Title

East-West Revisited: Is Holistic Thinking Relational Thinking?

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Abstract

Analogical reasoning is at the core of human cognition, but is it universal? Do people from different cultures reason analogically in the same way? Despite the prevalence of analogical research, to date, there is almost no cross-cultural work investigating analogical reasoning in adults from non-WEIRD cultures. Here we fill this important gap by revisiting a long-standing cross-cultural difference—the holistic-analytic difference among Easterners and Westerners (Nisbett, 2001)—to ask whether this difference is also evident in analogical reasoning. Decades of cross-cultural research showed that Easterners are more attentive to contextual relations than Westerners, giving way to an untested presumption that Easterners are more relational, more analogical than Westerners. We tested this assumption using the classic holistic-analytic task and scene analogy mapping task with US and Chinese participants. While we replicated the holistic-analytic (East-West) difference, US and Chinese participants did not differ in the analogy task.

Keywords: analogical reasoning; cross-cultural study; holistic-analytic thinking

Introduction

Analogical reasoning—the ability to perceive the sameness of relations across domains and events—is at the core of human cognition (Hofstadter, 2001; Penn et al., 2008). Analogical reasoning is essential in wide-ranging areas of cognition, from causal reasoning and problem-solving, to literature creation and language acquisition to enabling scientific discoveries (Gick & Holyoak, 1980; Gentner, 2003; Murphy, 2004).

Given the fundamental nature of analogy, an important question is whether analogical reasoning universal: do people from different cultures reason analogically in the same way? A recent review analyzing cross-cultural analogical developmental studies suggests that they may not (Christie, Gao, Ma, 2020). For example, Japanese 4-year-olds showed better performance in analogical reasoning tasks compared to the US children (Kuwabara & Smith, 2012). Likewise, Chinese 3-year-olds could match relations in a simple relational task while their US peers could not (Carstensen et al., 2019). But since there are only very few studies of

analogical development across cultures, we cannot yet derive a clear pattern of the universality and/or cross-cultural differences of analogical development.

The lack of cross-cultural analogical studies is even direr among adults. To our knowledge, no work directly examines whether adults from different cultures reason analogically in the same way. To address this important gap, we decided to test a prevailing, yet untested assumption that Easterner adults are better analogical reasoners than Westerners.

This prevailing assumption—that Easterners are better in analogical reasoning than Westerners—comes from an extremely rich body of research showing that Easterners are more "relational" than Westerners (Nisbett, 2001). The main argument is that people from interdependent culture (such as China and Japan) are more attentive to relations between self and others as well as among people in their society, whereas people from independent culture (e.g., the US) are more focused on the self. These differences in *holistic vs. analytic thinking* (Nisbett et al., 2001) translate to differences in perception, memory, and categorization. For example, in the classic aquarium task by Masuda and Nisbett (2001) participants were asked to observe a scene (e.g., an aquarium) containing focal objects, active objects, inert objects, and background. Later, participants were asked to describe what they have seen from memory. Japanese participants reported more relational content about the scene (i.e., the fish is passing the rock) rather than talking solely about the object itself (i.e., I have seen a golden fish) compared to American participants. That is, Japanese participants showed greater attentional biases toward relational and contextual information than American participants. Similar results were also obtained with Chinese vs. US participants (Chua et al., 2005). Using an eye-tracking paradigm for another version of the focal-background task, this study found that Americans attended more exclusively to focal objects, while Chinese participants attended to both focal objects and background. Indeed, many other perception and memory studies have replicated these East-West differences (e.g., Ji et al., 2000; 2001; Choi et al., 2007; Kitayama et al., 2003; 2009).

Since analogical reasoning is predicated upon relational reasoning—to perceive analogical matches is to perceive the sameness of relations—it is logical to presume that superior

attention to relations should be generalized into superior analogical reasoning. That is, we should expect that adults from interdependent cultures (Easterners) should be better in their analogical reasoning than adults from independent cultures (Westerners). Indeed, as we mentioned before, a few developmental studies confirmed this prediction: children from Japan and China are better than their US counterparts in analogical reasoning tasks (but see recent evidence from Murphy et al., 2021 refuting this conclusion).

