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Cross-cultural differences in cognitive development: Attention to relations and objects

Megumi Kuwabara *, Linda B. Smith

Department of Psychological and Brain Sciences, Indiana University, Bloomington, IN 47405, USA

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ABSTRACT

Growing evidence indicates a suite of generalized differences in the attentional and cognitive processing of adults from Eastern and Western cultures. Cognition in Eastern adults is often more relational and in Western adults is more object focused. Three experiments examined whether these differences characterize the cognition of preschool children in the two cultures. In Experiment 1, 4-year-olds from the two cultures ($N = 64$) participated in a relational match-to-standard task in two conditions, with simple or richly detailed objects, in which a focus on individual objects may hurt performance. Rich objects, consistent with past research, strongly limited the performance of U.S. children but not Japanese children. In Experiment 2, U.S. and Japanese 4-year-olds ($N = 72$) participated in a visual search task that required them to find a specific object in a cluttered, but organized as a scene, visual field in which object-centric attention might be expected to aid performance and relational attentional pattern may hinder the performance because of relational structure that was poised by the scene. U.S. children outperformed Japanese children. In Experiment 3, 4-year-olds from both cultures ($N = 36$) participated in a visual search task that was similar to Experiment 2 but with randomly placed objects, where there should not be a difference between the performance of two cultures because the relational structure that may be posed by the scene is eliminated. This double-dissociation is discussed in terms of implications for different developmental trajectories, with different developmental subtasks in the two cultures.

* Corresponding author. Fax: +1 812 855 4691.
E-mail address: mekuwaba@indiana.edu (M. Kuwabara).

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Introduction

Classic theories presume that development—at least in its broad strokes—is universal across cultures. However, there is growing evidence of cross-cultural differences in adults in behavioral studies (Chiao & Blizinsky, 2010; Kim et al., 2010), cognitive studies (Chua, Boland, & Nisbett, 2005; Kitayama, Duffy, Kawamura, & Larsen, 2003; Masuda & Nisbett, 2001, 2006; Masuda et al., 2008; Nisbett & Masuda, 2003; Nisbett & Miyamoto, 2005; Nisbett, Peng, Choi, & Norenzayan, 2001), and neural studies (Han & Northoff, 2008; Hedden, Ketay, Aron, Markus, & Gabrieli, 2008). The developmental origins and timing of these differences is clearly important to understanding the role of culture in cognition and to understanding the developmental process more generally (e.g., see Kuwabara, Son, & Smith, 2011; Moriguchi, Evans, Hiraki, Itakura, & Lee, 2012; Richland, Chan, Morrison, & Au, 2010). Here, we report new evidence on cross-cultural differences in preschool children's performances in two tasks: attention to relations in a relational matching task and attention to individual objects in a search task.

The cross-cultural question

Western and Eastern cultures appear to differ in the degree to which they emphasize decontextualized versus contextualized interpretations of objects (Masuda & Nisbett, 2001, 2006; Nisbett, 2003; Nisbett & Miyamoto, 2005; Nisbett et al., 2001). For example, in one study, adults from the United States and Japan were asked to describe an aquarium (Masuda & Nisbett, 2001). The U.S. participants described the large fish in the center of the display. The Japanese participants described the central fish in *relation to* peripheral components (e.g., water color, plants, small fish). This difference between more individual object focused attention in Westerners and more relational attention in Easterners has been documented in a variety of tasks, including perceptual, social, and reasoning tasks (Chua et al., 2005; Ji, Peng, & Nisbett, 2000; Kitayama et al., 2003; Masuda & Nisbett, 2001, 2006; Masuda et al., 2008; Nisbett & Masuda, 2003; Nisbett & Miyamoto, 2005; Nisbett et al., 2001; Richland, Zur, & Holyoak, 2007).

Some findings suggest that cultural differences in perceptual and cognitive tasks begin early. In the rod and frame task, 6-year-old Japanese children's judgments of rod length were more influenced by the size of a surrounding frame than were the judgments of their U.S. counterparts (Duffy, Toriyama, Itakura, & Kitayama, 2009). In a task asking children to match facial expressions to emotions, 4-year-old Japanese preschoolers were influenced by the context (happy or scary event), whereas U.S. preschoolers interpreted emotional state as a more trait-like property of the individual (see also Ji, 2008, and Lockhart, Nakashima, Inagaki, & Keil, 2008, for related findings with school-age children). Finally, in a recent study particularly relevant to the current one, Richland and colleagues (2010) reported that 4-year-olds in Hong Kong were better able than U.S. children to map relational roles across pictures of everyday events. In brief, although the number of studies with young children is as yet limited, they consistently point to cross-cultural differences in preschoolers that are like those in adults in implicating a Western cognitive system biased toward decontextualized objects versus an Eastern system biased toward objects in relation to context.

Objects and relations

When one views a scene, one can focus on an individual decontextualized object or on the relational structure within the scene as a whole, and the cross-cultural evidence (Masuda & Nisbett, 2001) suggests that adults from Western and Eastern cultures are differentially biased with respect to these options. Bias to emphasize objects as individuals versus sensitivity to relational structure has also played a role in theorizing about the development of relational reasoning (Gentner & Rattermann, 1991; Rattermann & Gentner, 1998). The key results—primarily on studies of Western children but using a variety of experimental tasks—suggest an early emphasis on objects and their individual properties and a sensitivity to relational structure that emerges and becomes more robust during the late preschool period (Brooks, Hanauer, Padowska, & Rosman, 2003; Enns & Cameron, 1987; Goswami & Brown, 1990; Kotovsky & Gentner, 1996). The overall developmental pattern fits Gentner's (1988)

relational shift hypothesis, which proposes a shift during the preschool years from more object-based comparisons to more relational comparisons. Studies testing this proposal have shown better relational reasoning when object properties correlate with the relations, that relational reasoning by preschoolers falters when object similarities are pitted against relational similarity, and that preschoolers have greater success in finding the relational structure when objects are simple and abstract than when they are rich and perceptually interesting in their own right (e.g., Gentner, Loewenstein, & Hung, 2007; Markman & Gentner, 1993; Rattermann & Gentner, 1998; Rattermann, Gentner, & DeLoache, 1990).

