

# Cross-cultural Differences in Analogical Reasoning

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## Abstract

Much research in developmental psychology and cognitive development presumes a universal developmental trend that is independent of culture. One such trend, from object to relational knowledge, is seen over and over. However, most of this research is based on the study of children and individuals from Western cultures. This paper considers the possibility that this developmental trend might differ in different cultures.

## Introduction

A relation is a structured connection between entities that is about the role of those components in the event. The participating components are relevant to this relational structure, not because of their own individual properties but rather because of their relation to the other entities. Thus for the relation “A is bigger than B”, the size of A matters, but not its particular size, only its size in comparison to that of B.

Relations and relational reasoning are arguably the core of higher human thought. Research has shown relational structures to be important to human perception and reasoning (Hummel & Biederman, 1992; Doumas, Hummel, & Sandhofer, 2008), mathematics (e.g. Mix, 2008), analogy (e.g. Gentner, 1983), science (Gentner, 1982a), and language (e.g. Gentner, 1982; Gentner & Namy, 2006).

## Objects are the problem

Considerable research has focused on the development of relational reasoning. The key developmental problem appears to be one of going beyond the properties of the individual objects. That is, young children often fail in relational reasoning tasks because they attend to the objects as individuals, not the relations among the objects (Gentner, 1988; Gentner & Namy, 1999; Gentner & Rattermann, 1991; Gentner & Toupin, 1986; Kotovsky & Gentner, 1996). In one study, Rattermann, Gentner, and DeLoach (1990) presented three and four year old children and adults with sets of three objects with the objects in the set ordered by increasing size. For example, one set (the

experimenter's set) might be comprised of a small car, medium cup, and big house. The other set (the participant's set) might include a small cup (that is the same as the medium cup in the other set), a medium house (that is the same one as the big house in the other set), and a big floor pot. One object in the experimenter set (say the middle sized cup) was indicated as the winner and children were asked to indicate the winner in their set. They could choose the middle-sized object in their set (same relation but different object) or they could choose the cup (same object but in a different relation to other objects). Three and four year old children consistently choose the matching objects; adults choose the object in same relational role in the set. In brief, younger children appear to attend to objects and adults more to relations.

A subsequent study (Rattermann and Gentner, 1998) showed that making the objects simpler increased relational responding by children. The experimenter constructed sets in which all objects were cups, only varying size, or in which, as described above, they were richly detailed and varied in kind. Children made many more object responses and few relational responses with the rich than with the simpler stimuli. Apparently, the rich stimuli pushed children to attend to the objects – as individuals – rather than to their role in the larger scene. In general, the results in this robust literature show that older children and adults are much better able to ignore objects and discern the relations even in complex scenes than the younger children. The key developmental changes occur around 4 years of age and are sometimes referred to as the “relational shift” (e.g. Gentner, 1988; Rattermann & Gentner, 1998).

## Cultural differences?

The priority of objects over relations is likely to be universal aspect of human cognition. Gentner (1982b) proposed two related hypotheses with respect to this idea. First, she proposed that objects were perceptually and cognitively prior than relations because they derive from universal

psychological processes and a common physical world. Second, she suggested that relations were not only developmentally later and cognitively more difficult, but also more variable across cultures and dependent for their development on culturally specific support (such as language). Consistent with this proposal, there is now considerable evidence showing cross-cultural and cross-linguistic differences in *particular relations*, especially in the domains of quantity (e.g. Zhang & Schmitt, 1998) and space (e.g. Majid, et al., 2004).

