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Cultural differences in visual attention: Implications for distraction processing

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We investigated differences between participants of East Asian and Western descent in attention to and implicit memory for irrelevant words which participants were instructed to ignore while completing a target task (a Stroop Task in Experiment 1 and a 1-back task on pictures in Experiment 2). Implicit memory was measured using two conceptual priming tasks (category generation in Experiment 1 and general knowledge in Experiment 2). Participants of East Asian descent showed reliable implicit memory for previous distractors relative to those of Western descent with no evidence of differences on target task performance. We also found differences in a Corsi Block spatial memory task in both studies, with superior performance by the East Asian group. Our findings suggest that cultural differences in attention extend to task-irrelevant background information, and demonstrate for the first time that such information can boost performance when it becomes relevant on a subsequent task.

A growing number of studies on cultural cognition have reported differences between individuals from East Asian and Western cultures, with the two groups displaying patterns that tend towards more holistic versus more analytic cognition, respectively. In particular, with respect to attention and perception, East Asians have been reported to display a wider scope of attention and attend more to contextual information than Westerners who tend to display a narrower focus of attention and attend more to salient objects. For example, relative to Westerners who process and remember more central features of a visual field, East Asians detect more changes and recall more information in the background of complex visual scenes (Boduroglu, Shah, & Nisbett, 2009; Masuda & Nisbett, 2001), are more sensitive to semantic incongruency between target objects and background scenes (Goto, Ando, Huang, Yee, & Lewis, 2010), and show shorter eye fixation durations on central objects and more saccades to background scenes (Chua, Boland, & Nisbett, 2005; Goh, Tan, & Park, 2009). East Asians are also more sensitive to contextually deviant irrelevant information (as indexed by greater novelty P3 amplitudes; Lewis, Goto, & Kong, 2008), are more likely to be influenced by surrounding facial expressions when judging the emotion of a target's expression (Masuda, Wang, Ishii, & Ito, 2012; Masuda *et al.*, 2008), and perform better on visuospatial tasks requiring the processing of objects in relation to their surrounding context (e.g., 'relative condition' in the Framed-Line Test; Kitayama, Duffy, Kawamura, & Larsen, 2003). There is also evidence of cultural differences in brain activity patterns during the performance of visuospatial

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tasks involving absolute or relative judgments with each group displaying greater effort, as indexed by increased activation in frontoparietal control regions and suppression of default mode regions, during culturally non-preferred judgments than during preferred judgment conditions (Goh *et al.*, 2013; Hedden, Ketay, Aron, Markus, & Gabrieli, 2008), consistent with the notion that culture impacts attention and perception.

Studies have also demonstrated that previous contextual information has different effects on East Asians and Western participants on subsequent task performance. For example, East Asians show poorer recognition of previously seen objects that are shown with a new background relative to the original or no background; Westerners are not influenced by this manipulation (Chua *et al.*, 2005; Masuda & Nisbett, 2001). In addition, the extent to which participants recognize the new object–background pairing, as revealed by the N400 incongruity effect, is negatively correlated with East Asians' performance only (Masuda, Russell, Chen, Hioki, & Caplan, 2014), consistent with the notion that previous contextual information plays an important role in related subsequent tasks more so for East Asians than for Western participants.

Despite the growing literature on cultural differences in visual attention, a relatively unexplored question is whether these differences remain robust when participants are instructed to ignore or intentionally focus attention on particular features of a visual field. Most previous studies allow their participants to freely view the stimuli without providing analytic or holistic attention instructions, raising the possibility that cultural differences may be attenuated or even eliminated when such instructions are provided. We explore the ability to control attention on a task that enables detection of differences in current task performance as well as performance on a delayed test of memory for their relevant information. To this end, we use a task in which subsequent performance can be improved by irrelevant information from the original task, in contrast to previous work in which attention to context has disrupted performance (Chua *et al.*, 2005; Masuda & Nisbett, 2001; Masuda *et al.*, 2014).

In two separate experiments, we exposed participants of East Asian or Western descent to background distractor words they were told were irrelevant to a target task (a colour naming Stroop task in Experiment 1 and a 1-back task on pictures in Experiment 2). Here, our definition of 'background' (or distracting) and 'central' (or target) features is based on their relevance to the task as dictated by task instructions, rather than by their location on the screen. We tested participants' performance on the target tasks, and subsequently, their implicit memory for the distracting words using category generation in Experiment 1 and a general knowledge test (Blaxton, 1989; Mulligan, 1998) in Experiment 2. We hypothesized that if the broader focus of attention reported for people of East Asian descent is an enduring disposition (Kahneman, 1973), they should process the distractor words regardless of the instructions and so show priming for these words on the subsequent task (i.e., display a boost in performance). In both experiments, we demonstrate that only participants of East Asian descent show a benefit on the priming tasks from previous distractor words, a benefit seen without a cost to the original task.

