may interfere with logical evaluations. As a result, valid arguments with implausible conclusions may be mistakenly thought to be invalid, and invalid arguments with plausible conclusions may be mistakenly thought to be valid. This is known as the *belief bias effect* in psychology (Evans, Barston, & Pollard, 1983; Newstead, Pollard, Evans, & Allen, 1992; Oakhill & Johnson-Laird, 1985; Revlin, Leirer, Yop, & Yop, 1980). On the other hand, to the extent that one's reasoning strategy favors logic, one should be willing or able to "decontextualize," that is, separate form from content. This study was a first investigation into possible cultural differences in the belief bias effect. It was expected that Koreans would show a stronger belief bias than European Americans. Furthermore, this cultural difference in belief bias was expected to emerge holding logical reasoning ability constant, as measured by performance on the abstract arguments.

5.1. Method

5.1.1. Participants

Eighty-seven European American students at the University of Michigan (35 men, 52 women, age $M = 19$) and 99 Korean students at Yonsei University in Seoul, South Korea (71 men, 28 women, age $M = 23$) participated in this study for partial course credit. In addition, a separate group of 30 European Americans (12 men, 18 women, age $M = 19$) and 30 Koreans (18 men, 12 women, age $M = 22$) rated the believability of the conclusions as a manipulation check.

5.1.2. Materials

Argument validity was crossed with conclusion believability, generating four arguments for each of the four following argument types: valid/believable, valid/nonbelievable, invalid/believable, invalid/nonbelievable. As can be seen in the representative examples in Table 3, valid and invalid arguments had different belief contents. After participants evaluated the 16 arguments, they were asked to evaluate additional eight arguments having the same logical structure as the prior arguments except that they were presented in abstract form, and hence believability was irrelevant. These abstract arguments were instantiated by letters and foreign unfamiliar words. Thus, each participant evaluated a total of 24 arguments.

Table 3
Selected arguments in Study 4

Valid/believable
Premise 1: No police dogs are old
Premise 2: Some highly trained dogs are old
Conclusion: Some highly trained dogs are not police dogs
Valid/nonbelievable
Premise 1: All things that are made of plants are good for the health
Premise 2: Cigarettes are things that are made of plants
Conclusion: Cigarettes are good for the health
Invalid/believable
Premise 1: All tall athletes have large foot size
Premise 2: Famous basketball players have large foot size
Conclusion: Famous basketball players are tall athletes
Invalid/nonbelievable
Premise 1: If a country is a member of the European Community, it is permitted to apply for loans from the European Bank
Premise 2: India is not permitted to apply for loans from the European Bank
Conclusion: India is a member of the European Community

Each type of argument as described above in turn consisted of four kinds of valid logical forms and their invalid counterparts that varied in difficulty: Modus Ponens (All A are B. C are A. C are B.), Modus Tollens (All A are B. C are not B. C are not A.), Modus Tollens conditional arguments conforming to a permission schema (If A is B, it may get C. X is not permitted to get C. X is not B.), and an argument of the form: No A are B. Some C are B. Some C are not A.

5.1.3. Procedure

The study was conducted in a classroom setting. Participants received a questionnaire packet containing the 24 syllogistic and conditional arguments. The concrete arguments consisting of the four different types were listed in a scrambled order, followed by the abstract arguments, also in scrambled order. For the Korean participants, all materials were translated into Korean using the back-translation method (Brislin, 1970). Participants were given as much time as they needed, with all participants completing the study within 20 min.

Participants were instructed to evaluate whether or not the conclusion followed logically from the premises for each argument (they had to circle either yes or no). Unlike in Study 3, in which participants were not made aware that the task could be solved by applying logic, in this study, strong instructions were presented that explicitly encouraged logical reasoning:

> In this study, you are going to see a series of problems. In each problem, you must decide whether the stated conclusion *follows logically* from the premises or not. You must suppose that the premises are true and limit yourself only to information contained in these premises. Do not be concerned if some of the terms in some of the problems seem unfamiliar to you . . . For each problem, decide if the given conclusion *follows logically from the premises*. Circle YES if, and only if, you judge that the conclusion can be derived from the given premises. Otherwise circle NO. You can take your time to answer each problem. However, do not spend too much time on any single problem.

The dependent measure was each participant's percentage of "Yes" responses for each argument type, indicating whether or not the participant thought the conclusion of the argument did follow logically from the premises.