The question we ask here, however, is whether there are more general cultural differences, not in how one thinks about a particular relational structure but in the general tendency to focus on objects as individuals versus in terms of their roles in a relational structure. This possibility is suggested by recent findings indicating broad cross-task differences in attentional and perceptual styles as a function of the cultural background of the individual. In particular, Nisbett (Nisbett, et al., 2001) and his colleagues found that people in Eastern cultures are more holistic – focusing on the whole scene and its relational structure whereas people in Western cultures are found to be more analytic – focusing on the focal objects (Masuda & Nisbett, 2001). For example, in one study, adults from the United States and from Japan were asked to describe scenes; in one case, the scene was of an aquarium. Adults from the United States described the scene in terms of the main focal object (a large fish in the center). Adults from Japan described many more peripheral components (water color, plants, small fish) in relation to the central fish. Moreover, in subsequent memory tests, adults from the United States did not notice changed aspects of the scene (e.g., water color) whereas adults from Japan did. These findings suggest a broader whole scene attentional style for Easterners and a more object-focused style for Westerners.

These differences need not mean that individuals from Eastern cultures are generally more sensitive to relational structures than Westerners, but it might. If so, it might also mean that the well-documented developmental trend from more object based to more relational based reasoning in children, the so-called relational shift (e.g. Gentner, 1988; Rattermann & Gentner, 1998), might more robustly characterize the cognitive development of children growing up in Western than Eastern cultures.

#### **Relational judgments are not all-or-none**

Figure 1 illustrates one task commonly used to study relational reasoning in children (see Kotovsky & Gentner, 1996). Children are presented with a target card (shown on the box) with three

objects in a particular relation. The shown relation might be described as small-big-small or more abstractly as a symmetrical relation around a center object, ABA. The children are then presented with two choice cards, shown below, and asked to select the one that “matches” or “goes with” the target card. As shown in Figure 2, different choice cards for the very same target card may be constructed to assess just the abstractness of children’s relational representations. For example, the first pair of choice cards in Figure 2, use the very same 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. Notice, however, that it is *still* a relation match. If children merely represented the individual objects with *no relations represented* then all the cards would be representationally the same – big and small red hexagons. The second set of choice cards (size to size) samples a somewhat more abstract relation – small-big-small; the third and fourth cards require a more abstract representation of the relation that can be realized with many different object properties (size, shape, color) that is, symmetry around a center object, ABA. Considerable research with western children show that they are much more likely to make relational matches based on more perceptual relations than ones based on more abstract relations (Kotovsky & Gentner, 1996). As noted earlier, one can also vary the complexity (or objectness) of the elements from which the relation is composed (as illustrated in Figure 5 as compared to Figure 1). Western children succeed with simpler objects more readily than with complex ones.

#### **Present Purpose**

There have been no systematic cross-cultural studies that investigate the development of relational reasoning and the “relational shift.” This is the main purpose of the present study. Building on past research, the study compares 4 years old children’s performances in the relational matching tasks illustrated in Figures 1 and 5, testing for the abstractness of the relation apprehended by children as illustrated in Figure 2. Experiment 1 uses simpler stimuli and Experiment 2 uses more complex and richly detailed objects.

#### **Experiment 1: Simple Geometric Shapes**

##### **Method**

##### **Subjects**

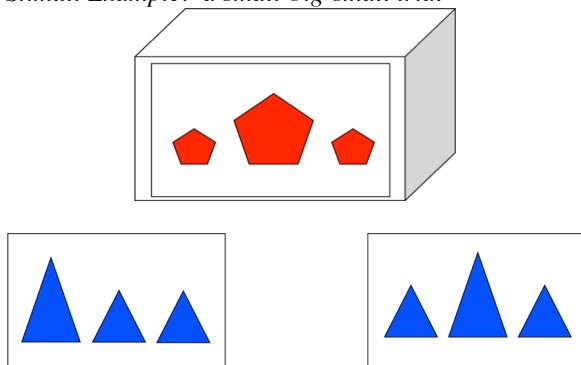
The participants were 27 children residing in Yamanashi, Japan and Indiana, USA: 13 monolingual English-speaking children and 14 monolingual Japanese-speaking children. The mean age of English

speaking children was 48.0 months and Japanese-speaking children was 47.1 months ranging from 40 to 54 month olds. The gender of participants was about equally distributed in both populations.