However, sensitivity to relational structure is not the only cognitive skill developing during the preschool period. Preschoolers also become increasingly able to isolate and attend selectively to a single object, ignoring the surroundings and distractions (see Hanania & Smith, 2010, for a review). What is the relation between developing skills in selective attention to objects and sensitivity to relational structure, and do they differ across cultures? If young Eastern children are learning their culture's emphasis on relations, and if young Western children are learning their culture's emphasis on objects, then one might predict not just that Eastern children are more advanced in relational tasks relative to their Western peers but also that Western children are more advanced than their Eastern peers in tasks requiring focused attention on a single object. Furthermore, if, as Gentner (1988) hypothesized, these two developing skills sometimes compete with each other, then cross-cultural differences might be most evident in relational tasks with salient individual objects and in object judgment tasks with salient but irrelevant relational contexts. Before turning to the experiments, we provide background on the specific relational and object-focused tasks used in the experiments.

Relational matching

One task widely used to study preschoolers' sensitivity to the relational structure in visual displays is the match-to-standard task illustrated in Fig. 1A. Children are presented with a target display and are asked to find "the match" among two choice displays, only one of which matches in the relations among the elements. There are a number of versions of this task, and preschoolers generally have difficulty in all of them (Gentner & Rattermann, 1991; Markman & Gentner, 1993). The variant that we chose to use in the current study is one where the two choice cards contain the same element objects and differ only in their relational match (Kotovsky & Gentner, 1996) (see Fig. 1A). This task is easier than many of the other versions—giving children an opportunity to show their emerging ability to match relations—because there is only one possible correct response: The relational match choice matches in its relational structure, the foil does not match at all, and the two choices differ only in relational structure. Although Western preschoolers do relatively well in this task with simple abstract objects, their performances suffer when the elements in these arrays are rich detailed objects (cf. Fig. 1A vs. Fig. 1B) (Gentner & Rattermann, 1991; Gentner et al., 2007; Markman & Gentner, 1993; Rattermann et al., 1990; Son, Smith, & Goldstone, 2011). Children also perform better when the relevant relation is more concrete than when it is abstract (cf. Fig. 1A, columns a and b, vs. Fig. 1A, columns c and d) (Gentner & Rattermann, 1991; Kotovsky & Gentner, 1996; Rattermann & Gentner, 1998). For example, the relation in Fig. 1A is a symmetry relation (usually called as an "ABA" relation); two identical objects are at the extreme, and a different object is in the middle. However, the specific relation on the card can also be characterized at different levels of abstractness: small–big–small or less–more–less or, most abstractly, symmetry or ABA, such that for any property the two at the extreme match and the one in the middle is different. In general, the more abstract the relational match required, the less likely preschoolers are to succeed.

Accordingly, in Experiment 1, we examined preschoolers' ability to make relational matches in this matching-to-sample task using simple versus rich objects. One possible outcome is that rich objects interfere with children's ability to make relational matches across cultures, a result that would suggest the universal potency of richly detailed objects over relations for young children. That is, Eastern children might be more advanced than Western children in the developmental path from more object based to more relationally based representations, but for Eastern children, like Western children, richer objects might well interfere with relational representations. Alternatively, the attentional pull of objects—and the interference generated by rich objects in relational matching tasks—may be a