A separate group of European American and Korean students rated the believability of the conclusions, as a manipulation check for believability, and in order to establish the functional equivalence of the believability information for both cultures. Participants rated the conclusions of the 16 concrete arguments, deciding their believability on a scale anchored between −3 (Very nonbelievable) and +3 (Very believable), with 0 being neither believable nor nonbelievable.

5.2. Results and discussion

5.2.1. Manipulation check

The believability manipulation was successful for both cultures: European Americans and Koreans agreed that believable conclusions were indeed believable and nonbelievable ones were indeed nonbelievable. Averaging across all eight believable and eight nonbelievable conclusions, European Americans rated believable conclusions, $M = 2.12$, $SD = .58$, which is significantly different from 0, $t(29) = 19.92$, $p < .001$, and they rated nonbelievable conclusions, $M = -2.12$, $SD = .43$, which is also different from 0, $t(29) = 27.39$, $p < .001$. Similarly, Koreans' ratings of believable and nonbelievable arguments were different from 0, $M = 1.29$, $SD = .79$, $t(29) = 8.93$, $p < .001$, and $M = -2.20$, $SD = .47$, $t(29) = 25.80$, $p < .001$, respectively.

Although the ratings of European Americans and Koreans did not differ for nonbelievable conclusions, $t < 1$, Koreans found believable conclusions to be significantly less believable than did European Americans, $t(58) = 4.63$, $p < .001$. The weaker Korean commitment to the believable conclusions works against finding support for the hypothesis of this study (for invalid arguments), which predicts a *stronger* belief bias for Koreans. Results consistent with this prediction, therefore could not be due to differential commitment to the believable conclusions.

5.2.2. Abstract arguments

Fig. 7 presents the results for the abstract arguments. There was evidence for response bias, such that Koreans were overall less likely to respond "Yes," $F(1, 184) = 14.41$, $p < .001$. To evaluate performance in discriminating valid from invalid arguments while controlling for response bias, a single measure of accuracy was computed: hits (percentage of "Yes" responses for valid arguments) minus false alarms (percentage of "Yes" responses for invalid arguments). There was no cultural difference in accuracy, $t < 1$, $M = 45.1$ and 48.5% for European Americans and Koreans, respectively. Consistent with this pattern, there was no culture by argument validity interaction, $F < 1$. Thus, any cultural differences found in belief bias cannot be attributed to differences in logical reasoning tendency.

As can be seen, participants' reasoning, regardless of culture, tracked the logical structure of the arguments. European Americans and Koreans rated valid arguments as valid at significantly above chance (i.e., 50%), $t(86) = 17.34$, $p < .001$, and $t(98) = 11.42$, $p < .001$, respectively. Similarly, they rated invalid arguments as not valid at significantly above chance, $t(86) = 4.61$, $p < .001$, and $t(98) = 9.75$, $p < .001$, respectively.

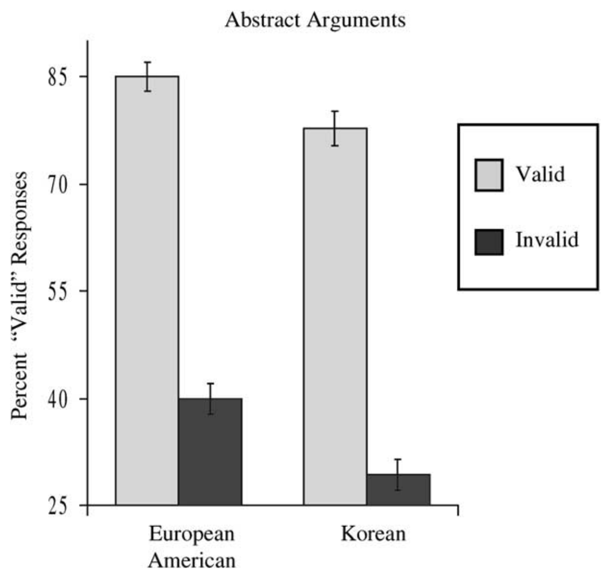

Fig. 7. Deductive reasoning with abstract arguments: percent "valid" responses (Study 4).