At the same time, there are reasons to suspect that Easterners' analogical reasoning may not be superior/different than that of Westerners. This is because one component of holistic reasoning: thematic thinking, does not map to analogical reasoning. Other than the perception and memory studies we have reviewed, East-West (Holistic-Analytic) differences have also been characterized as differences in categorization. In a typical paradigm, participants are given three objects (e.g., monkey, panda, banana) and asked to group them into two categories. Chinese participants are more likely to group items thematically (monkey-banana; panda), whereas US participants are more likely to group items taxonomically (monkey-panda; banana) (Ji et al., 2000; 2004). This East-West difference pattern of categorization has been quite robust, and in fact, Easterners' thematic thinking has been synonymized with "relational thinking" (Estes et al., 2012). But in analogical reasoning (e.g., Structure Mapping Theory (Gentner, 1983; Markman & Gentner, 1997)), thinking about thematic relations *per se* does not help analogical reasoning because analogical reasoning is about perceiving the similarity of *any* relation, be that relation a thematic relation or a taxonomic relation. That is, the tendency to favor one kind of relation (thematic relation) should not translate into superior domain-general analogical reasoning. From this perspective, we do not expect that Eastern adults should be superior in their analogical reasoning compared to Western adults.

In sum, a rich body of research on East-West cognitive style differences offer both possibilities: 1) That Easterners are superior to Westerners in analogical reasoning; or 2) The two cultures do not differ in their analogical reasoning. The prevailing assumption, however, is (1): that Easterners are superior to Westerners in analogical reasoning. To test this, and to begin filling the gap of cross-cultural analogical studies, we test US and Chinese participants (from mainland China) in two classic tasks: a scene analogy mapping task (Markman & Gentner, 1993) and a thematic-taxonomic categorization task (Ji, et al., 2004). We expect to replicate the East-West differences in the thematic-taxonomic task, where participants from China are more thematic while US participants are more taxonomic. The critical question is whether this cultural difference carries over to the scene analogy task: do Chinese participants perform better in the analogy task than US participants?

Study 1

Given established cognitive style differences in Easterners vs. Westerners, we asked whether these differences are also found in analogical reasoning. To do this, we test participants from US and mainland China in scene analogy mapping task (Gentner & Markman, 1993) and thematic-taxonomic categorization task (Ji et al., 2004). We select these two tasks as each is the standard task in measuring adults' analogical reasoning and holistic-analytic thinking respectively. In addition, to bolster the holistic-analytic differential analysis, we also include a standard measure of independent-interdependent scale as a comparison for holistic-analytic difference (Lu & Gilmour, 2007). Our question is whether the US vs. Chinese participants will show differential performance in both analogy and holistic-analytic tasks, or whether they only differ in the holistic-analytic task.

Method

Participants Two hundred and twelve Chinese participants (104 male, 108 female, M_{age} = 22.49 years, SD = 2.75, range = 18 – 34 years), and one hundred and ninety-six US participants (88 male, 105 female, 3 others, M_{age} = 25.00 years, SD = 2.50, range = 18 – 35 years) participated in Study 1. The study was conducted online. US participants were recruited from Amazon M-Turk, while Chinese participants were recruited from wjx.cn, a Chinese platform comparable to M-Turk.

To reduce variability of experimental environment, we explicitly instructed participants to use mobile phones to complete the study. Thirty-three participants who did not follow this instruction were excluded from the final analysis, yielding a final sample of 375 participants, 178 US, and 197 Chinese participants.

Materials and Design Participants completed three tasks: scene analogy mapping task (Markman & Gentner, 1993), thematic-taxonomic categorization task (Ji et al., 2004), and interdependence-independence self-construal scale (Lu & Gilmour, 2007). We adapted all original materials into an online format. The order of presentation of the analogy and thematic-taxonomic tasks was counterbalanced, self-construal scale was always presented last.

Procedure To reduce the variability of presentation sizes, all participants completed the study on a mobile phone. While there are still screen size variations on mobile phones, we reasoned that this variation is still smaller than computers-tablets-mobile phones variation.