EXPERIMENT 1

In this experiment, individuals of East Asian or Western descent first performed a Stroop task in which they had to report the font colour of words that were irrelevant to the task. Unbeknownst to participants, a subset of those words consisted of exemplars of different taxonomic categories. After a filled interval, participants completed a category-generation task, with half the categories being represented in the initial Stroop task. If participants of East Asian descent encode and maintain access to the distractor words, despite instructions to only focus on their colour features, then they are expected to show greater priming of those words in the category-generation task relative to participants of Western descent.

Method

Participants

Fifty-six undergraduates (17–25 years old, $M = 19.28$ years, $SD = 1.83$; 21 male) participated for course credit. Twenty-eight of the participants were of East Asian descent ('East Asians') and 28 were of Western descent ('Westerners') based on self-report. East Asian participants identified themselves as such if their parents immigrated to Canada from East Asian collectivist countries including China, Korea, and Japan. None of the participants from the Western group reported a culture of origin typically regarded as collectivist. However, the East Asian participants were all first generation Canadians, with the exception of three participants who immigrated to Canada in early adulthood ($M = 13.33$ years, $SD = 1.53$). All participants were native English speakers or had learned English before age 7, with the exception of the three participants from the East Asian group noted above.[1] A higher proportion of participants from the East Asian group, however, learned a second language than was the case for participants in the Western group (100 vs. 59%), $\chi^2(1, N = 51) = 12.47$, $p < .001$ (data missing from five participants). The two groups were matched on age (East Asians: $M = 19.50$ years, $SD = 1.82$; Westerners: $M = 19.07$ years, $SD = 1.84$), years of education (East Asians: $M = 13.50$ years, $SD = 1.35$; Westerners: $M = 13.32$ years, $SD = 1.44$), and scores on the Shipley (1946) vocabulary test (East Asians: $M = 28.36$ years, $SD = 5.05$; Westerners: $M = 29.67$ years, $SD = 3.92$), $ps > .2$. Data were replaced from two Westerners who intentionally used words from the Stroop task on the category-generation task (see Procedure for more details). All experimental protocols were reviewed and approved by the university's research ethics board.

Stimuli

Two lists of 24 words each were created for the Stroop task and counterbalanced across participants. Twelve of the 24 words on each list served as category exemplars on the subsequent category-generation task (i.e., critical words), with three members of each of four different taxonomic categories (e.g., 'pineapple', 'blueberry', and 'lime' for fruit). The category exemplars were selected based on norms (Howard, 1979), indicating that they were, on average, the 11th, 12th, and 13th most commonly generated exemplars for their respective categories (see Appendix A). The remaining 12 filler words (same in both lists) were matched to the critical words in frequency of occurrence using the English Lexicon database (Balota *et al.*, 2007). An additional 8 words were added to each list to serve as primacy and recency buffers for a total of 32 words per list. The stimuli were presented in lowercase, 18-point bold Courier New font, in one of four different colours

[1] *All the results remain the same if data from those three participants are excluded.*

(red, blue, green, or yellow) against a black background and used equally often. There was no relationship between the words and their font colour.

There were eight categories in the category-generation task, with half the categories being represented in the initial Stroop task, and the other half represented in the alternate Stroop list. Thus, counterbalancing provided a baseline measure of how often the critical words were generated when they were not previously seen.

Procedure

During the Stroop task, participants were instructed to respond as quickly as possible to the font colour of the words by pressing one of four buttons on a response box. Participants were explicitly instructed to ignore the words as processing them would slow down performance. The words were presented individually at the centre of the screen until a response was made, for a maximum of 2,000 msec. Each word was separated by an interstimulus interval of 2,000 msec. Four words were first presented as a primacy buffer, followed by 24 words (12 critical and 12 filler) in random order, followed by a final four words, which served as a recency buffer. Participants performed a 7-item colour-word practice Stroop prior to the task, in which colour words were presented in congruent (e.g., 'BLUE' in blue) or incongruent (e.g., 'BLUE' in red) colours.