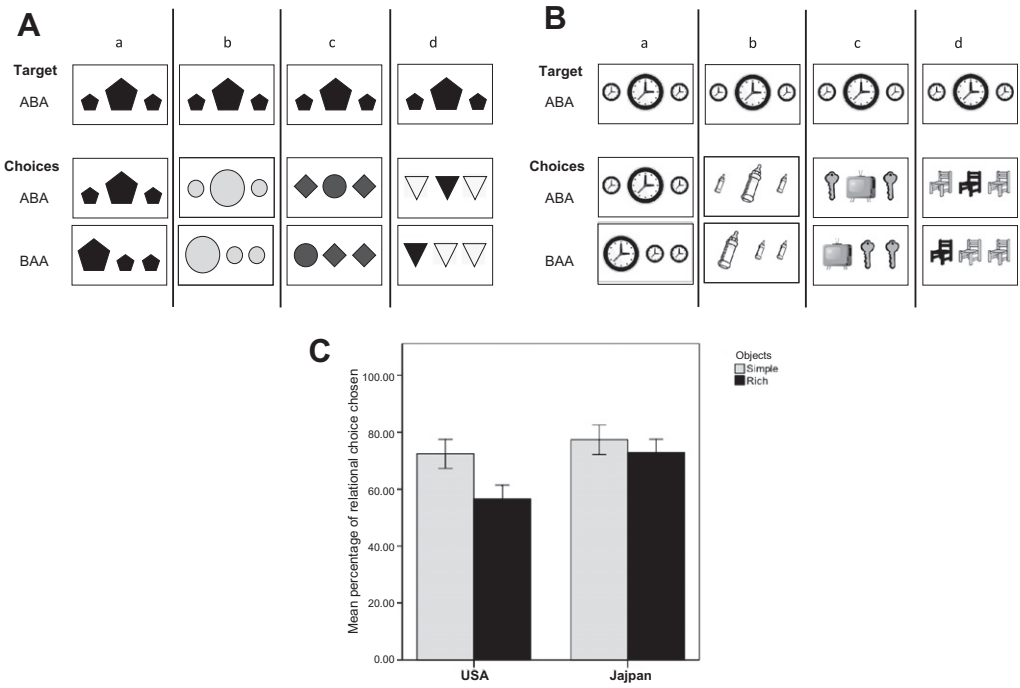

Fig. 1. (A, B) Stimuli examples for Simple (A) and Rich (B) conditions. As seen, different choice cards for the very same target card were constructed to assess just the abstractness of children's relational representations. As seen in column a, the first pair of choice cards uses the very same shapes or objects as in the target card, and thus the relational match is also an identity match that does not require children to ignore individual object properties. The second set of choice cards (size to size) presents a somewhat more abstract relation, namely small–big–small (column b). The third and fourth sets of choice cards require a more abstract representation of the relation that can be realized with many different object properties (shape and color), that is, symmetry around a center object, ABA (see column c for shape example and column d for color example). (C) Mean percentages of correct relational choice chosen by children from the United States and Japan in the Simple and Rich conditions. The error bars show ±1 standard error.

problem primarily in Western cultures as young children acquire the culturally specific biases of their elders.

Visual search

The ability to focus attention on a single decontextualized target object and to ignore distractions is itself an important cognitive achievement (Casco, Tressoldi, & Dellantonio, 1998; Goldstone, 1998; Johnston & Dark, 1986; Lleras, Porporino, Burack, & Enns, 2011), and this ability is known to increase substantially during the preschool years, again from research focused primarily on Western children (Aslin & Smith, 1988; Brooks et al., 2003; Hanania & Smith, 2010; Miller, 1990; Plude, Enns, & Brodeur, 1994; Smith, 1989; Woody-Ramesy & Miller, 1988). A variety of tasks have been used to investigate the development of selective attention to objects and its component skills (Goldberg, Maurer, & Lewis, 2001; Kerns & Rondeau, 1998; Kochanska, Murray, & Harlan, 2000; Levy, 1980; Ruff, Capozzoli, & Weissberg, 1998; Ruff & Lawson, 1990; Smith, 1989). Here, we measured children's increasing ability to focus attention on a single element in a visual scene using a visual search task.

Visual search has been widely studied in the adult literature (Duncan & Humphreys, 1989; Matusz & Eimer, 2011; Treisman, 1982; Trick & Enns, 1998) as well as in developmental studies (Day, 1978; Donnelly et al., 2007; Enns & Cameron, 1987; Hommel, Li, & Li, 2004; Kanaka et al., 2008; Lobaugh, Cole, & Rovet, 1998; Trick & Enns, 1998; Yoshida, Darby, & Burling, 2011). In these tasks, a search

target is specified and participants are asked to find it in a cluttered array, which may be either a random assortment of objects (Donnelly et al., 2007; Gerhardstein & Rovee-Collier, 2002; Trick & Enns, 1998; Wellman, Ritter, & Flavell, 1975) or a coherent scene (Brockmole, Castelhano, & Henderson, 2006; Neider & Zelinsky, 2005; Vurpillot, 1968). As far as we can determine, there have been no direct cross-cultural comparisons of performances in either variant of these tasks. The developmental evidence suggests that adult-like performance does not emerge until children are 6 years of age or older (Hommel et al., 2004; Lobaugh et al., 1998; Ruskin & Kaye, 1990; Trick & Enns, 1998) and that at least part of the early difficulty is maintaining a representation of the goal while avoiding or inhibiting attention to distractors in the scene (Hommel et al., 2004).

If the ability to focus on decontextualized objects is a cognitive skill encouraged by Western culture, and if as a consequence young Western children are developing more rapidly in this domain than their Eastern peers, then there should be measurable cross-cultural differences in this task. Moreover, if Japanese children's culturally specific bias to attend to relational structure interferes with attention to a decontextualized object, then cross-cultural differences should be greater when the target array is embedded in a coherent scene rather than in an array of random objects. Alternatively, one might hypothesize that Eastern children would do better in these search tasks than Western children because some findings suggest that Eastern children develop more robust executive control skills earlier than do Western children (Lahat, Todd, Mahy, Lau, & Zelazo, 2010; Oh & Lewis, 2008; Sabbagh, Xu, Carlson, Moses, & Lee, 2006). However, the current prediction is that despite this possible cross-cultural difference in executive control, U.S. children will be more advanced in object search tasks than Japanese children because of the habitual cultural bias to focus on objects.

The relational matching task was used in Experiment 1, and object search tasks were used in Experiments 2 and 3.

Experiment 1

Method

Participants

The participants were 32 monolingual Japanese-speaking children residing in Yamanashi, Japan, and 32 monolingual English-speaking children residing in Indiana, United States. Participants in the two groups were matched pairwise for age (±1 month, mean = 47.7 months, range = 40–55), and there were nearly equal numbers of boys and girls in the two groups. Statistical analyses within each cultural group revealed no differences between boys and girls, and thus this factor is not considered further. All children were from middle-class families with at least one parent having a college education. Children within a culture group were randomly assigned to either the Rich or Simple condition and to either the ABA or BAA standard. Thus, the design is a 2 (Stimuli: Simple or Rich) × 2 (Relation: ABA or BAA) with all conditions between participants.

Stimuli

Each stimulus array consisted of three picture elements mounted on an 11 by 17-cm card. In the Symmetry (ABA) condition, the relation was different in the middle, with a central element differing from two matching flankers. In the Asymmetry (BAA) condition, the relation was different–same–same, with the two matching objects side-by-side on the right side of the card. The Simple standard consisted of three red pentagons, and the Rich standard consisted of three clocks, small–big–small for the ABA sets and big–small–small for the BAA sets. For each child, the same standard was used on every trial.