For the scene analogy task, participants were asked to select the object in the bottom picture that was "more similar" to the object pointed by the arrow in the top picture. The instruction was the same in Chinese; "similar" was translated into "相似" (xiāng sì). There were three options to choose from in the bottom picture: an analogical match (object occupying the same relation as the arrowed object on the top picture), an object match (an identical-looking object), and a

distractor (an irrelevant object) (see Figures 1a,b). If participants perceived the analogical match, then they should choose the relational match rather than the object match or the distractor. The instruction of choosing a similar match was left deliberately open; participants could interpret it to mean either a similar relation or a similar object.
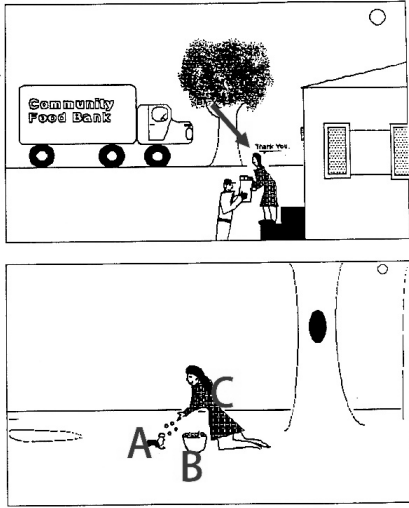

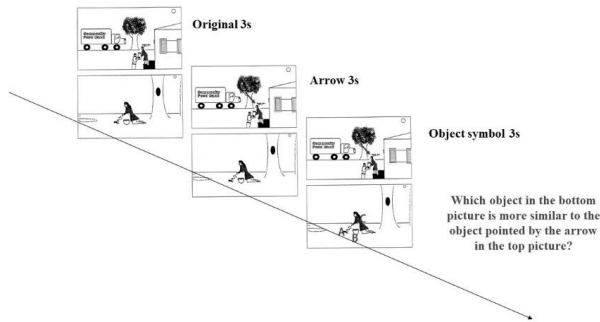Figure 1a. Sample of eating relation in analogy task.

Figure 1b. Demonstration of the process in analogy task.

For the thematic-taxonomic categorization task, in each test trial participants were given three items (e.g., "monkey-panda-banana"); their task was to choose two of the three items that were more closely related. There were 10 test trials and 10 fillers—items that were not related either in a thematic or a taxonomic way (e.g., "bank-hospital-cinema"). Participants' answers were coded into Thematic (if they chose monkey and banana), Taxonomic (monkey-panda), or Irrelevant. All items and procedures were identical to the original study (Ji et al., 2004), except for one modification: we eliminated the explanation process. In the original task, participants were asked to explain their answers (why they categorized the items as such) for every trial. We eliminated this because in pilot study many participants reported the explanation process rendered the study tedious and lengthy, resulting in non-completion of the whole study. As such, we

decided to only collect the categorization answer, without asking participants to justify their answers.

After the Analogy and Thematic-Taxonomic tasks (the presentation order of these two tasks was counterbalanced across participants), participants completed the self-construal scale (Lu & Gilmour, 2007). This scale corresponded to the concept of self-construal (Markus & Kitayama, 1991), measuring the relationship between self and others, one's behavior towards others, and decisions in social life. Participants rated 42 statements from 1-7 (1-strongly disagree, 7-strongly agree), 21 statements for independence self-construal, and 21 statements for interdependence self-construal. The order of appearance of the statements was randomized.

Finally, participants reported their basic demographic information, such as the place they mainly grew up in (the state/the province), gender, age, and education level.

Results and Discussion

We first analyzed the data from the thematic-taxonomic categorization task. Consistent with prior literature, Chinese and US participants indeed differed in their categorization patterns. Chinese participants chose more thematic choices compared to the US participants, $t (373) = 5.082$, $p < .001$, 95% CI [.080, .180]; while US participants chose more taxonomic choices compared to Chinese participants, $t (373) = 4.912$, $p < .001$, 95% CI [.074, .173] (Figure 2). To corroborate this East-West difference, we analyzed data from the self-construal scale. Again, consistent with prior findings, Chinese participants received higher scores in the interdependence self-construal, $t (373) = 7.935$, $p < .001$, 95% CI [9.173, 15.223], while US participants received marginally higher scores in independence self-construal scale, $t (373) = 1.797$, $p = .073$, 95% CI [-.238, 5.277]. In sum, Chinese participants were more holistic and interdependent, while US participants are more analytic and independent.
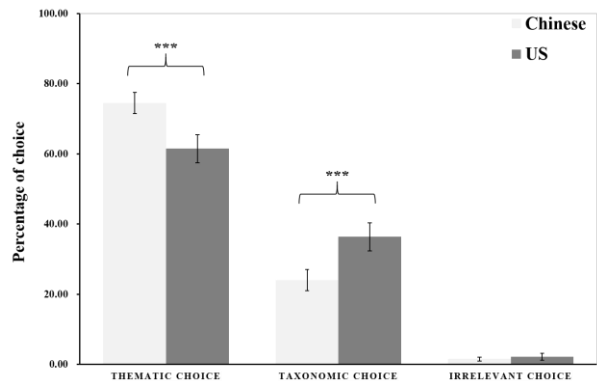