5.2.3. Concrete arguments

We anticipated that Koreans, relative to European Americans, would be more likely to evaluate the arguments as valid when the conclusion is believable, and less likely to do so when the conclusion is nonbelievable. A culture by argument validity by conclusion believability ANOVA revealed a main effect of argument validity, $F(1, 184) = 1161.73$, $p < .001$, indicating sensitivity to logical structure; conclusion believability, $F(1, 184) = 90.45$, $p < .001$, indicating a belief bias; and culture, $F(1, 184) = 26.91$, $p < .001$, indicating a response bias (discussed below). Critically, there was a three-way interaction between culture, argument validity, and conclusion believability, $F(1, 184) = 4.73$, $p < .05$. This three-way interaction reflects the fact that the belief bias was stronger for valid than invalid arguments,[2] and that it was larger for Koreans than for Americans, but only for valid arguments. Therefore, the belief bias effect was examined separately for valid and invalid arguments, with culture as a between-groups factor, and conclusion believability as a within-groups factor.

5.2.3.1. Valid arguments. As may be seen in the top panel of Fig. 8, the predicted interaction was obtained: Koreans showed a stronger belief bias effect than Americans, $F(1, 184) = 4.31$, $p < .05$. Overall, there was a belief-bias effect across cultures, $F(1, 184) = 86.45$, $p < .001$. As in abstract arguments, there was a difference in response bias such that Koreans were overall less likely to respond "Yes," $F(1, 184) = 11.82$, $p < .002$.

5.2.3.2. Invalid arguments. Contrary to predictions, no culture by conclusion believability interaction emerged for invalid arguments, $F < 1$ (bottom panel of Fig. 8). The belief bias effect was replicated for invalid arguments, $F(1, 184) = 25.27$, $p < .001$. The response bias across cultures emerged again, $F(1, 184) = 13.43$, $p < .001$.[3]

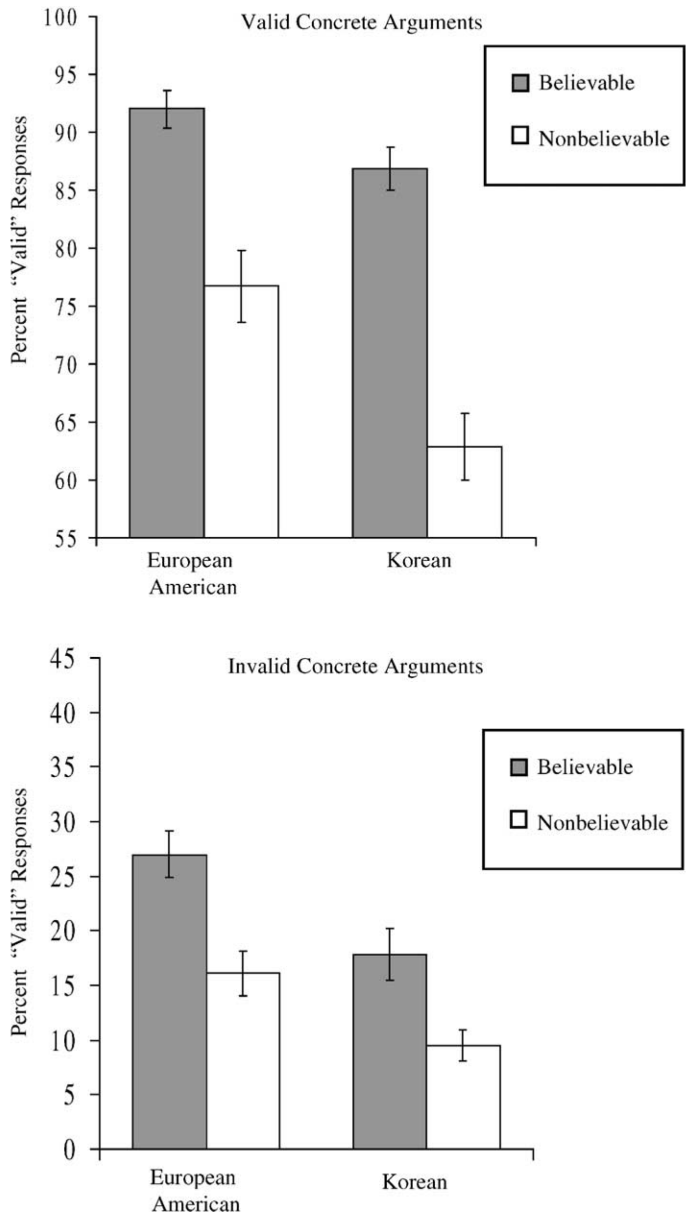

Fig. 8. Deductive reasoning with concrete *valid* and *invalid* arguments: percent "valid" responses (Study 4).

