Effect of culture on memory for binding different types of visual information

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**Abstract**

The degree of individualism or collectivism in a culture has observable effects on cognitive processing. Participants from collectivist cultures are less able to identify a previously displayed object when presented with a novel background than participants from individualist cultures. This can be interpreted as collectivist cultures more likely to process information field dependently. We tested explicitly whether collectivist or individualist cultures are more likely to bind foreground and background images and whether such binding is differentially affected for object-scene and action-scene combinations. Across three experiments participants viewed item-context composites, then completed a forced-choice recognition task. In Experiment 1, 61 UK and 57 Malaysian participants viewed object-scene composites, with UK participants significantly more accurate in correct composite recognition, with Experiment 2 demonstrating this difference was not due to cultural differences in object familiarity. In Experiment 3, 62 UK and 67 Malaysian participants viewed action-scene composites, with no significant difference between cultures in proportion of items recognised. The results of Experiment 1 suggest that the UK sample were able to store high-fidelity representations of visual features as an association between item and context, while the Malaysian sample were unable to. This result is discussed in relation to both cultural, and cognitive psychology.

**Keywords**

Culture, Visual Long-Term Memory, Binding Memory, Item-Context Recognition

**Highlights**

* Western participants are more accurate in recognition of specific object-scene bound representations
* Across both cultures bound representations that only altered the background were significantly more likely to be recognized than bound representations that only changed foreground, or both elements

In the field of culture, a large number of studies have suggested there are differences between Western and East Asian cultures. Westerners are thought to engage in analytical processing, focusing on salient objects, while East Asian cultures engage in holistic processing, focusing on processing scenes within context. This difference has been suggested to be due to Western cultures typically being more individualist while East Asian cultures are typically more collectivist (Gutchess et al., 2006, Masuda & Nisbett, 2001; Na et al., 2010; Nisbett; 2003; Nisbett & Masuda, 2003). Within these studies, American and Japanese participants view a focal object in a scene (e.g., fish in a pond), and after a delay recognition of the focal objects are tested with visual scenes manipulated so that old objects may be presented in an old or new background, or a new object may be presented in an old or new background, with participants completing a Yes/No (YN) recognition task on the focal object (Chua, Boland, & Nisbett, 2005; Masuda & Nisbett, 2001). In a seminal paper, Masuda and Nisbett (2001) reported that Japanese participants were more likely to describe previously seen video clips contextually than American participants who focused more on foreground details. Likewise, in speeded recognition tasks Japanese participants were more accurate when the target object is presented in the same training context whereas American participants were unaffected by the contextual manipulations but were overall slower than East Asian participants when identifying the focal object in all conditions. This difference based upon culture was suggested to be evidence of decontextualisation (analytical processing) in American participants and binding (holistic processing) in Japanese participants; Americans were slower due to processing the object and background separately, whilst Japanese participants were quicker due to the holistic binding, but at the cost of reduced accuracy when the context changed. Follow up studies ultilising a change-blindness paradigm (where participants are required to identify changes in either foreground or background) also observed that East Asian participants were much more attentive to contextual changes while American participants were more attentive to focal object changes (Masuda & Nisbett, 2006). This is further expanded upon in the culture-based attentional bias theory that suggests that Americans are better than East Asians at detecting changes in the centre of the screen, suggesting that East Asians allocate their attention more broadly (Boduroglu et al., 2009). Within the theory, there is some evidence that culture influences early attention (Chua et al., 2005; Goh et al., 2009; Ji et al., 2000; Kitayama et al., 2003) with American participants looking at central objects sooner and longer than East Asian participants, who made more saccades to the background, suggesting East Asians allocate attention more broadly than Westerners. This results in greater detection in changes to contextual stimuli but at the expense of reduced reaction time for changes in focal objects, supporting the interference effect of novel backgrounds in Masuda and Nisbett’s (2001) study although this has been disputed in some eye-tracking studies that have found no effect on culture on saccades (Evans et al., 2009; Rayner et al., 2007).

Although these studies have demonstrated cultural differences in visual recognition, much of the focus has been on how context can affect recognition of a focal object, with little research on the recognition of the context itself. At present only one study has looked at this: Millar et al. (2013) investigated the influence on culture on separate foreground and background recognition. In their first experiment, participants were shown objects or backgrounds and in a subsequent recognition task were shown the original image, a similar image, or a new, foil image. In a second experiment, the object and background were shown in a composite image before a recognition task displayed the items separately, with recognition scored as either specific- (seen for old items, not seen for similar), or general- memory (seen for old items and similar items. It was observed that Americans exhibited greater accuracy in specific memory compared to East Asians, while both cultures performed similar on measures of general memory, with this pattern observed across both object and background recognition. From this, Millar et al. suggested that Western culture’s analytical focus means individuals are more likely to study specific details of focal objects, whilst East Asian cultures, by focusing on the holistic image, miss these specific details but have a general recognition similar to Western participants. The result appears consistent with the visual long-term memory literature that has largely focused on Western participants, with recent research on image recognition demonstrating humans have a remarkable ability to recognise visual items, with scene (Konkle, Brady, Alvarez, & Oliva, 2010), object (Brady, Konkle, Alvarez, & Oliva, 2008), and action (Urgolites & Wood, 2013a) recognition observed to accuracy levels above 80%, suggesting that we are able to store high-fidelity representations of previously seen stimuli.