On each trial, children's task was to choose between two cards as the best match to the standard. The ABA and BAA choices always contained the same individual objects, but they were arranged differently to create the different relational structures. In the Simple condition, all elements were simple geometric shapes varying in shape, color, and size. In the Rich condition, all elements were line drawings of everyday objects varying in object kind, color, and size. In both conditions, children received an ordered set of trials. The first two match trials were composed of the same elements as the standard

(as in Fig. 1A, column a). The next two trials, each unique, used different objects (as in column b), but the relevant relational property, size, remained the same (e.g., for ABA, big in the middle). After this, the trials progressed to more abstract relational matches with fewer overlapping properties (e.g., different in some way in the middle; see columns c and d), and there were always two unique trials, each of progressively more abstract relation. In total, there were 14 trials ordered in this way.

Procedure

The experiment began with two practice trials in which the standard consisted of three matching objects and the choices were between one card that was identical to this practice standard and one card that differed in all aspects (three different objects). Children were asked, "Which one is more like this one?" (gesturing to the standard) in English and "Docchi ga kore mitai?" in Japanese. The goal of these two trials was to ensure that children understood this to be a matching task. Children were coached to do the task and to put the match in the response box on which the standard was attached, but children were not given any information that the task was to match by relations. All verbal comments and gestures were stringently neutral with respect to objects versus relations and referred to the card as a whole. The test trials with the test standard began immediately after these practice trials, and there was no coaching or feedback. The spatial location of the correct match varied randomly across trials.

Results and discussion

Children's numbers of correct relational matches were submitted to a 2 (Stimuli: Rich or Simple) $\times$ 2 (Country: Japan or United States) ANOVA). The analysis yielded a main effect of stimuli, with children performing better on the Simple stimuli than on the Rich stimuli, $F(1, 60) = 4.21$, $p < .05$, $d = 0.07$. The analysis also yielded a main effect of country, with Japanese children performing better than U.S. children, $F(1, 60) = 4.61$, $p < .04$, $d = 0.07$. The interaction between the stimuli types and countries was not reliable, $F(1, 60) = 1.31$, $p = .26$, $d = 0.02$. This overall pattern suggests that Japanese children are generally better than U.S. children in making relational matches with both the simple and complex objects.

However, a closer look at the data and the pattern in Fig. 1C suggests that the overall country differences were due principally to differences in performance in the Rich condition. Planned comparisons (alpha = .05, Bonferonni correction) indicate that U.S. children performed more poorly in the Rich condition ($M = 56.70\%$, $SD = 18.53$) than in the Simple condition ($M = 71.65\%$, $SD = 20.72$), $F(1, 31) = 5.10$, $p < .05$, $d = 0.15$, whereas Japanese children performed equally well in the two conditions (Simple: $M = 76.79\%$, $SD = 20.78$; Rich: $M = 72.32\%$, $SD = 18.05$), $F(1, 31) = 0.41$, $p = .53$, $d = 0.01$. Moreover, the poorer performance of U.S. children in the Rich condition characterized their choices on the easier matches as well as on the progressively harder matches. The mean percentage of relational match choice for the six easier trials—two exact match trials (e.g., clocks matching clocks) and four size transfer trials with different objects (e.g., big one in the middle)—in the Rich condition was 56.25% for U.S. children (comparison with chance, $t(15) = 1.03$, $p = .32$) versus 77.08% for Japanese children (comparison with chance, $t(15) = 4.33$, $p < .01$). Indeed, U.S. children on the exact match trials (as in Fig. 1B, column a) performed at 59.38%, which did not differ from chance, $t(15) = 1.15$, $p = .27$. The poor performance of U.S. children on all Rich condition trials, including the easy ones, is consistent with a construal of the standard in terms of only object kind (e.g., clocks). Under such an object representation, there is no basis for choosing between the relational match and nonmatch because they both contain the same objects.

The lack of a reliable interaction in the omnibus ANOVA despite the magnitude of the mean differences (and reliable planned comparisons) is due to the large individual differences that characterized both groups and conditions. In the Simple condition, performance ranged from 44% to 100% correct for U.S. children and from 36% to 100% correct for Japanese children. In the Rich condition, performance ranged from 29% to 94% correct for U.S. children and from 35% to 94% correct for Japanese children. These individual differences are consistent with the idea that relational matching is an emerging skill for children in this age range in both cultures and that children in both cultures are progressing toward—and will ultimately achieve—the ability to make relational matches in this task. The pattern

of individual performances also suggests that, as a group, Japanese children are progressing more rapidly than U.S. children. As further evidence for this conclusion, we classified individual children as passing if their individual performance was reliably above that expected by chance (exceeding 67%, $B(12)$, $p < .05$). For the Simple condition, 44% of U.S. children passed, whereas 69% of Japanese children did so; this distribution difference in the frequency of passing and failing is not reliable, $\chi^2(1) = 2.03$, $p = .15$. For the Rich condition, only 19% of U.S. children passed, whereas 56% of Japanese children did so, and this is a significant difference, $\chi^2(1) = 4.80$, $p < .03$. Japanese children's skill in finding relational matches in the Rich condition characterized their performance on the more abstract relations as well as on the more concrete relations. Japanese children matched relationally on 77.08% of the less abstract trials, $t(15) = 4.33$, $p < .01$, and on 68.75% of the more abstract trials, $t(15) = 4.74$, $p < .01$.

In sum, the results suggest that Japanese children are *overall* more advanced in this relational matching task than are their U.S. counterparts *and* that U.S. children's likelihood of success suffers relative to that of Japanese children when the elements in the relational array are richly detailed objects. The findings replicate the earlier results of Richland and colleagues (2010), showing advanced relational reasoning in children living in Hong Kong versus the United States, and extend this difference to a Japan–U.S. comparison and to a perceptual relational matching task.