As was the case with abstract arguments, performance in the concrete arguments was well calibrated to logic. All eight comparisons of the means to chance level were significant at $p <$ .001, for European Americans and Koreans, for both believable and nonbelievable arguments.

In sum, Koreans showed a stronger belief bias effect than European Americans, though only for valid arguments. Because European Americans and Koreans showed the same degree of logical reasoning for the abstract arguments, we can conclude that the stronger belief bias of

Koreans was not due to differences in logical reasoning ability, but rather to differing tendencies to decontextualize the content of an argument from its logical structure.

6. General discussion

The present research investigated cultural preferences for formal and intuitive reasoning. Formal reasoning is rule-based, emphasizes logical inference, represents concepts by necessary and sufficient features, and overlooks sense experience when it conflicts with rules or logic. Intuitive reasoning is experience-based, resists decontextualizing or separating form from content, relies on sense experience and concrete instances, and overlooks rules and logic when they are at odds with intuition.

We compared the reasoning of European American, Asian American, and East Asian university students, under conditions where a cognitive conflict was activated between formal and intuitive strategies of thinking. The central hypothesis was that European Americans would be more willing to set aside intuition and follow rules than East Asians. The results were overall consistent with the hypothesis.

Although in each study we strived to rule out obvious methodological artifacts, it is possible that each individual finding could be subject to an alternative explanation. For this reason, we note that each specific cultural difference reported in this paper should be interpreted with caution. However, our strategy of seeking converging evidence from four rather different paradigms, using different sets of instructions, tasks, stimuli, and cultural samples suggests that the best explanation for the cognitive differences that emerged in these studies is that there are different cultural preferences for the use of cognitive strategies to solve the same problem.

We now consider two alternative explanations for the overall pattern of cultural differences. First, it is possible that East Asians are less practiced than Americans with experimental situations such as these, and as a result performed less well on such cognitive tasks which happened to favor rule-following. Because the presumed difference in familiarity applies to the experimental situation, in general, cultural differences should have emerged in all tasks and conditions. However, this was clearly not the case. Differences emerged only when formal and intuitive strategies were in conflict. European Americans and East Asians performed similarly when there was no conflict between the two strategies (positive matches in the Rule Condition of Study 1), when they were instructed simply to implement an intuitive strategy (*exemplar-memory condition* in Study 1), or a formal strategy (*abstract deductive reasoning* in Study 4).

The second possibility is that the cultural groups did not differ in reasoning tendencies, but perhaps they differed in the way they interpreted the experimental setting (Orne, 1962). That is, European Americans and East Asians had different hypotheses regarding the experimenter's expectations about what is a preferable mode of reasoning, and the cultural differences reflected different patterns of hypothesis guessing. Although this consideration cautions us about extending these findings to settings outside of the laboratory, we believe this explanation is unlikely to account for the entire pattern of results. In two of the studies, participants were clearly and explicitly instructed to use a formal strategy (Studies 1 and 4); therefore, European American and East Asian participants presumably had similar awareness of the experimenter's expectation that the formal strategy is the appropriate one to use. Nevertheless, we found significant cultural differences in the extent to which the intuitive strategy "interfered" with the formal strategy.

The results for Asian Americans revealed that they were either similar to European Americans, or intermediate between European Americans and East Asians, possibly reflecting a substantial though not complete socialization into the Western mode of thought. Because Asian Americans are exposed to many of the same extrafamilial experiences as European Americans (in that they largely experience the same societal and educational environment), but are likely to differ in the kinds of intrafamilial and peer socialization they experience, this finding suggests that cognitive socialization is at least partly due to proximal influences.[4]