Following the task, participants completed a 10-min non-verbal filler task (a computerized version of Corsi's, [1972]; Block-Tapping Test, adapted from Rowe, Turcotte, & Hasher, [2008]) included to hide the connection between the initial task and the subsequent category-generation task. In the Corsi Block task, nine two-dimensional grey squares (arranged spatially as in Corsi, 1972) were presented against a white background. During each trial, some of the squares turned black successively in a particular sequence that participants were required to recall (with no time limits) by pressing a touch-sensitive screen. The task began with a set size of 4 squares and ended with a set size of seven squares, with three trials for every set size for an overall total of 12 trials. We selected this task as a filler task because it is non-verbal, and our critical memory measures were verbal and because it taps relational processing given the irregularly placed locations of the squares. On that basis, we anticipated that East Asians might show higher visuospatial working memory scores than Westerners.

During the category-generation task, participants listed up to eight exemplars for each of eight different categories (four target and four baseline categories). Participants were informed that the task was administered to obtain norms for future research. Each category label was printed individually on an index card. Cards were presented one at a time, and participants were allotted 1 min to write eight exemplars, giving the first instances that came to mind. Target and baseline category cards were presented in the same alternating order to each participant.

Following the category-generation task, participants were asked whether they had noticed a connection between the tasks and, if so, whether they intentionally used exemplars presented in the initial Stroop task to complete the category-generation task. Data from two participants who reported using such a strategy were excluded, as in previous studies (Amer & Hasher, 2014; Biss, Ngo, Hasher, & Campbell, 2013). Finally, participants completed a background questionnaire and the Shipley (1946) vocabulary test.

Results and discussion

A nonparametric Mann–Whitney test was used to analyse group differences in Stroop task accuracy, as the scores were not normally distributed. Accuracy was near ceiling for both groups (*Mdn* = 96%) and did not differ, $U = 386.0$, $z = -0.10$, $p > .9$. Stroop reaction times (RTs) were trimmed by removing incorrect trials and trials that were 2.5 standard deviations (or more) above or below the mean for each participant (1.8% for East Asians and 1.9% of trials for Westerners). The two groups (East Asians: $M = 590$ ms, $SD = 97$; Westerners: $M = 605$ ms, $SD = 84$) showed no reliable difference in RT, $t(54) = 0.62$, $p > .5$.

With respect to baseline words generated (i.e., the proportion of critical words generated that were presented in the alternate list and not previously seen), there was no difference between the two groups (East Asians: $M = 0.19$, $SD = 0.11$; Westerners: $M = 0.23$, $SD = 0.10$), $p > .1$. Priming scores were calculated for each group by subtracting the group's average proportion of generated baseline words from each individual's proportion of generated critical words, as is typical in the priming literature (Jelicic, Craik, & Moscovitch, 1996; Roediger, Weldon, Stadler, & Riegler, 1992; Rowe, Valderrama, Hasher, & Lenartowicz, 2006). That is, if, for example, a participant from the Western group generated 4 of 12 critical words, then priming for that individual was calculated as: .33 (proportion of generated critical words) − .23 (group average baseline score for Westerners) = .10. This method is typically used to account for random individual variation in baseline performance.[2] As illustrated in Figure 1, East Asians, $t(27) = 2.68$, $p < .05$, $d = .51$, but not Westerners, $p > .1$, showed reliable priming for the critical words previously shown as distractors on the Stroop task, and the group difference in priming was significant, $t(54) = 2.86$, $p < .01$, $d = .78$.

On the Corsi Block filler task, East Asians ($M = 86.96\%$, $SD = 5.89$) showed a higher visuospatial working memory span than Westerners ($M = 80.84\%$, $SD = 9.0$), $t(54) = 3.01$, $p < .005$, $d = .82$. There was no relationship between priming and visuospatial span or priming and Stroop RT, *r*s < .17, *p*s > .5. Additionally, the group differences in priming remained significant when visuospatial span, Stroop RT, and second-language learning were all held constant, $t(46) = 2.07$, $p < .05$.