Experiment 2

There are (at least) two (not mutually exclusive) reasons why Japanese children may perform better than U.S. children in a relational matching task: Japanese children may simply be better at detecting and processing relations *and/or* U.S. children may be fighting their more advanced and habitual focus on single objects. If the second hypothesis is correct and U.S. children are biased to attend to decontextualized individual objects, then U.S. children should perform better than Japanese children in a task that requires sustained focus on a single target object. To test this second hypothesis, Experiment 2 used a visual search task in which children were asked to find a specified target in a relationally coherent scene. Given a richly detailed scene of a city—with houses, buses, and people—how readily can a child find the bicycle in that scene? Success in search tasks requires children to maintain an internal representation of the target object (Yoshida et al., 2011) and to systematically scan the scene for that target while not being distracted by nontarget objects or the narrative relations in the array. The primary dependent measure in visual search tasks—in adults (Duncan & Humphreys, 1989; Matusz & Eimer, 2011; Treisman, 1982; Trick & Enns, 1998) as well as in children (Day, 1978; Donnelly et al., 2007; Enns & Cameron, 1987; Hommel et al., 2004; Lobaugh et al., 1998; Trick & Enns, 1998; Yoshida et al., 2011)—is search time. That is, we expected both groups of children to be able to find the target picture if given enough time, but we predicted that U.S. children would do so more rapidly than Japanese children.

Method

Participants

The participants were 36 monolingual Japanese-speaking children residing in Yamanashi, Japan, and 36 monolingual English-speaking children residing in Indiana, United States. The two groups of children were matched pairwise (±1 month) for age (and, with a few exceptions, for gender as well), with a mean age of 48.1 months (range = 40–55). There were nearly equal numbers of boys and girls. Statistical analyses within each cultural group revealed no differences between boys and girls. Children were randomly assigned to one of two search conditions. Data from two U.S. children and one Japanese child were excluded for failure to understand the task (i.e., to actively search for a particular object).

Stimuli

The eight scenes were taken from children's picture books and were typical of that genre for both cultures. The eight search targets were banana, dog, cow, bicycle, octopus, flamingo, raccoon, and peacock. In an effort to ensure that the task was challenging, all scenes were rendered in black and

white. In addition, we created two search conditions (between participants). In the Less Distraction condition, as shown in panel a of Fig. 2A, all elements in the scene, including the target, were black and white. In the More Distraction condition, as shown in Fig. 2A, panel b, the scenes and target object were again black and white, but one *irrelevant* object was made more salient by presenting that object in color.

Procedure

The task was to find the search target as rapidly as possible and to indicate that target by pointing to it in the picture. Children were given a maximum of 20 s to find the target per scene. Prior to search, children were first shown a picture that was from the same basic category but not identical (differing in size and perspective) to the target picture. Children were told to find the target object "as quickly as possible" because it was a "race." The start of the trial was signaled by the experimenter saying, "Ready? Go" and then turning over the paper to show the scene to be searched. Children's search was timed from the start of the page turn to the response by a stopwatch. Because testing in Japan and the United States occurred in a variety of locations, these were not video-recorded. There were two experimenters; one tested the Japanese children in Japan and some of the U.S. participants, and the second experimenter tested only U.S. participants. Both of the testers were highly trained on timing of responses. A comparison of the two testers' timing of the response times generated by a paired sample (matched for age and gender) of the search times (also matched for stimulus) of 10 U.S.

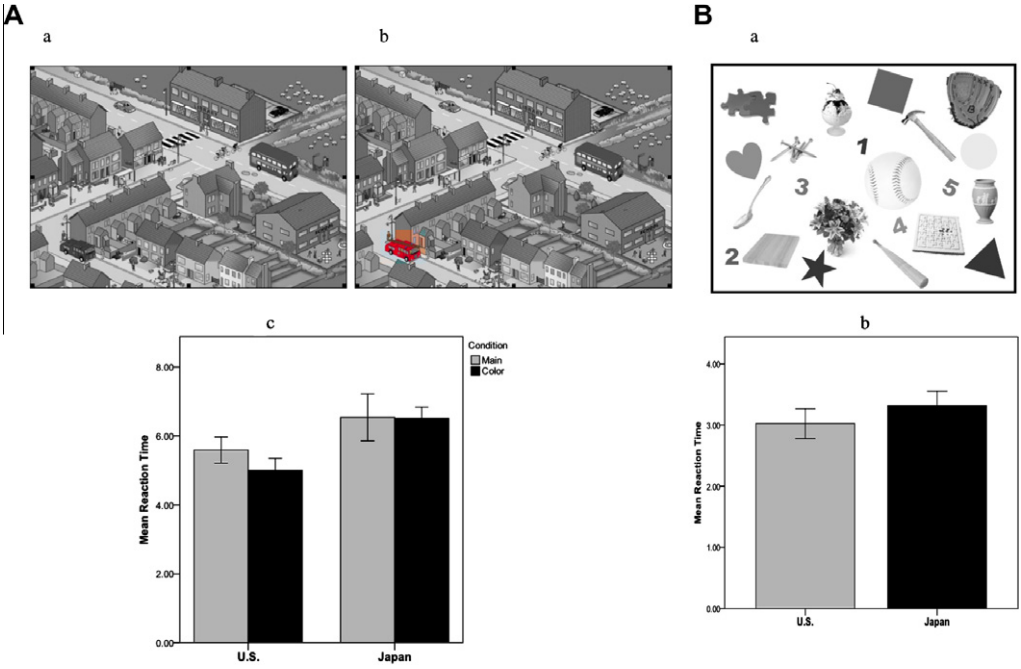

Fig. 2. (A, panels a and b) Examples of the stimuli used in Experiment 2 for the Less Distraction condition (a) and the More Distraction condition (b). For this trial, the target was a bicycle. Trials in the Less Distraction condition were colored black and white, and there was no distracting competitor against the target object. Trials in the More Distraction condition were colored black and white except the distracting competitor against the target object. For this example, the distractor is a red car. (A, panel c) Mean reaction times to find a target object for correct search in Less Distraction and More Distraction conditions for children from the United States and Japan. The error bars show ±1 standard error. (B, panel a) Example of the stimuli used in Experiment 3. The objects are randomly placed in the whole paper with distractors such as numbers and simple shapes. For this example, children looked for a hammer in Order 1 and looked for a flower in Order 2. (B, panel b) Mean reaction times to find a target object for correct search trials in Experiment 2 for children from the United States and Japan. The error bars show ±1 standard error. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