6.1. *Possible social origins of the cultural differences in reasoning*

Why are Western and East Asian participants biased towards different modes of reasoning? The attempt to answer this important question must of course be speculative at this time because it involves complex sociological and historical issues beyond the scope of this paper, and we leave it as an open question for the future. Here we mention briefly three factors that have been identified by philosophers, ethnographers, and social historians (for a fuller discussion, see Nisbett et al., 2001). First, the practice of *adversarial debate* prevalent in Western cultures, as opposed to the practice of consensus-based decision making prevalent in East Asia have been linked to analytic versus holistic cognitive orientations, respectively (e.g., Lloyd, 1990; Ohbuchi & Takahashi, 1994). Second, *pedagogical practices* emphasizing critical thinking in Western classrooms, as opposed to experience-based learning in Chinese classrooms appear to encourage differing modes of thinking in Western and East Asian societies (On, 1996; for a review, see Tweed & Lehman, 2002). Third, many historians of science and philosophy both Western and East Asian have reported important cultural differences in the dominant *philosophical traditions* that have influenced the intellectual practices in the West and East. Early Greek and Chinese philosophy, science, and mathematics were quite different in their strengths and weaknesses. Many Greek philosophers looked for universal rules to explain events and were concerned with categorizing objects with precision and with respect to their "essences." There was a marked distrust of intuition. Chinese philosophers, especially Taoists, were more pragmatic and intuitive, and were distrustful of formal logic and rational distinctions (Fung, 1952; Liu, 1974; Lloyd, 1990, 1996; Nakamura, 1960/1988; Needham, 1954; Russell, 1945; for a discussion of the evidence, see Norenzayan, 2001).

We found cognitive differences in reasoning that to some degree mirror differences in philosophical traditions. As provocative as this congruence may be, we cannot know at this time if these traditions are actually implicated in such reasoning processes. Whether or not there is psychological continuity between these philosophical traditions and reasoning processes remains an open question. The findings reported in this paper and elsewhere (see Nisbett et al., 2001) can serve as one starting point for such interdisciplinary investigation.

6.2. *Normative considerations: reasoning strategies as tools for thought*

Although a full examination of normative issues is beyond the scope of this paper, it is nevertheless important to mention several normative considerations.

A general point about analytic and holistic thinking is that each mode of thought produces a mixed bag of normative and non-normative outcomes. For example, in deductive reasoning, analytic thinkers tend to respond more logically than holistic thinkers, but in causal attribution, the former more readily commit the fundamental attribution error than the latter (Norenzayan & Nisbett, 2000). Conversely, holistic thinkers are more accurate in covariation detection (Ji et al., 2000), yet they are more vulnerable to hindsight bias (Choi & Nisbett, 2000). Thus, neither the analytic nor the holistic mode guarantees accuracy in reasoning.

In two studies presented here, the East Asian reliance on intuitive processes led to less accurate responses than the American reliance on rule-based approaches. In Study 1, East Asians made more errors when asked to categorize the negative matches—for which a conflict existed between rule-based and exemplar-based judgments. We note, however, that under other task conditions, intuitive responses could lead to *more* accurate responses than would formal processes. In fact, many life circumstances present us with poorly structured cognitive problems that may favor intuitive strategies. This can occur when a rule is poorly defined, or only partially predictive. For example, in the category learning procedure of Study 1, suppose the rule were made only partially predictive of the categories, such that it would accurately predict category membership for positive match animals, but would predict the *wrong* category for negative match animals. In such a situation, it has been shown that switching to an exemplar-based strategy leads to superior overall performance than continuing to use the rule (e.g., Allen & Brooks, 1991, Experiment 4), and East Asians might perform more accurately than European Americans (a proposal that remains to be tested).

East Asians also made more errors in Study 4, in which they were explicitly asked to judge the logical validity of the concrete arguments, as opposed to their plausibility or convincingness. Though this is an error, and undoubtedly one that would have been acknowledged by the participants themselves given their performance with fully abstract materials, it is the result of a bias that does not always yield less reasonable conclusions than the rationalistic bias of Westerners. Indeed, many East Asian scholars have noted that in East Asian cultures logic does not enjoy the normative status that it does in the West. In Japanese culture, for example, "to argue with logical consistency is thus discouraged, and if one does so continuously one may not only be resented but also be regarded as immature" (Nagashima, 1973, p. 96). Liu (1974) makes a similar point about China when he writes, ". . . it is precisely because the Chinese mind is so rational that it refuses to become rationalistic and . . . refuses to separate form from content" (p. 325). Consistent with these assertions, recent evidence indicates that Koreans rank "being an intuitive person" to be important for work success more than Americans, whereas the opposite is true for "being a logical person" (Norenzayan & Sanchez-Burks, 2002). Furthermore, in some of the research conducted by our colleagues, European Americans have been shown to make errors, in their efforts to be logically consistent, that actually result in judgments that are incoherent in the sense that one judgment actually follows from the opposite of the other (Peng & Nisbett, 1999; Davis et al., 2000). These errors were avoided by East Asian participants, who, however, made logical errors of their own in their attempts to reconcile opposing views.