Figure 2: Participants' choices of thematic, taxonomic, and irrelevant choice in Study 2. US and Chinese participants differed in their thematic and taxonomic choices.

Having replicated the holistic-analytic cognitive style difference between Chinese and US participants, the critical question was whether participants differed in their analogical

reasoning. Our results clearly showed that US and Chinese participants did not differ in their analogical reasoning, as measured by scene analogy task. Chinese participants selected the relational (analogical) match at 18.0% (M = .180, SD = .234), while the US participants did so at a comparable rate of 18.9% (M = .189; SD = .206). US and Chinese participants also did not differ in their selection of object matches: Chinese participants selected object match at 78.5% (M = .785, SD = .260), while US participants selected object match at 77.7% (M = .777, SD = .216) (Figure 3).
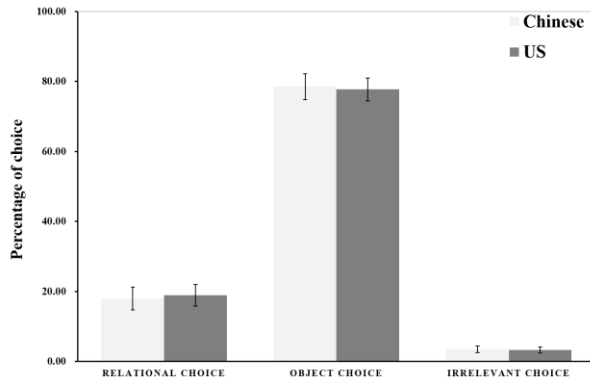

Figure 3: Participants' selection of relational choice, object choice, and irrelevant choice in Study 1. US and Chinese participants did not differ in their selection pattern.

To further analyze participants' analogical reasoning across cultures, we looked at individual patterns of responding, categorizing each participant as a Relational Chooser (choosing the relational choice in at least 7 out of 8 trials), or Object Chooser (choosing object choices in at least 7 out of 8 trials). Under this criterion, there were 211 Object Chooser (118 Chinese, 93 US), and only 7 Relational Matcher (5 Chinese, 2 US). These numbers showed an overwhelming bias for choosing object over relational matches. Importantly, this tendency is the same across the two cultural groups, χ^2 (1, n = 218) = 3.596, p = .058.

Next, we analyzed whether there was any correlation between scores in the self-construal scale, thematic-taxonomic choices, and performance in the scene analogy task. Pearson's correlation analysis showed that scores on the interdependence scale were positively correlated with thematic choices *(r (375) = .132, p = .011)*, that is, the participants who scored higher on the interdependence scale were also more likely to make thematic choices. Interestingly, however, scores of the interdependence scale were negatively correlated with relational choices in the scene analogy task *(r (375) = -.103, p = .046)*. That is, contrary to the prevailing assumption that people with greater interdependence cognitive style should be more relational, our results suggest that higher interdependence predicts a lower level of analogical reasoning. No other correlations across the three tasks were significant.

In conclusion, in Study 1, we replicated previous cross-cultural findings that Easterners were more holistic than

Westerners. Surprisingly, however, this difference did not translate to analogical reasoning differences as measured by the scene analogy task; participants from US and China were equally likely to choose object matches over relational matches. To our knowledge, this is the first study that documented cross-cultural similarity in analogical reasoning, while at the same time replicating the East-West holistic-analytic difference. Because our study was the first one that used the scene analogy paradigm in a Chinese context, it was critical to replicate the finding. We did so in Study 2.