### Stimuli

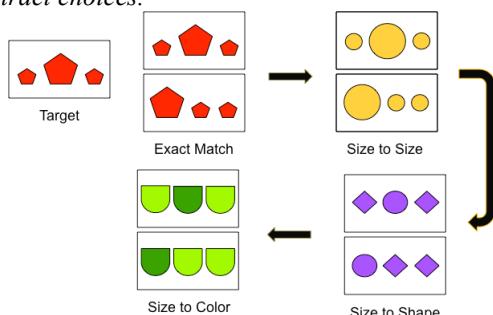
The task was based on that of Kotovsky and Gentner (1996) and is illustrated in Figure 1.

*Figure 1*  
*Stimuli Example: a small-big-small trial*



Children were presented with one relational target (either ABA or BAA structure) on the box. The same target card was used for all testing trials. Then, they were given two choice cards, one was a relational match and the other did not provide a match. The spatial location of the choice cards on each trial was randomly determined. Trials were presented in a series, with 4 test trials for a target card that progressed from less to more abstract relational matches as indicated in Figure 2. There were 7 unique testing choice cards (constructed from different shapes, colors and sizes) tested twice for a total of 7 by 2 repetitions (or 14 judgments per child). The order of target cards (either ABA or BAA) was randomly determined.

*Figure 2: Relational matches based on increasingly abstract choices.*



### Procedure

On each trial, children were shown the target card and the card was placed on the box. Then, children were shown two choice cards – one with relational

match and the other with non-relational match. Children were asked to pick one of the choice cards, such as “Which one is more like this one” by pointing to the target card on the box in English and “*Docchi ga kore mitai?*” in Japanese. Children were asked to pick the card of their choice and place the card in the box.

### Results

As shown in Figure 3, children in both groups predominantly chose the relational match given these simple stimuli. Overall, the mean percentage of relational match choice chosen by children was 74.0% for children from the United States and 75.9% for children from Japan, which did not differ,  $F(1,26)=.052, p=.82$ .

Both Japanese and American children matched relationally significantly above chance (50%),  $t(12)=4.35, p<.01$  children from the United States and  $t(13)=4.395, p<.01$  for children from Japan.

*Figure 3*  
*Graph of overall relational response*

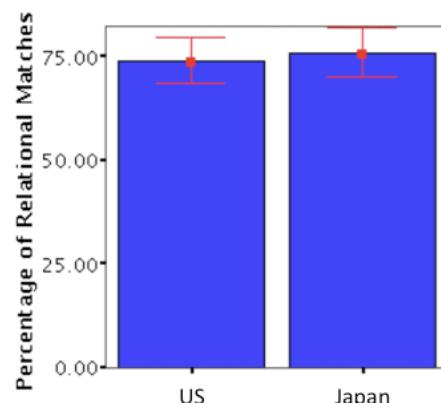
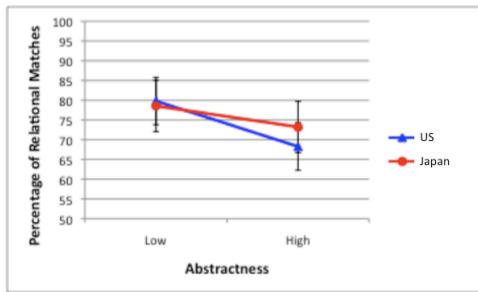


Figure 4 shows the performance as a function of the abstractness of the relation. Performance for both groups declined as a function of abstractness, though not reliably (report main effect for ANOVA for kind of choice); this decline was greater for children from the United States than for children from Japan; however, the interaction is not reliable,  $F(1,25)=.66, p=.42$ .