The philosopher Stich (1990) has said that "there are no intrinsic epistemic virtues . . . cognitive mechanisms or processes are to be viewed as tools or policies and evaluated in much the same way that we evaluate other tools or policies" (p. 24). If there are culturally diverse ways to go about the business of cognition, and if there are culturally diverse systems of justification which serve the needs of various cognitive communities, then the reasonable philosophical position would be to evaluate thinking in terms of the local standards of justification, as well as specific task requirements (Stich, 1990; see also Resnick, 1994). This is not to say that it is unreasonable to criticize specific inferential practices, even by the standards of another culture, but that criticism must be cognizant of inferential goals and cultural context.

Notes

1. In this study, *typicality* describes a kind of intuitive reasoning distinct from *family resemblance*. Typicality is used to refer to peoples' intuitions about the "goodness" of naturally occurring exemplars, whereas family resemblance is objectively determined as the proportion of features shared among category members, as in Study 2.
2. That the belief bias was larger for *valid* than invalid arguments is surprising. Typically, the belief bias tends to be larger for *invalid* than valid arguments (Evans & Over, 1996; Newstead et al., 1992). However, this interaction can be reliably eliminated, and even non-significantly reversed, when (1) strong instructions are used that emphasize logical reasoning and logical necessity, or (2) when the invalid arguments are *determinately invalid*, that is, invalid because the conclusion definitely fails to follow from the premises. In contrast, *indeterminately invalid* arguments are invalid because the premises give insufficient information to judge whether the conclusion holds or not (Evans, Handley, Harper, & Johnson-Laird, 1999; for a discussion, see Newstead et al., 1992). Both of these factors were simultaneously present in this study. That is, very strong logical instructions were used, and three of the four invalid argument forms were determinately invalid. This could explain why the impact of belief was reversed, i.e., a stronger belief bias effect was found for valid arguments.
3. Two of the four argument forms used in this study did not have "ALL" quantifiers for the second premise and the conclusion (second and third argument forms in Table 3). It is possible that this could have created quantifier ambiguity, i.e., interpreting them in terms of existential (SOME) instead of universal (ALL) quantifiers. Note, however, that there was no evidence in the solution rates to these particular arguments that this was the case. Nor is there any reason to believe that this potential ambiguity was any different for the two cultures. Nevertheless, we reanalyzed the data by considering only the argument forms that explicitly stated all the quantifiers (first and fourth argument forms in Table 3, for a total of eight arguments). Almost identical results were obtained: there was a main effect of logic, $F(1, 184) = 696.50$, $p < .001$; a main effect of belief, $F(1, 184) = 85.35$, $p < .001$; a main effect of culture, $F(1, 184) = 26.72$, $p < .001$ (reflecting the difference in response bias), and a three-way logic by belief by culture interaction, $F(1, 184) = 5.17$, $p < .03$, indicating a stronger belief bias for Koreans, but only for valid arguments. Culture by belief interaction for valid arguments, $F(1, 184) = 3.07$, $p = .08$, and for invalid arguments, $F(1, 184) = 1.95$, ns.
4. Although this research was not concerned with gender, *post hoc* analyses were conducted to examine gender differences in thinking except for Study 1 (where there was an inadequate sample size). Overall, there was some tendency for women to follow

intuitive strategies more than men. In Study 2, women were more likely to follow a family resemblance strategy in the *similarity judgment condition* than men, although the difference did not reach significance ($p = .10$). No gender differences were found in the *classification condition*. In Study 3, women showed a stronger typicality effect than men in the *high salience of typicality condition*. No gender differences were found in the *low salience of typicality condition*. In Study 4, no gender differences were found for abstract arguments, and for concrete invalid arguments. Women showed stronger belief bias compared to men for concrete valid arguments only. Importantly, the gender differences in all instances were orthogonal to the cultural differences. The analyses for gender differences are available from the first author.

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