Study 2

In Study 1, we found that both Chinese and US participants preferred object similarity over relational similarity in the scene analogy task. Participants in Study 1 were instructed to

choose the item that was most "similar"/"相似(xiāng sì)" to the target item. The instruction and its corresponding translation may influence participants' selection of choices, making participants think more of perceptual similarity rather than relational similarity. For this reason, in Study 2 we adopted a more open-ended instruction for the same scene analogy task, using the phrase "goes with" instead of the phrase "similar to" of Study 1. The full instruction in Study 2 was: "Which object in the bottom picture *goes with* the object pointed by the arrow in the top picture?". The Chinese translation of "goes with" was 匹配 (pǐ pèi). We wanted to know whether this change of wording affects participants' relational choices. Importantly, Study 2 also served as a replication test, examining whether the non-differential analogy performance found in Study 1 was robust. We also ran the thematic-taxonomic categorization task and the self-construal scale in Study 2; these tasks were identical to Study 1.

Method

Participant One hundred and fifteen Chinese participants (46 male, 69 female, M_{age} = 21.74 years, SD = 2.16 years, range = 18 – 27 years), and ninety-five US participants (44 male, 51 female, M_{age} = 24.52 years, SD = 2.15 years, range = 19 – 34 years) participated in Study 2. Ten participants were excluded from the final analysis because they used devices other than mobile phones, yielding a final sample of 200 participants, 86 US and 114 Chinese participants. As in Study 1, Chinese participants were recruited from wjx.cn, and US participants were recruited from Amazon M-Turk.

Materials and Procedure As in Study 1, participants completed three tasks: the scene analogy task, the thematic-taxonomic categorization task, and the self-construal scale. The materials and procedure are identical to Study 1, with one exception: a change of wording instruction in the scene analogy task. Instead of "Which object in the bottom picture is more *similar to* the object pointed by the arrow in the top picture?", in Study 2 the instruction was changed to "Which object in the bottom picture *goes with* the object pointed by the arrow in the top picture?" The phrase "goes with" was

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translated as 匹配（pǐ pèi）in Chinese. No other changes were made in Study 2.

Results and Discussion

We first analyzed participants' taxonomic-thematic categorization pattern. As in Study 1, Chinese and US participants differed in their categorization pattern: Chinese participants chose more thematic choices compared to US participants, $t (198) = 2.048$, $p = .042$; while US participants chose more taxonomic choices compared to Chinese participants, $t (198) = 2.297$, $p = .023$ (Figure 4). Likewise, we replicated Study 1's results of self-construal scale. Chinese participants received higher scores in the interdependence self-construal, $t (198) = 5.635$, $p < .001$, 95% CI [8.299, 17.485], while US participants received higher scores in the independence self-construal scale, $t (198) = 2.444$, $p = .015$, 95% CI [.876, 8.199].
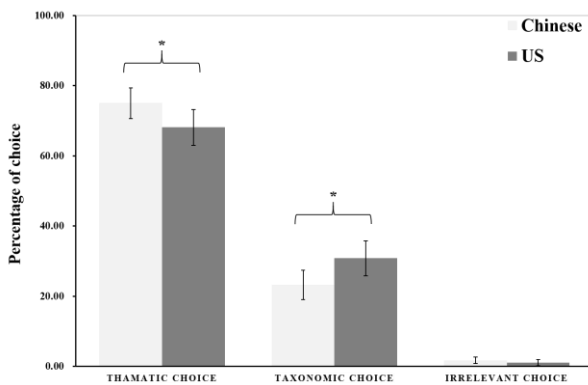

Figure 4: Participants' choices of thematic, taxonomic, and irrelevant choice in Study 2. US and Chinese participants differed in their thematic and taxonomic choices.

Next, we analyzed the participants' performance in the scene analogy task. As in Study 1, Chinese and US participants did not differ in their relational choices. Chinese participants chose relational matches at 28.3%, while US participants chose relational matches at 22.7% ($t (198) = 1.825$, $p = .070$, 95% CI [-.005, .117]). As before, US and Chinese participants did not differ in their selection of object matches: Chinese participants selected object matches at 67.5%, while US participants selected object matches at 72.4% ($t (198) = -1.384$, $p = .168$) (Figure 5).