*Figure 4*  
*Performance as a function of the abstractness of the relation.*



Overall both groups of children preformed very well, and equivalently with these simple stimuli. Indeed, the overall high level of performance may make the task insensitive to the detection of cultural differences. At the very least, then, Experiment 1 tells us that children in both cultures – at least with simple stimuli – understand the task and can apprehend the relations. This sets up the goal for Experiment 2; to challenge children's relational reasoning by making the constituent objects more complex and known kinds. Does this manipulation have a greater effect on children from the United States than from Japan?

## Experiment 2: Complex Objects

### Method

The experimental method was identical to the experiment 1 except that we used drawing of common everyday objects, as illustrated in Figure 5, instead of simple geometric patterns.

### Subjects

Twenty-seven children residing in Yamanashi, Japan and Indiana, USA participated: 12 monolingual English-speaking children and 15 monolingual Japanese-speaking children. The mean age of English speaking children was 46.2 months and Japanese-speaking children was 46.8 months ranging from 40 to 54 month olds. The gender of participants was about equally distributed in both populations. All participants completed both training trials successfully.

### Stimuli and Procedure

All aspects of the experiment were identical as Experiment 1 except for the stimuli. We used clip art objects instead of geometric shapes that were used in the Experiment 1. An example of stimuli is shown in Figure 5. An example of the 4 choice sets for one target – increasing in the abstractness of the relational match – is shown in Figure 6.

Figure 5

Stimuli Example: Same polarity and same dimension set (Size to Size)

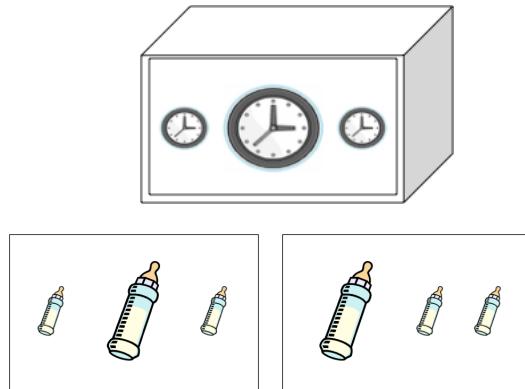
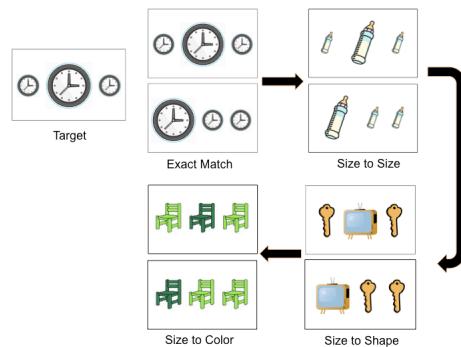


Figure 6: Relational matches based on increasingly abstract choices.

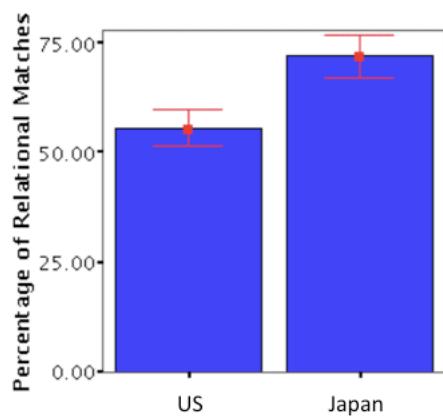


### Results

As shown in Figure 7, children from Japan continued to perform well even with these more complex objects, but children from the United States performed poorly. Overall, the mean percentage of relational match choice chosen by children was 55.7% for US children and 72.1% for Japanese children,  $F(1,26)=6.32$ ,  $p<.05$ . Japanese children chose relational matches significantly above chance (50%),  $t(14)=4.57$ ,  $p<.01$ , but US children's relational matches did not differ from that expected by chance (50%),  $t(11)=1.42$ ,  $p=.18$ .