participants did not differ (to increase sensitivity to possible differences, the random variable was search time, 8 searches $*$ 5 paired participants), $t(39) = 0.54$, $p > .59$.

Results and discussion

The key prediction was that the U.S. children should be able to find the specified target in a cluttered scene more rapidly than should the Japanese children. This prediction was confirmed, as shown in Fig. 2A, panel c. A 2 (Country) $\times$ 2 (Condition) $\times$ 2 (Order of Presentation) ANOVA, with mean reaction time (for correct targets found) as the dependent variable, yielded only a main effect of country, $F(1, 66) = 6.28$, $p < .05$, $d = 0.10$. On average, it took U.S. children 5.30 s ($SD = 1.45$) to find 4.75 targets ($SD = 0.95$), whereas it took Japanese children 6.53 s ($SD = 2.25$) to find 4.97 targets ($SD = 1.15$). There were no effects of the two stimulus conditions on time to find the target. Children in both cultural groups and in both stimulus conditions performed with equal accuracy, finding approximately 60% of the targets; on average, U.S. children found 59.4% of the targets ($SD = 11.88$) and Japanese children found 62.1% ($SD = 14.38$). Overall, the findings are consistent with the hypothesized cultural differences suggesting more object-focused attention in Western cultures than in Eastern cultures, and they further suggest that this difference emerges early.

However, it is also possible that Japanese children may have a higher threshold to respond once a target is found, and thus their overall slowness need not imply a different skill level in focused attention on an object. Therefore, it is critical to show that there is a visual search task in which cultural differences in response time are not expected and not found. If Japanese children are more sensitive to the relational and narrative structure in the scenes, and if this sensitivity interferes with rapid and focused search for a single object, then Japanese children might not be slower than U.S. children if the search array was a random assortment of elements rather than a coherent scene. This hypothesis was examined in Experiment 3.

Experiment 3

Method

Participants

The participants were 18 monolingual Japanese-speaking children residing in Yamanashi, Japan, and 18 monolingual English-speaking children residing in Indiana, United States. The two groups of children were pairwise matched (±1 month) for age (and, with a few exceptions, for gender as well), with a mean age of 46.6 months (range = 40–55) and with nearly equal numbers of boys and girls. Statistical analyses within each cultural group revealed no differences between boys and girls.

Stimuli

The task was similar to that used in Experiment 2; children were asked to search for an object in a cluttered array. However, for this experiment the array consisted of randomly placed objects on a white background, not a scene. There were 12 unique search arrays. Two groups of children searched for different pictures in each array and saw the arrays in different orders. The search targets were cat, car, crayon, bird, fork, rabbit, fish, cake, hammer, cup, dog, and television (TV) for Order 1, and the search targets were shoes, snowman, toothbrush, dog, bucket, chicken, cow, flower, table, scissors, umbrella, and monkey for Order 2 (see Fig. 2B, panel a).

Procedure

The procedure was exactly the same as in Experiment 2. Again, two experimenters tested children; one tested all of the Japanese children and some of the U.S. children, and the other tested only U.S. children. To ensure comparability in the search times measured by Japanese and U.S. testers, five Japanese children were videotaped during this task. The Japanese and U.S. coders scored the response times independently. A comparison of the two testers' timing via a paired sample t test with search

trial as the random variable (to increase sensitivity to possible differences, 12 search $*$ 5 paired participants) indicated no systematic differences in timing, $t(59) = 0.14$, $p > .88$.

Results and discussion

If it was the relational coherence of the scenes that limited Japanese children's, but not U.S. children's, search times in Experiment 2, and if Japanese children are not simply overall slower, then there should be no cultural group differences. This prediction was confirmed, as shown in Fig. 2B, panel b. A 2 (Country) $\times$ 2 (Gender) $\times$ 2 (Order of Presentation) ANOVA, with mean reaction time as the dependent measure, yielded no significance on any variables and no significant interactions, $F(1, 28) = 0.49$, $p = .49$, $d = 0.02$, for the main effect of culture. The same analyses of the number of targets found also yielded no reliable differences. On average, it took U.S. children 3.02 s ($SD = 1.03$) to find 11.78 targets ($SD = 0.43$) and took Japanese children 3.31 s ($SD = 1.02$) to find 11.44 targets ($SD = 0.86$). Children in both groups performed with equal accuracy, finding approximately 92% of targets. Note, however, that although cultural differences are not significant, the absolute differences between the means are in the same direction as in Experiment 2, and thus there may be an overall advantage for Western children in search tasks or Japanese children may be overall slower in reaction time tasks, possibilities that merit further examination in future studies. Nonetheless, the cross-cultural differences are clearly much less robust in this task context than in that of Experiment 2, suggesting that cultural differences in threshold to respond cannot explain the Experiment 2 pattern and that the differences between Eastern and Western children in object search tasks are more robust when the array contains search-irrelevant relational structure.