As in Study 1, we analyzed the individual pattern of relational and object choices, categorizing participants as either Relational Chooser (choosing the relational choice in at least 7 out of 8 trials) or Object Chooser (choosing object choices in at least 7 out of 8 trials). Under this criterion, there were 82 Object Choosers (46 Chinese, 36 US), and only 4 Relational Choosers (4 Chinese). As in Study 1, the pattern of Relational and Object Choosers did not differ across cultures, $\chi^2 (1, n = 86) = 2.279$, $p = .131$. There were no significant differences in terms of gender, age, and education level; these variables did not correlate with analogical performance.
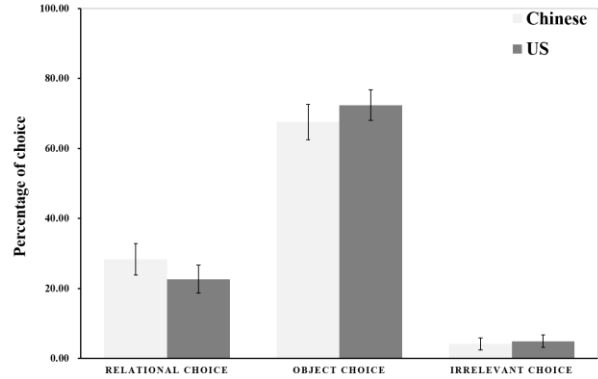

Figure 5: Participants' selection of relational choice, object choice, and irrelevant choice in Study 2. US and Chinese participants did not differ in their selection pattern.

Next, we analyzed whether there was any correlation between scores in the self-construal scale, thematic-taxonomic choices, and performance in the scene analogy task. In contrast to Study 1, we did not find significant correlations between interdependence scale and analogical performance. Instead, Pearson's correlation analysis showed a negative correlation between participants' independence score and their relational choices in the scene analogy task, r (200) = -.140, p = .048. It is unclear why we found this opposite pattern.

Comparison of Study 1 and Study 2

Did the change of wording from "similar to" to "goes with" affect performance in the scene analogy task? We compared results from Studies 1 and 2 for each cultural group. For Chinese participants, the change of wording resulted in higher relational choices (Study 1 $M_{relational} = .180$ vs. Study 2 $M_{relational} = .283$, $t (309) = 3.699$, $p < .001$, 95% CI [.048, .158]) and lower object choices (Study 1 $M_{object} = .785$ vs. Study 2 $M_{object} = .675$), $t (309) = -3.535$, $p < .001$, 95% CI [-.170, -.049]. For US participants, the phrase "goes with" slightly reduced their object choices (Study 1 $M_{object} = .777$ vs. Study 2 $M_{object} = .724$, $t (262) = -1.915$, $p = .057$). But the wording did not significantly affect participants' relational choices (Study 1 $M_{relational} = .189$ vs. Study 2 $M_{relational} = .227$, $t (262) = 1.433$, $p = .153$). While the change of wordings slightly elevated relational responding among Chinese participants, both Chinese and US participants selected more object choices than relational choices. This pattern of responding remains. As in Study 1, US and Chinese participants did not differ in the scene analogy task, both groups selected more object choices than relational choices.

There was no significant difference between Study 1 and 2 in the thematic-taxonomic task and the self-construal scale. Overall, the results of Study 2 replicated Study 1: we found differences between US and Chinese participants in classic analytic-holistic tasks, but US and Chinese participants did not differ in their analogical reasoning, as measured by the scene analogy mapping task.

General Discussion

In this study, we asked whether analogical reasoning is universal by revisiting the East-West holistic-analytic cognitive style difference. Rather than using the approach of doing an analogy study with any non-WEIRD cultures, we focused on the East-West difference because there is an untested presumption that Easterners are superior in their analogical reasoning. This presumption stems from many findings that participants from interdependent cultures pay more attention to relations among objects and people compared to participants from the West. So much so that this holistic thinking has also been termed "relational thinking" – the same term that is used to characterize analogical thinking. But is relational-holistic thinking the same as relational-analogical thinking? To our knowledge, no previous studies have directly probed this question. Yet this understanding is important for a comprehensive view of what "relational thinking" means.

