Perceiving an object in its context—is the context cultural or perceptual?

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S. Kitayama, S. Duffy, T. Kawamura, and J. T. Larsen (2003) found that East Asians, when shown a line inside a square, memorized more accurately the ratio of the line's length relative to the square than the line's absolute length, whereas North Americans showed the opposite results. Because of this study's important implications on cultural influence to visual perception, we attempted to replicate it in China and USA, without success. Our 120 participants as a whole estimated a line's relative length more accurately than its absolute length, regardless of culture. Our results can be explained by the advantage of an explicit frame of reference in the ratio estimation, an advantage well known in the literature. Namely, the square as a frame of reference is more useful in the relative than in the absolute estimation of the line's length when the size of square changed from study to recall.

Keywords: length perception, culture, memory, visual cognition

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Introduction

A fundamental assumption in vision research is that visual perception of all peoples is the same, regardless of their cultural background. This assumption, however, has been challenged (Han & Northoff, 2008; Nisbett, 2003). A particularly noteworthy challenge is the framed-line test (Kitayama, Duffy, Kawamura, & Larsen, 2003). Participants in this test were first shown a line inside a square. They were then asked to reproduce from memory the line inside a second, empty square either in absolute length or in proportion to the square size. It was found that European Americans reproduced more accurately in the absolute than in the relative task, opposite to the Japanese participants.

This study is noteworthy because (1) it is one of only two such studies with objective answers (Ji, Peng, & Nisbett, 2000); (2) the stimulus's cultural context was minimal, the effect was therefore compelling; and (3) the results from the Americans were surprising since this contradicted known results in vision. Namely, the presence of a visible frame of reference in the relative task (the square) is expected to yield better performance than in the absolute task (Baranski & Petrusic, 1992; Rock & Ebenholtz, 1959).

The claim that culture influences visual perception was apparently strengthened by a recent brain imaging study (Hedden, Ketay, Aron, Rose Markus, & Gabrieli, 2008). Here, participants matched, either in absolute or relative length, two line-in-square stimuli in consecutive trials. In comparison to the baseline when two stimuli were identical and presumably easier to match, East Asians and European Americans gave rise to opposite patterns in frontal and parietal brain regions that had been associated with attentional control. Specifically, blood oxygenization level dependent (BOLD) responses were higher in the absolute task and lower in the relative task for East Asians and opposite for European Americans. These results were interpreted as confirming the behavioral findings in Kitayama et al. (2003) since greater BOLD responses in these brain regions were presumably indicative of extra effort. Importantly, Hedden et al. (2008) found no accuracy difference between the two tasks for either group of participants, thereby claiming that the BOLD results were not due to behavioral accuracy. However, it remains unexplained why accuracies were different in Kitayama et al. but not in Hedden et al.

In the current study, we attempted to replicate the Kitayama et al. (2003) study with participants in China and USA. In contrast to the interaction effect between

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culture and task found in Kitayama et al., we found that participants were more accurate in the relative than absolute task, regardless of culture. This makes sense because of the frame of reference was perceptually present and useful in the relative task but was hardly helpful in the absolute task.

Experiments

We tried as much as possible to repeat the same experiment as in Kitayama et al. (2003), except in Experiments 1 and 2 a square was defined as a black outline on an 8.5 × 11-inch white paper, whereas a square was defined as paper cutout in Kitayama et al. Each participant was tested with a block of five absolute trials and a block of five relative trials. The order of these two blocks was counterbalanced between participants. In each trial, a participant (1) was shown a line inside a square, (2) was instructed to memorize the line either in absolute length or in proportion to the size of the square, and (3) reproduced the line from memory in a blank square. Estimation errors in absolute values were analyzed, as in Kitayama et al.

The experiments in China were conducted in Chinese, and those in Los Angeles in English. The UCLA participants also completed the following questionnaire at the end of the test: (1) Born in US? (2) Years in US? (3) First language? (4) Language spoken at home? (5) Ethnicity? (6) Nationality?