General discussion

The findings make four empirical contributions. First, they replicate and extend previous findings showing that children developing in Eastern cultures, relative to those developing in Western cultures, are advanced in relational matching tasks. The task used here, one based on relations in perceptual arrays, shows that this advantage holds even when the task does not involve social contexts. Second, the results suggest that rich objects interfere more with the representation of relations for children developing in Western cultures than for children developing in Eastern cultures. Third, the current results show, for the first time, an advantage for Western preschool children in visual search tasks; Western children found the target in a scene more rapidly than did Eastern children, suggesting that they were better able to maintain a focused search of the target object. Fourth, the results suggest that the relational structure in coherent scenes slows object search times for Japanese children relative to U.S. children. Overall, then, the pattern suggests a cross-cultural double dissociation in relational-focused versus object-focused tasks.

A cultural double dissociation

Western cultures (and languages) are characterized as emphasizing individuals and objects, whereas Eastern cultures and languages are characterized as emphasizing relations within a larger whole (Lucy, 1992; Markus & Kitayama, 1991; Nisbett, 2003). This very characterization suggests that objects and relations are in opposition as cultural themes. An extensive and elegant set of experimental analyses (Gentner & Rattermann, 1991; Gentner et al., 2007; Kotovsky & Gentner, 1996; Markman & Gentner, 1993; Rattermann & Gentner, 1998; Rattermann et al., 1990) of (principally Western) children's relational reasoning also led Gentner (1982) to propose that relations and objects compete, such that children show more advanced relational reasoning when objects are abstract and simple and show less advanced relational reasoning when objects are rich and detailed. In other work, Goldstone, Medin, and Gentner (1991) showed that U.S. adults could be primed to favor object comparisons over relational comparisons or to favor relational comparisons over object comparisons. The current findings provide further evidence for a competition between object- and relational-centered perception of scenes and further suggest that this competition may be at the core of East–West

cognitive differences. That is, in their entirety, the results suggest a bias for object-centered comparison by Western children and for more relational-centered comparisons by Eastern children.

Critically, it is not that children in one culture are more generally advanced than children in the other culture. Rather, there is a strong crossover effect in relative performance on the two tasks. To illustrate this, *z* scores were calculated across all children's scores in the relational matching with rich objects (Experiment 1); *z* scores were also calculated across all children's scores in the object search with relational scenes (Experiment 2). Then, the means of the *z* scores were calculated separately for the two groups in each of the two tasks. Fig. 3 shows the crossover interaction (with positive *z* scores indicating more relational matches in Experiment 1 and faster search times in Experiment 2). In this sample of preschoolers, Japanese children stand out as more advanced in the relational matching task, whereas U.S children stand out as more advanced in the object search task.

The fact that these cross-cultural differences are evident in preschoolers indicates that the pervasive cross-cultural differences reported in adults emerge early. However, it is important to keep in mind that these differences are not all-or-none; both Easterners and Westerners reason relationally, and Easterners and Westerners can—when the task demands it—sustain attention on individual objects. Overall, the results suggest that in a context where an interpretation in terms of a decontextualized object or in terms of a relation is possible, U.S. children will favor the object interpretation and Japanese children will favor the relation interpretation. This conclusion is similar to one suggested by Kuwabara and colleagues (2011) in a study of how Japanese and U.S. children interpret facial expressions; Japanese children interpreted emotional expressions in terms of the surrounding context (a happy or scary event), whereas U.S. children interpreted emotional expressions as a trait-like characteristic of the individual that persisted across contexts. Differential biases toward relational-based versus object-based interpretations might, over time, be expected to lead to pervasive cultural differences across a number of domains, including social judgments (Ji, 2008; Kanagawa, Cross, & Markus, 2001; Lockhart et al., 2008; Masuda et al., 2008) and verb learning (Choi, McDonough, Bowerman, & Mandler, 1999), as well as in relational matching and object search tasks.

The fact that cross-cultural differences are evident as young as preschool, a fact for which there is increasing evidence (Kuwabara et al., 2011; Moriguchi et al., 2012; Richland et al., 2010), also constrains hypotheses about their origins; the experiences that transmit these cultural biases must be pervasive in the lives of young children. Two possible lines of transmission that might be expected to influence early cognition are social interactions and language. The literature on cross-cultural differences in social and emotional appraisals suggests pervasive cultural differences in the social experiences of young children (Cole, Bruschi, & Tamang, 2002; Frijda, Kuipers, & Ter Schure, 1989; Markus & Kitayama, 1991; Matsumoto & Ekman, 1989; Mesquita & Frijda, 1992; Mesquita & Walker, 2003;

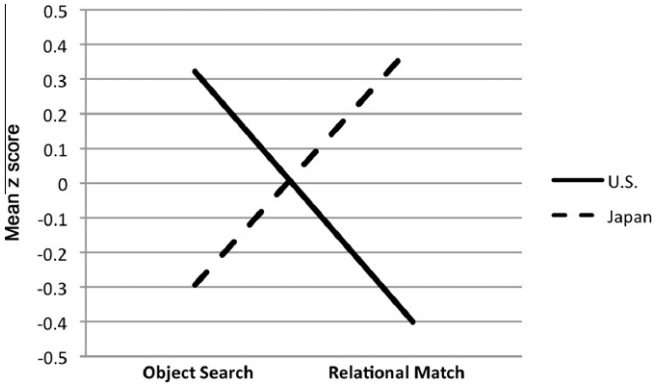

Fig. 3. Mean *z* scores for children's relational choices for Rich condition in Experiment 1 and mean *z* scores for reaction times in Experiment 2. Positive *z* score means better performance on both tasks (better relational matching in Experiment 1 and faster object search performance in Experiment 2). As seen in the graph, children from Japan performed better in Experiment 1 and children from the United States performed better in Experiment 2.