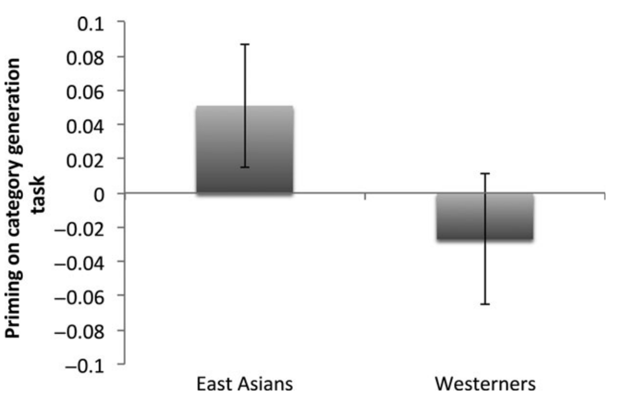

Figure 1. Mean priming from previous distractors on a category-generation task. Error bars represent 95% confidence intervals of the means.

[2] *Group differences in priming remain the same in both experiments if personal, rather than group, baseline scores are used and the opportunity to improve over the baseline is accounted for (see Experiment 2 Results and discussion for more details).*

East Asians showed implicit memory for task-irrelevant words while participants of Western descent did not. This effect was seen despite instructions to attend only to the target information in the task (i.e., colour features of the words). This suggests that instructions do not eliminate cultural differences in attention, and that, in some cases, information carried from one task to another, as a consequence of a holistic pattern of attention, can become beneficial. Furthermore, the results suggest that the holistic processing of the irrelevant words did not interfere with target task performance, as there were no group differences in Stroop accuracy or RT (if anything, participants of East Asian descent were numerically, but not reliably, faster on the Stroop task). It is possible, however, that the Stroop task was not sensitive enough to show an accuracy or reaction time detriment from distractor processing, especially given that performance was near ceiling for both groups. To further explore the relationship between culture and processing of distractors, we conducted a conceptual replication of Experiment 1 using a different encoding task and a different conceptual knowledge task from the ones used in the present study. We also added a reading with distraction task known to be particularly sensitive to the detriments of distraction processing (Darowski, Helder, Zacks, Hasher, & Hambrick, 2008).

EXPERIMENT 2

In our second experiment, distractor words were presented in the context of a 1-back task on pictures, with the words individually superimposed on the target pictures (task used in Amer & Hasher, 2014 and adapted from Biss *et al.*, 2013). The words served as answers on a subsequent general knowledge test. A reading with distraction task was administered at the end of the session. Based on the results from Experiment 1, we expected only participants of East Asian descent to show an advantage of distraction processing on the general knowledge test. Here, we had two opportunities to see the potential cost of distraction on a current task: (1) on the 1-back task on which East Asians might be slowed or more error prone than Westerners; and (2) during the reading with distraction task on which East Asians might show greater disrupted reading effects when distractors were words rather than strings of *X*s. As well, the Corsi task was used again, to replicate the finding that East Asians show higher visuospatial span on a working memory task that might rely on relational processing.

Method

Participants

Sixty undergraduates (17–24 years old, M = 18.77 years, SD = 1.61; 26 male) participated for course credit. Thirty-two reported being of East Asian descent (using the same criteria as in Experiment 1), and 28 reported being of Western descent (none of whom were from collectivist cultures). With the exception of one participant from the East Asian group who learned English at age 13, all participants were native English speakers or learned English before age 6.[3] In addition, although a higher proportion of East Asians were exposed to a second language relative to Westerners (88% vs. 75%), the difference did not reach significance, $\chi^2(1, N = 60) = 1.56, p = .21$. Data from participants in the Western group were reported in a previous study (Amer & Hasher, 2014). However, four

[3] *Excluding the data from that one participant does not change any of the results.*

participants from the earlier group were excluded because they came from a non-Western collectivist (e.g., South Asian) culture of origin. As in Experiment 1, the groups from our final sample were matched on age (East Asians: M = 18.66 years, SD = 1.21; Westerners: M = 18.89, SD = 1.99), years of education (East Asians: M = 12.91 years, SD = 1.25; Westerners: M = 13.04 years, SD = 1.40), and Shipley (1946) vocabulary scores (East Asians: M = 28.98 years, SD = 3.32; Westerners: M = 30.63 years, SD = 3.85), ps > .05. Data from three Westerners and two East Asians were replaced as follows: 1 Westerner performed poorly on the initial 1-back task, 1 Westerner intentionally used words from 1-back task in the general knowledge test, and 2 East Asians and 1 Westerner failed to follow general task instructions. All protocols were approved by the university's research ethics board.