Experiment 1

We first replicated the Kitayama et al. (2003) results from Asians by running 20 students (10 male, 10 female) at the University of Science and Technology of China, Hefei. We also confirmed the known results in vision by running in a control experiment 20 other students from the same university, except this time allowing the students to use their fingers to help memorize a line's absolute length. The controls also used a credit card as a ruler to draw lines and as additional memory aid. A two-way ANOVA revealed that the memory aid improved overall performance ($F(1, 38) = 7.19$, $p = .01$); and that the relative task was more accurate than the absolute task ($F(1, 38) = 9.22$, $p = .004$), which was mainly due to the relative task's higher accuracy of the experimental group (interaction: $F(1, 38) = 4.39$, $p < .05$; task difference within the control group: $F < 1$) (Figure 1). The accuracies of the experimental group were also numerically comparable to those in Kitayama et al.

Experiment 2

We ran 64 students at UCLA, including 25 European Americans, 29 Asian Americans, and 10 other Americans. A two-way ANOVA was conducted by combining with the experimental group from Experiment 1. The main effect of task was highly significant ($F(1, 81) = 12.01$, $p < .001$). Importantly, the main effect of culture (Chinese, Asian American, non-Asian American) was not significant ($F(2, 81) = 1.35$, $p = .27$) nor was the interaction ($F(2, 81) = 1.58$, $p = .21$). A more stringent selection of participants yielded virtually the same results, when only 20 European Americans (who had been in the US most of their lives), 20 Chinese- or Korean Americans, and the 20 Chinese in Experiment 1 were compared.

Next, we correlated the size of estimation error with the number of years in the US for the Asian Americans, with the absolute and relative tasks, respectively. According to Kitayama et al. (2003), one would expect a negative correlation for the absolute task and a positive correlation for the relative task. However, no correlation was found ($R^2 < .04$).

Experiment 3

In the experiments above, the squares were defined by their outlines printed on paper. In reviewer comments,

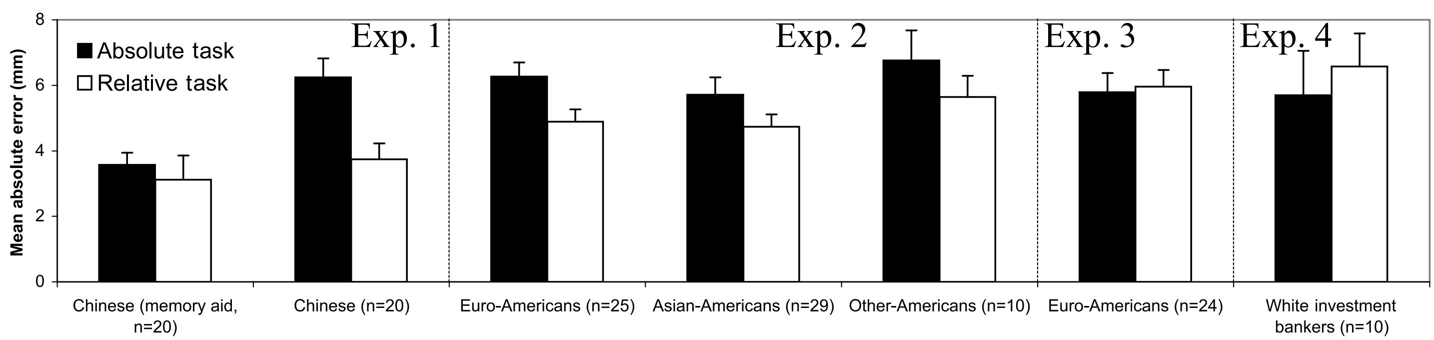

Figure 1. Absolute values of error in line reproduction from the absolute and relative tasks in Experiments 1–4 by participants in China and in USA. The absolute task was never less error prone than the relative task, contrary to what was found in Kitayama et al. (2003). Error bars represent standard error of the mean.