Scherer, 1997; Tsai, Knutson, & Fung, 2006). In particular, parents may encourage Japanese children to attend to the contextual appropriateness of emotional displays (Fernald & Morikawa, 1993; Friedlmeier & Trommsdorff, 1999; Okagaki & Sternberg, 1993), with Eastern parents focusing on behavior in the context of its effect on others and Western parents focusing on individual responsibility. A second possible transmission vector is language because there are systematic differences in the frequency of object names versus relational terms in these two languages (Fernald & Morikawa, 1993; Ogura, Dale, Yamashita, Murase, & Mahieu, 2006). But other aspects of culture, such as moral judgments, parenting, and concepts of self and relations with others may be relevant as well (Bersoff & Miller, 1993; Fernald & Morikawa, 1993; Friedlmeier & Trommsdorff, 1999; Kagitcibasi, 2005; Miller, 1986; Okagaki & Sternberg, 1993; Sabbagh et al., 2006). Determining these transmission lines will be crucial to understanding how culture influences the developmental process more generally as well as in the domains of relational reasoning and attention to objects. In light of the current results, whatever the transmission vector is, it must be powerful enough to lead to measurable differences in performance in such fundamental and seemingly non-culturally specific tasks as matching perceptual relations and searching for an object in a cluttered array and to do so by 4 years of age.

Relations and objects

The results also have implications for the development of relational reasoning. Much of this research, perhaps because it has been focused on Western children and adults, is often couched in terms of a tension between the individual objects that participate in some instance of a relation and the variabilized relation itself (Doumas, Hummel, & Sandhofer, 2008; Gentner, 1983; Holyoak & Thagard, 1997; Hummel & Holyoak, 1997). The current results suggest that this characterization in terms of a competition is correct, but they also suggest that the tension may yield more in one direction in Eastern cultures and more in the other direction in Western cultures. Consistent with the idea that there is a competition between attention to object and attention to relations, Goldstone and colleagues (1991) showed that adults' relational judgments increased in tasks with high relational similarity and that object-to-object matches increased in tasks with high object-to-object similarity, as if object or relational reasoning can be primed by contexts that highlight one or the other aspect of the display (see also Bulloch & Opfer, 2009; Leech, Mareschal, & Cooper, 2008). These experimental findings may be relevant to cross-cultural differences in that different cultures may, in a sense, "prime" different perspectives. Living in a culture where attending to the whole scene and relations within that scene is the cultural norm may lead to a bias—a default mode—that is more sensitive to relations and relatively poor at focusing on the individual elements in the relational whole. In contrast, living in a culture that emphasizes individual and decontextualized objects may bias attention to objects, creating strong sustained attention to a single object but weaker sensitivity to relational structure, especially in contexts with compelling objects.

Relational reasoning improves with age and with domain-specific expertise in U.S. children, and it is likely that it does as well in Japanese children (e.g., Bulloch & Opfer, 2009; Gentner & Rattermann, 1991; Goswami & Brown, 1990; Rattermann & Gentner, 1998). The interesting possibility raised by the current results is that the developmental trends and the sub-achievements of which they are composed may differ across the two cultures. That is, the differences might not be as simple as more rapid development in one culture versus the other. For example, skilled relational reasoning in U.S. children may require children to inhibit prepotent tendencies to attend to individual objects (see Viskontas, Morrison, Holyoak, Hummel, & Knowlton, 2004, for a related suggestion), and more sophisticated relational reasoning may depend on this prior achievement. Thus, U.S. children may benefit from simplified and less interesting objects in the teaching of relations because the simpler stimuli weaken the competition from participating objects themselves. In contrast, the developmental task for Japanese children may be different and not depend so much on inhibiting attention to individual objects. However, many cognitive tasks in Japanese culture, as well as in U.S. culture, require a focus on—and reasoning about—individual objects across diverse contexts. Thus, success in tasks requiring selective attention to a single target—while ignoring scene elements—may develop later and require systematic inhibition of prepotent tendencies to represent the objects in relation to context. These are, as yet, an untested prediction.

Downstream implications

This double dissociation between U.S. and Japanese children's performance in relational matching and object search tasks suggests fundamentally different developmental trajectories that may need to solve fundamentally different problems on the way to maturity—with U.S. children needing to inhibit attention to objects in order to reason relationally and Japanese children needing to inhibit attention to relational context in order to represent (and reason about) decontextualized objects. This is a conjecture, but it is one with important implications for how we think about the developmental process; is it a universal path or does it build on itself, with each earlier development, including biases, providing the context for how the next achievement must be made? These findings may also have practical relevance for education, particularly for mathematics education. Because of the greater success of Eastern children, relative to U.S. children, on international measures of mathematics achievement, there has been interest in borrowing educational techniques from Eastern educational systems (Schaub & Baker, 1991; Wang, 2005; Westbury, 1992). If the component tasks that children need to solve to learn about objects and relations are different in different cultures, then the simple transfer of a curriculum from one culture to the other might not be possible. In addition, relevant to this last idea is the current finding that U.S. children perform better than Japanese children in a search task requiring a sustained focus on a single object as target. A focus on the decontextualized object has it own strengths (see, e.g., Bulloch & Opfer, 2009; Nisbett, 2003) that are also relevant to mathematics and higher level reasoning and, therefore, might be leveraged in successful mathematics training in the West.

In conclusion, there have been growing calls for a more cross-cultural understanding of development (Boroditsky, 2001; Segall, Lonner, & Berry, 1998; Yoshida & Smith, 2003). Such findings seem likely to tell us not just about different cultures or the diversity of human cognition but also about developmental mechanisms and the developmental process—how regularities in the developmental environment set the developing system on different trajectories and how developmental tasks are different in different cultures (Sethuraman & Smith, 2010).

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