Stimuli

Two 20-word lists were created and counterbalanced across participants for the 1-back task. The distractor words were individually superimposed on line drawings selected from Snodgrass and Vanderwart (1980), which were coloured red to make them easily distinguishable from the words. Ten of the 20 words were critical items that served as answers to subsequent general knowledge questions. The critical words (and their corresponding knowledge questions) were selected from Blaxton (1989) – see Appendix B. The remaining 10 filler words (same on both lists) were matched to the critical words in length and frequency of occurrence. There was no relation (e.g., semantic or associative) between the words and target pictures. Twenty non-words, matched to the words in length, were also used as distractors, and an additional 16 non-words were used as primacy and recency buffers. The superimposed words and non-words were presented in uppercase, 18-point bold Arial font in black.

Twenty questions were used in the general knowledge test, with answers for half the questions being presented as distractors on the initial 1-back task. Answers for the remaining baseline questions were presented on the alternate 1-back list, and thus, counterbalancing provided a baseline measure of general knowledge. Six easy questions were added at the beginning and the end of the task to boost morale and disguise the task's implicit nature, for a total of 32 questions.

Four short passages that told a coherent story were used on the reading with distraction task (adapted from Connelly, Hasher, & Zacks, 1991). The task required participants to read the passages or 'target text' (presented in italicized typeface) while ignoring interspersed distractors (presented in upright typeface). There were two within-subject conditions with two passages in each condition. In a low-interference condition, the distractors consisted of strings of *X*s, and in a high-interference condition, the distractors were words or phrases related in meaning to the content of the story. Difference in reading time between the low and high-interference conditions and the number of distractor words read ('intrusions') indexed the ability to control distractors during target task performance. After each passage, four six-alternative multiple-choice questions about the passage were administered to test comprehension.

Procedure

During the 1-back task, participants were presented with a stream of pictures and instructed to press one key when two consecutive pictures were identical and another key when they were different, while ignoring the superimposed distractors to improve accuracy. Each picture was presented for 1,000 msec and separated by an ISI of 500 msec. Each picture and distractor word or non-word was presented twice throughout the task. Critical words were always paired with the same pictures. Filler words and non-words were paired with different pictures to ensure that participants could not respond to the 1-back trials based on the distracting material rather than the target pictures. There were a total of 17 repetition trials, with critical words never appearing on such trials. Following a practice session of 20 pictures presented alone with no overlapping distractors, participants were presented with 100 trials in the following order: four pictures presented alone, eight pictures with superimposed non-words (primacy buffer), 80 pictures with superimposed words (20 words occurring twice for a total of 40 trials) or non-words (20 non-words occurring twice for a total of 40 trials), and finally eight pictures with superimposed non-words (recency buffer). After completing the 1-back task, participants performed the same Corsi Block filler task administered in Experiment 1.

On the general knowledge task, questions were presented one at a time on a computer screen for 10 s with an ISI of 500 msec. Participants were requested to give the first response that came to mind and were informed that the task was being administered to obtain norms for future research. Two practice questions were administered first, followed by the 32 questions. Target and baseline questions were administered in the same alternating order to each participant. An awareness questionnaire similar to the one used in Experiment 1 was administered following the task, and data from the one participant who reported intentionally using distractor words presented in the initial 1-back task as answers to subsequent general knowledge questions were excluded.

Participants completed the reading with distraction task following the general knowledge task. Stories were presented on a computer screen in the following order: One low-interference story, two high-interference stories, followed by a final low-interference story. Participants read each story out loud, and the total time to complete reading each story as well as the number of distractor words read in the high-interference condition (intrusions) were recorded and scored by trained research assistants. Participants then completed four multiple-choice comprehension questions after each story by pressing a key (numbers 1–6) corresponding to the correct answer. They were informed that the correct answer for the multiple-choice questions repeated the exact wording from the target text in each passage (plausible, but incorrect, answers were presented as distractors in the high-interference condition). As in Experiment 1, participants completed a background questionnaire and the Shipley (1946) vocabulary test at the end of the testing session.

Results and discussion

A nonparametric Mann–Whitney test showed that accuracy on the 1-back trials was near ceiling for both groups (Mdn = 98%) and did not differ, $U = 366.0$, $z = -1.24$, $p > .2$. As in Experiment 1, RTs on the initial task were trimmed by removing incorrect trials and trials that were 2.5 standard deviations (or more) above or below each participant's mean (3.3% of trials for East Asians and 2.6% of trials for Westerners). East Asians (M = 464 msec, SD = 81) responded faster than Westerners (M = 506 msec, SD = 81) on the 1-back trials, $t(58) = 2.02$, $p < .05$, $d = .53$.