Kitayama maintained that the results could be due to "too strong" a context, relative to the original design in Kitayama et al. (2003) when a square was defined by paper cutout. Consequently, we repeated the experiment at UCLA with each square defined as paper cutout and with 26 additional participants. Data were analyzed from 24 of the 26 participants who were Western European Americans (the remaining two were a Ukrainian and a white South African). This time, the task difference was non-significant ($F(1, 23) = .066 < 1$; the results were little changed when all 26 participants were included). Numerically, the error in the absolute task was slightly smaller than in the relative task (5.79 vs. 5.96 mm) as compared to 6.35 and 3.71 mm in Kitayama et al.

We combined data in this experiment ($n = 26$) and in Experiment 2 ($n = 25$ Euro-Americans), with a between-subject factor of stimulus (paper cutout vs. outline) and a within-subject factor of task. Neither of the main effects was significant ($F < 1$). Only the interaction was $F(1, 59) = 5.35$, $p = .024$, meaning that when outlined squares were changed to paper cutouts, the higher accuracy of the relative vs. absolute task ceased to exist. In this sense, Kitayama's hypothesis was partially correct that the task effect is reduced with a weakened context. Specifically, when the paper cutout was presented against light background, the luminous contrast at the square's boundary was lower. As a result, the information of line to square ratio was more impoverished, which could lead to poorer encoding, memory retention, and reproduction. In comparison, the lower contrast could less hinder the absolute task since it was less distracting. However, this line of reasoning does not explain why the absolute task was more accurate than the relative task. Kitayama et al. (2003) attributed this to culture. We could not find this effect. This is the main difference between the two studies.

We should be cautious however since we found only a null effect. Since each participant did only 10 trials total, our null effect could be due to the noisy data. Indeed, a number of participants were apparently confused, particularly on the 6th trial when the task was switched. Nevertheless, when trials with large errors were excluded, the same qualitative pattern of results remained. We therefore decided to collect data from additional participants. In personal communications, one author of Kitayama et al. (2003) suggested that a participant's socioeconomic background also played a role. We hence tested without pay 10 Caucasian investment bankers in a downtown Los Angeles firm, presuming that they might give rise to a stronger task effect.

Experiment 4

This experiment was otherwise identical to Experiment 3. No difference between the two tasks was found, $F(1, 9) = .28 < 1$, although the error in the absolute task (5.70 mm) was numerically smaller than in the relative task (6.57 mm).

We then jointly analyzed data from Experiments 3 and 4 ($n = 36$). Still, no significant task difference could be found, $F(1, 35) = 1.66$, $p = .21$, even though the error in the absolute task (5.77 mm) was numerically smaller than in the relative task (6.80 mm). In comparison, Kitayama et al. (2003) found a significant difference with $n = 20$ (3.71 vs. 6.35 mm).

Overall analysis

To overcome the difficulty of the small number of trials per task per participant, we analyzed data of 1199 trials from all participants ($n = 120$) except the 20 Chinese controls in Experiment 1 (data from one trial were missing due to experimenter error). Three additional trials were excluded because the absolute values of the error were greater than 70 mm. A two-way ANOVA yielded a significant main effect of task, $F(1, 117) = 6.44$, $p = .012$, with the absolute task more error prone (6.02 mm) than the relative task (5.17 mm). The main effect of culture (non-Asian American, Asian American, Chinese) was not significant, $F(2, 117) = 1.84$, $p = .16$. The interaction was marginally significant, $F(2, 117) = 2.37$, $p = .098$.

Kitayama et al. (2003) used either an error's absolute value or its ratio over the correct line length and found the same pattern of results. Using the ratios, however, we found no significant effects ($F < 1$ for the main effect of task). Only when an error's sign was taken into consideration, the same ratio analysis gave rise to a significant main effect of task, $F(1, 117) = 46.88$, $p \ll .001$ (absolute task: −3.41%, relative task: 3.27%). The main effect of culture and the interaction were not significant. Consistent with these results from the signed ratios, the two-way ANOVA of signed errors gave rise to a significant main effect of task, $F(1, 117) = 63.31$, $p \ll .001$ (absolute task: −1.98 mm, relative task: 1.88 mm). In other words, all participants on average slightly underestimated a line's length in the absolute task and overestimated it in the relative task. Although it is unclear why the under- and over-estimation occurred, and although the average of signed errors is not a particularly good measure, all our participants consistently showed the same behavior, regardless of culture.