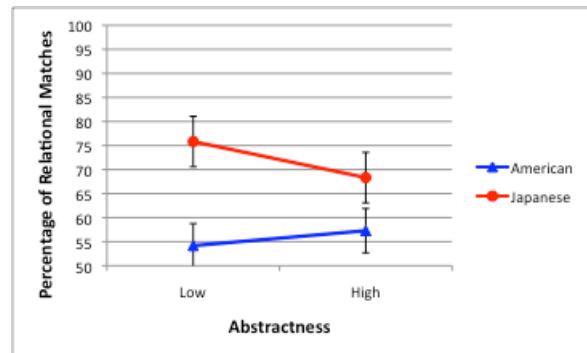
Figure 7

Graph of overall relational response



Perhaps, the most remarkable finding is that US children's poor performance characterized the more perceptual matches as well as the more abstract matches. For less abstract sets, the mean percentage of relational match choice chosen by children from the United States was 54.17% as compared to 75.83% for children from Japan. Given that children from the United States performed poorly on even these matches suggests that they represented the cards merely in terms of the objects, e.g., "clocks". Under such an object representation, there is no basis for choosing between the two choice sets. For more abstract sets, the mean percentage of relational matches by children from the United States was 57.29% but 68.33% for children from Japan. Japanese children's relational matches exceeded that expected by chance for both the less and more abstract choice sets,  $t(14)=4.12$ ,  $t(14)=4.36$ , respectively, for both sets  $p<.01$ . However, children from the United States performed at the chance level (50%) for both less and more abstract sets,  $t(11)=.886$ ,  $p=.394$ ,  $t(11)=1.63$ ,  $p=.13$ , respectively as shown in Figure 8.

*Figure 8*  
*Relational responding as a function of the abstractness of the relational choices.*



These results strongly suggest that competing representations in terms of individual objects are a bigger challenge for children developing in the Western culture of the United States than for children developing in Japan.

## General Discussion

These results raise the possibility that aspects of the well-documented relational shift, and in particular the potency of object-centered representations, may be a particularly characteristic aspect of development in Western cultures that is weaker or less robust in other cultures. Although this is a first result in this area and although further studies are needed before firm conclusions are warranted, the findings nonetheless remind that cognitive development takes place in the large context of language and culture and thus the patterns discerned in any experimental study may be specific to that context.

As has been noted by many others (e.g. Nisbett, 2001; Lucy, 1992), western thought and languages are highly object focused. One domain in which these differences have been noted is in language. English is a more noun-heavy language than Japanese (Gopnik & Choi, 1995; Yoshida & Smith, 2001): For example, in spoken language to children, there are many more nouns in English than Japanese but more verbs in spoken language in Japanese than English; further and related to this, English requires speakers to explicitly express the subjects and objects in sentences (the arguments for the relational verb) whereas these arguments are frequently dropped in Japanese, leaving sentences that consist of the verb, the relational term, only. This observation raises the question of the observed differences – and the particularly poor performance of the children from the United States with rich and *nameable* objects is dependent on their nameability. A further related question is whether naming the objects, perhaps even the simple ones, would increase the group differences. Another domain in which a more relational versus more individualistic stance has been noted in comparisons of eastern and western judgments concerns social relations. For example, studies have shown that adults from eastern culture judge emotion of the focal person considering the emotional expressions of surrounding person (Masuda, et al. 2008) whereas adults from western culture judge emotion of focal person individually. Thus it is possible that the origins of these differences derive not from language per se, but from broader cultural perspectives that emphasize all kinds of relations.

In sum, the present results suggest that children growing in an eastern culture are more

sensitive to relations in the context of interesting and complex individual objects whereas children growing in a western culture are less able to resist representations in terms of individual objects. If this interpretation is correct, we should find that children from the United States are *better* than children from Japan in tasks requiring them to attend to individual objects and ignore their relation to other surrounding objects. We are currently testing this hypothesis. If the expected group differences are observed, they would emphasize the dependence of cognition – and cognitive development – on the cultural context in which cognition and development take place.

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