On the general knowledge task, Westerners ($M = 0.26$, $SD = 0.14$) correctly answered a greater proportion of the baseline questions than East Asian ($M = 0.18$,

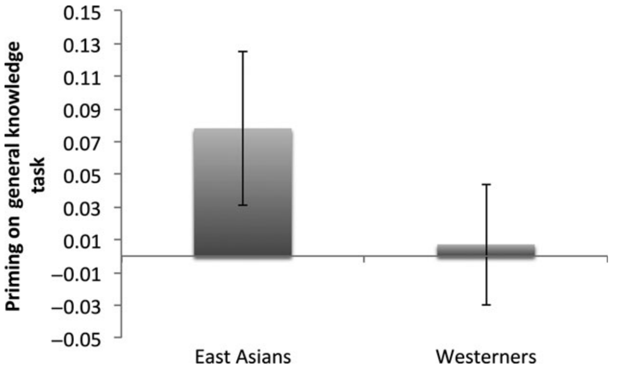

Figure 2. Mean priming from previous distractors on a general knowledge task. Error bars represent 95% confidence intervals of the means.

SD = 0.13), $t(58) = 2.26$, $p < .05$, $d = .59$. An examination of the priming scores (calculated by using each cultural group's baseline scores as in Experiment 1) demonstrated that East Asians, $t(31) = 3.00$, $p < .01$, $d = .53$, but not Westerners, $p > .7$, showed reliable priming for distractors. The cultural difference in priming scores was also significant, $t(58) = 2.08$, $p < .05$, $d = .55$, consistent with the findings from Experiment 1 (Figure 2).

As in Experiment 1, East Asians (M = 88.83%, SD = 8.61) correctly recalled more sequences on the Corsi Block filler task relative to Westerners (M = 83.66%, SD = 9.71), $t(58) = 2.19$, $p < .05$, $d = .57$, and neither Corsi Block performance nor RT performance on the 1-back task showed a relationship with priming, rs < .17, ps > .7. The group differences in priming also remained significant when Corsi Block performance, RT on the 1-back task, and second-language learning were all held constant, $t(55) = 2.06$, $p < .05$.

There were no reliable differences between the two groups on any of the measures from the reading with distraction task, including both speed of reading and accuracy in answering comprehension questions, all ps > .1 (Table 1).

One concern with our findings is that relative to participants of East Asian descent, participants of Western descent showed higher baseline performance levels in both experiments (i.e., frequency of generating particular category exemplars in Experiment 1 and verbal knowledge in Experiment 2). As a result, there were group differences in opportunities to improve over the baseline and so show priming effects. To address this issue, we recalculated group differences in priming using a method that accounts for the baseline score differences. With this new method, priming scores are calculated as the

Table 1. Reading with distraction performance for East Asians and Westerners

	East Asians		Westerners	
Measure	*M*	*SD*	*M*	*SD*
Reading time difference (s)	21.1	8.6	19.9	8.4
Overall comprehension accuracy (%)	79.5	12.3	75.7	10.3
High-interference story comprehension accuracy (%)	82.4	16.8	78.6	11.2
Number of intrusions	2.2	2.1	1.5	1.8

maximum priming possible based on the number of accurate/correct personal baseline responses, and thus, controls for differences in opportunities to improve over the baseline. That is, if, for example, a participant has a personal baseline proportion score of .2 and a target proportion score of .4, then priming is calculated as: (.4 − .2)/(.1 − .2) = .25. Using this method, the results remained the same, and East Asians showed more priming for distractors than Westerners in both Experiment 1 (East Asians: $M = 0.05$, $SD = 0.17$; Westerners: $M = -0.05$, $SD = 0.21$), $t(54) = 2.00$, $p = .05$, $d = .54$, and Experiment 2 (East Asians: $M = 0.09$, $SD = 0.18$; Westerners: $M = -0.02$, $SD = 0.21$), $t(58) = 2.13$, $p < .05$, $d = .56$. Thus, group differences in priming were not an artefact of differences in baseline scores.

The findings from the current experiment replicate those from Experiment 1 and suggest that individuals of East Asian descent use distraction from one situation to benefit future task performance. Importantly, attending to stimuli holistically did not seem to negatively impact target task performance. On the contrary, participants of East Asian descent showed *faster* average RT on the 1-back trials with distractors relative to those of Western descent.