Kitayama et al. (2003) cleverly included in both tasks the same trial whereby the second square was identical to the first. The correct line length therefore is equal to the first line, in both tasks. Consequently, any task difference in reproduction error from this trial could only be due to the task, not to the stimulus. A two-way ANOVA on the absolute values of error was conducted for this particular trial across the 120 participants. The only significant effect was the main effect of task. Namely, the error in the absolute task (5.20 mm) was significantly greater than in the relative task (3.97 mm), $F(1, 117) = 9.59$, $p = .002$. The main effect of culture was not significant, $F(2, 117) = 1.23$, $p = .30$. This indicates that, in the absolute task, participants relied less on the first square, presumably considered irrelevant. As a result, the memory recall was less accurate. This is strong evidence that the frame of reference suffices to explain the results, without resorting to culture.

Discussion

Ascertaining the extent to which visual perception is influenced by a perceiver's cultural background is important not only because of basic brain research with humans, but also because of the implications for animal research and for government policies (Cyranoski, 2006; Editorial, 2006). Our data do not support the hypothesis advocated in Kitayama et al. (2003) that basic visual perception is influenced by the perceiver's cultural background. Instead, the data could be explained by a simpler notion that a visible frame of reference helps encode more precisely a line's length relative to the frame than the same line's length independent of the frame (Rock & Ebenholtz, 1959).

This simpler explanation is also consistent with our results that when the size information of the frame was degraded—that is, when the frame was presented as white paper cutout against light background—the advantage of the relative task over the absolute task diminished. In no experiments in our study, however, was the absolute task more accurate than the relative task. A particularly interesting case is when the first and second frames were identical, where the solutions were also identical in both tasks. Because the stimuli were identical, any differential results could only be due to experimental instructions. Not surprisingly, because the frame size in the absolute task was irrelevant and presumably ignored by the participants, the absolute task was more error prone than the relative task.

Our results are also consistent with recent results that contradicted, at least partially, earlier findings by Nisbett and colleagues (Chang, Rotello, Li, & Rayner, 2008; Chen & Jiang, 2007; Rayner, Li, Williams, Cave, & Well, 2007). Although we cannot explain why the results are different between our experiments and those in Kitayama et al. (2003), it is worthwhile to list our methodological differences.

1. The Asian participants in Kitayama et al. (2003) were Japanese, whereas ours were Chinese. However, the discrepancy between the two studies is not between the Japanese and Chinese. The discrepancy is between the American participants in the two studies.
2. In Kitayama et al. (2003), the sequential order of the five trials in the absolute task and that of the five trials in the relative task was fixed across participants (while the task order was counterbalanced). We used both fixed and randomized sequences with counterbalancing. However, we do not expect this to be critical.
3. In Kitayama et al. (2003), a trial's first stimulus, a line in a square, was shown to a participant at one corner of the laboratory, whereas the second stimulus, the second square, was shown at a different corner. The purpose was to prevent the use of iconic memory. We did not move a participant from one place to another in the laboratory. By ensuring that no two stimuli were shown simultaneously, and given the short duration of iconic memory (Sperling, 1960), we believe that iconic memory was unlikely to play any role in the tasks. We also recruited and tested participants outdoors but could not find any difference between the indoor and outdoor results.

In conclusion, under no conditions could we find that reproduction of a line's absolute length was better than reproduction of length relative to the square enclosing it. This result is sensible in light of available information: a line estimated relative to a visible frame of reference is expected to be more accurate than encoded into memory without reference to any frame of reference.

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