To address the theoretical and cross-cultural gap we used classic tasks that have been used extensively in prior literature to measure analogical reasoning and holistic-analytic cognitive style difference. However, in the past, these tasks have not been compared within a single study. When tested with two tasks of holistic-analytic, we indeed found that US and Chinese participants differed, replicating the general East-West trend that had been found in the literature. Specifically, when asked to categorize items (e.g., monkey-banana-panda), Chinese participants gave higher thematic answers (monkey-banana) than did US participants while US participants gave higher taxonomic answers (monkey-panda) than did Chinese participants. There is a slight difference in our results compared to previous findings (e.g. Ji et al., 2000; 2004) where participants were more likely to favor the thematic over the taxonomic categorization. But within this pattern, the East-West difference remains. This East-West difference is also evident when measured by another holistic-analytic task: the self-construal scale. In two studies, we found that Chinese participants scored higher in the interdependent scale compared to US participants, while US participants scored higher in the independence scale compared to Chinese participants. This finding replicated the typical East-West differences.

The critical question is whether this East-West difference carries over to an analogy task. We used a scene analogy mapping task (Markman & Gentner, 1993) because it is a standard, classic task, which has been extensively used to measure adults' relational mapping. Contrary to the prevailing (but untested) assumption that Easterners are more relational, we did not find differences in analogical reasoning between Chinese and US participants. This non-differential results in analogical performance did not change after we changed the wordings in Study 2 ("goes with/匹配 (pǐ pèi)," suggesting the robustness of the results.

Instead of Easterners showing better analogical reasoning, participants from the US and China preferred to match the targets to object matches rather than to relational matches. This pattern of mapping is similar to the original study (Markman & Gentner, 1993), where US participants chose the object matches 56% of the time. In our study, the preference for object match is slightly elevated, in that participants chose object match at 67.5-78.5%. One possible explanation for this elevated incidence of object matching is that the options (object match, relational match, and distractor) were labeled with letters (A, B, C). This was necessary because our studies were conducted online, so participants used the letters to indicate their choices. In the original Gentner & Markman (1993) study participants were given the scenes and freely pointed to the picture that they thought was the match. It is possible that the labels in our study made participants more likely to attend to object matches. A similar effect had been found with children—after being trained with noun labels, children were even more likely to map targets to object matches (Shao & Gentner, 2016)

Why did US and Chinese participants not differ in their analogical mapping? We discussed possible explanations that motivate further research on holistic-analytic and analogical-relational thinking. First, it's possible that Chinese participants could have higher relational responses had the mapping task not included an object match competitor. While our study is the first to compare US and Chinese adults on an analogy task, there have been cross-cultural studies comparing children's relational performance (e.g., Kuwabara & Smith, 2012; Carstensen et al., 2019; see a recent review by Christie, Gao, & Ma, 2020). These studies in general found that children from Eastern cultures (China and Japan) were more relational than their Western (US) peers. However, as noted by Christie et al., 2020, none of those cross-cultural comparisons have directly pitted relational and object matches. That is, Eastern children are better relational reasoners when the task requires relational matching alone. Indeed, a very recent cross-cultural work supports this pattern. Murphy et al. (2021) tested US and Chinese children in a scene analogy task—an almost identical task to the one used in our study—and found that while Chinese children outperformed their peers when the task did not involve object matches, the two groups did not differ when there were object matches in the scenes. Murphy et al. (2021) proposed that reasoning analogically required executive function (EF) ability (Richland et al., 2013; Simms et al., 2018), in particular, participants had to inhibit a preference for object matching to match based on common relations. If we extend this hypothesis to our current findings with adults, one possible explanation is that Chinese and US participants do not differ in the scene analogy task because the two cultural groups do not differ in their EF.

The EF explanation gives rise to an important theoretical point for both relational-analogical reasoning and holistic-analytic cognitive style. It may be intuitive to presume that participants from holistic cultures who pay more attention to relations should also be more relational-analogical. But relational-analogical thinking does not automatically overlap with relational-holistic thinking. Our study only begins to explore this point. In a series of ongoing work, we again

compare US and Chinese participants, this time using a different analogy task (e.g., one without object matches) and a different holistic-analytic task (e.g., an aquarium scene task, directly measuring relational attention). Since both holistic-analytic cognitive styles and analogical reasoning are fundamental to human cognition, understanding the similarities and differences between these two are critical to our understanding of how humans think--to what extent culture shapes our cognition.

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