GENERAL DISCUSSION

Previous studies exploring cultural differences between East Asians and Westerners have mostly used instructions that allowed free allocation of attention (Fu, Dienes, Shang, & Fu, 2013; Kiyokawa, Dienes, Tanaka, Yamada, & Crowe, 2012; Masuda *et al.*, 2014 for exceptions). The two studies reported here used instructions that urged participants to focus on one aspect of a task (colour of words in Experiment 1 and repetition detection of a picture in Experiment 2) in the face of distracting words. We measured both concurrent task performance and subsequent implicit memory for the previous distraction using implicit conceptual knowledge tasks (category generation in Experiment 1 and answers to general knowledge questions in Experiment 2). The findings were consistent across the two studies. Distraction did not disrupt performance on the Stroop task, on reading with distraction, or on the 1-back task for East Asian participants. Nonetheless, we found substantial differences in performance on the subsequent implicit memory tasks. Additionally, on a visuospatial memory task that relies on the ability to remember irregular locations in sequence, East Asians outperformed Westerners.

Taken together, our findings suggest a cultural difference in visual attention that extends into the context of background irrelevant information (see also Fu *et al.*, 2013 for recent evidence demonstrating implicit learning of irrelevant letter sequences in East Asian, but not Western, participants). Participants of East Asian descent processed that information even when it was considered detrimental to task performance, suggesting that the broader focus of attention in East Asians is an enduring disposition. This relational encoding may have also contributed to the East Asian advantage in remembering the sequences of the irregularly placed squares in the Corsi block task. It is important to note, however, that cultural differences in the tendency of using previously encoded information may also account for a portion of the cultural variance in priming for previous distractors. That is, due to cultural differences in the categorization and organization of information (Ji, Zhang, & Nisbett, 2004), Westerners might be less inclined than East Asians to transfer previously encoded information to a subsequent, seemingly unrelated task. However, based on a relatively extensive literature demonstrating cultural differences in the processing of visual information (Boduroglu *et al.*, 2009; Chua *et al.*, 2005; Goto *et al.*, 2010; Hedden *et al.*, 2008), we postulate that culture-specific patterns of encoding primarily lead to differences in the processing of background irrelevant information, and subsequently, priming for such information.

Our results highlight the importance of examining cultural differences on visual processing and attention tasks beyond immediate task performance. Differences in how the two groups processed the stimuli were only apparent on a subsequent task that implicitly tested knowledge of those stimuli. This has significant implications for cultural studies on attention that rely on behavioural differences in concurrent task performance, and may have potentially contributed to a publication bias in the type of studies demonstrating cultural cognitive differences (see de Bruin, Treccani, & Della Sala, 2015, for a similar discussion on bilingualism).

Our results also demonstrate that contextual information encoded and carried over to new tasks can *improve* performance in certain circumstances. Previous studies have typically focused on how such information can hinder performance when it interferes with future task demands – for example, when old items on a memory task are displayed with new backgrounds (Chua *et al.*, 2005; Masuda & Nisbett, 2001; Masuda *et al.*, 2014). Here, we show that, in participants of East Asian descent, previous background irrelevant information boosts subsequent task performance when it becomes relevant, consistent with the pattern typically seen in Western older adults (Amer & Hasher, 2014; Biss *et al.*, 2013; Campbell, Hasher, & Thomas, 2010; Rowe *et al.*, 2006). In older adults, however, processing of distractors is commonly associated with lower target task performance (Connelly *et al.*, 1991; Lustig, Hasher, & Tonev, 2006) – an effect not observed in our East Asian participants – suggesting that different attentional mechanisms may account for the encoding of distractors in both groups. Regardless of the source of the effect, our results suggest cultural differences in the amount of information encoded in a visually complex scene and transferred to a new task. This greater knowledge of information may have implications beyond attention and perception in tasks such as learning statistical regularities and creative problem solving, for example.

The wider scope of attention in East Asian younger adults is commonly attributed to engagement in social practices that emphasize collectivism, as opposed to a Western emphasis on individualism. Western, individualistic cultures tend to stress the importance of independence and personal goals and accomplishments, while Eastern, collectivist cultures prioritize collective goals and interconnectedness with other group members. These differences in social value systems are hypothesized to have implications beyond how individuals view themselves and to influence attentional and perceptual systems involved in how they perceive their environment. That is, repeated engagement in tasks or practices that are consistent with and achieve collectivistic or individualistic cultural values influences neural structure and functions in a manner which results in culture-specific holistic or analytic processing styles, respectively (Kitayama & Uskul, 2011; Park & Huang, 2010). Our findings demonstrate that this cultural effect remains robust in participants who grew up in a Western society but whose cultural background was East Asian. This is consistent with other studies reporting attentional pattern differences between European and Asian Americans (Kitayama & Murata, 2013; Lewis *et al.*, 2008), and consistent with reports of differences in the extent to which both of these groups view themselves as independent or interdependent, with Asian Americans being more similar to East Asians than to European Americans (e.g., Lewis *et al.*, 2008; for a review see Oyserman, Coon, & Kemmelmeier, 2002). Our interpretation of the results is clearly speculative given that no questionnaires were administered to assess the degree to which our participants identify with their respective cultures and their individualistic or collectivist tendencies. Finally, our findings highlight the potential importance of considering culture in studies of attention and cognition. The failure to do so may contribute to irregularities in replication across studies.

Given the behavioural evidence of cultural differences in distraction processing, it is plausible that the two groups show culture-specific brain activity patterns while performing distraction control tasks. Culture differences in activity levels of a frontoparietal control network involved in attention control have already been demonstrated during the performance of a visuospatial task requiring absolute (preferred by Westerners) or relative (preferred by East Asians) judgments (Hedden *et al.*, 2008). It is possible, then, that the frontoparietal control network, which modulates activity in downstream sensory regions, regulates those regions in a culture-specific manner, with Westerners showing more activity in regions processing target, relevant information, while East Asians showing more distributed activity in regions processing relevant and irrelevant information. Consistent with that notion, Gutchess, Welsh, Boduroglu, and Park (2006) found that when viewing a complex visual scene with a focal object embedded in a meaningful background, Westerners show greater activity in ventral visual cortex object processing regions relative to East Asians. Similarly, EEG research has demonstrated greater amplitudes in event-related potentials (ERPs) indicative of orienting attention to and processing of target, focal objects in participants of Western descent relative to those of East Asian descent, providing more evidence that Westerners allocate more attention to central targets (Kitayama & Murata, 2013; Lewis *et al.*, 2008).

In conclusion, our findings provide compelling evidence that cultural differences in attention extend to the processing of task-irrelevant or distracting information. We demonstrate for the first time a cultural influence in how such information can boost subsequent task performance when it becomes relevant. This suggests that distraction plays a bigger role in the mental lives of East Asian, relative to Western, individuals and can have significant implications on the performance of related tasks.

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Appendix A: Category exemplars in Experiment 1

Category	Exemplars
List A	
Fruit	Pineapple, blueberry, lime
Relatives	Nephew, husband, daughter
Weather	Sun, thunderstorm, typhoon
Animals	Monkey, mouse, giraffe
List B	
Sports	Volleyball, rugby, polo
Metals	Bureau, rug, stool
Furniture	Platinum, nickel, bronze
Occupations	Salesman, writer, electrician

Appendix B: Critical words and general knowledge questions in Experiment 2

Critical word	General knowledge question
List A	
Hydrogen	What is the most abundant element in the sun?
Cologne	What German city is famous for the scent it produces?
Copper	What metal makes up 10% of yellow gold?
Scurvy	What disease is characterized by bleeding gums and results from a vitamin deficiency?
Concrete	What building material is made from mixing cement, aggregate, and water?
Socialism	What political theory advocates governmental ownership of all major industries within a country?
Margarita	What do you get when you mix tequila, triple sec, and lime juice?
Asylum	What name is given to a hospital where mental patients used to be treated?
Kangaroo	What animal is also called a wallaby?
Molasses	What is the syrup drained from raw sugar?
List B	
Gestation	What term refers to the period of pregnancy during which a mother carries an unborn child?
Barrel	What does a cooper make?
Cocaine	What drug did Sherlock Holmes take at the beginning of his career?
Sequoia	What is the large redwood tree found in northern California?
Rebuttal	In a debate, what term refers to the counterargument given after both sides have presented their initial arguments?
Caricature	What sort of cartoon distorts a person's features for satirical purposes?
Glaucoma	What eye disease leads to the loss of vision?
Marble	What is the Taj Mahal made of?
Sculpture	What is a stone carving called?
Vaccine	What is another name for an inoculation that is given for the prevention of a disease?