However, when expanded to specific item-context composite memory, where an action- or object- scene composite image is displayed and participants have to recognise that specific pairing (e.g., a man performing a twist in front of a harbour), proportion of items correctly recognised in Western participants drops significantly in two alternative forced-choice (2AFC) tasks to close to chance (Urgolites & Wood, 2013b). The result is more surprising as with the same composite stimuli, participants are able to recognise an individual element of the composite close to previously reported accuracy levels, again supporting Millar et al. (2013). These results suggest that while Western participants are capable of binding visual stimuli together, this process is difficult and prone to errors in spite of participants having a detailed memory of the individual elements.

The result can be interpreted within theories of recognition, for example, dual process theory of recognition memory assumes recognition can be split into two facets, familiarity and recollection, analogous to the general- and specific- memory split suggested by Millar et al (2013). Familiarity is considered an automatic process that allows recognition but no retrieval of specific detail, while recollection requires a conscious effort of specific details related to the encoding episode, requiring a longer processing time, with both suggested to rely upon different memory traces (for a summary, see Yonelinas, 2002, 2010; Zimmer et al., 2006). Familiarity is suggested to rely on an object ‘token’; information about the object such as colour, size, and shape, while recollection requires an episodic token, integrating the object-token with additional contextual information, allowing the ‘where, when, how’ questions to be answered (for a summary, see Ecker et al., 2004). When applied to the results observed in the culture literature, it appears that Western participants employ recollection, as demonstrated in Millar et al. and this theory can be interpreted as a potential explanation for the longer reaction time in Masuda and Nisbett (2001). East Asian cultures that rely on familiarity based recognition due to holistic processing would typically be quicker in their reaction times, but less accurate on specific recognition tasks, again as seen in Masuda & Nisbett.

Although this is a suitable explanation for the item- or context- recognition, it is unable to account for the accuracy in specific item-context composite recognition. One theory, suggested by Chalfonte and Johnson (1996) suggest there are at least two ways that feature binding may be expressed. Features may be independently represented, but associated or features may form a blended representation, distinct from the two features separately (Chalfonte & Johnson, 1996; Graf & Schacter, 1989). When applied to culture-based visual recognition, it appears that Western participants employ this independent but associated representation, as demonstrated by the existing literature, while East Asian cultures rely on blended representation, with this distinction supported by the existing cultural literature (Gutchess et al., 2006, Na et al., 2010; Nisbett; 2003; Nisbett & Masuda, 2003; Masuda & Nisbett, 2001), although it has not been explicitly tested in a specific composite memory task. As such, within the current study, we sought to examine whether there is a significant cultural difference between Western (UK) and East Asian (Malaysian) participants in recognition of specific item-context composite videos that can relate to this proposed difference in feature binding.

In order to ensure it was only specific item-context composite memory being tested, recognition was measured by a 2AFC task rather than a YN recognition task. While previous studies utilized a YN recognition paradigm (Chua et al., 2005; Evans et al., 2009; Masuda & Nisbett, 2001; Millar et al., 2013; Rayner et al., 2007), when the YN task is compared to 2AFC recognition tasks, performance on 2AFC is reliably better due to its performance being determined by the proportion of correctly identified items, minimizing false alarm rates from noise trials observed in the YN recognition task (Jiang, Wixted, & Huber, 2009). Furthermore, the same study observed a difference between Forced-Choice Corresponding (FC-C) and Forced-Choice Non-Corresponding (FC-NC). FC-C involves the target item being paired with a similar foil in order to generate similar levels of familiarity but stronger in the target item. As such, the familiarity may initially generate a high number of false alarms but recognition of the specific composite image should lead to a reliable difference throughout testing (Jiang et al., 2009). As such, the current study used a 2AFC paradigm with three types of foil, two FC-C and one FC-NC, with all visual components taken from previously existing stimuli but in novel composites in order to ensure it was specific binding memory that was being tested.

In accordance with Chalfonte and Johnson’s (1996) feature binding theory, we hypothesized that the Western participants would more accurately recognize specific object-scene composites compared to the East Asian participants due to Westerner’s analytical processing supporting associated, high-fidelity visual representations compared to the East Asian’s holistic processing supporting reduced fidelity, blended visual representations, making recognition more susceptible to the FC-C foils. In order to minimize any cultural effects of visual novelty, such as those demonstrated in Goh et al. (2009), The foils used in the testing phased contained stimuli already seen in the training phase but in new pairings to avoid novel visual information. Whereas previous studies have focused upon a largely Chinese/Japanese based participant group, this study has focused upon Malaysia, due to Malaysia being an Asian culture but using a Latin-based language as well as a high English speaking population. This population should account for de-confounding any potential effects a pictographic-based language, such as Chinese/Japanese may have upon complex image recognition, as previously suggested by Kühnen et al. (2001).

**2.1 Experiment 1: Object-Scene Composite Recognition**

**2.1.1 Method**

2.1.1.1 Participants

A total of 131 participants took part in the study (61 Western, 57 East Asian and 13 Other; pilot study data indicated that Russian participants did not identify as either Western or Eastern, see Table 2.1). Western participants were students from Lancaster University completing the task for course credit. East Asian and Other participants were recruited from Sunway University using an opportunity sampling method. All students who attended Sunway University required an English language requirement to IELTS minimum band 5.5, defined as a modest English Language User (https://onlineapplication.sunway.edu.my/?m=link&c=entry\_requirement). The experimenters comprised English, Mandarin and Malay speakers in order to ensure participants fully comprehended the study. Participants gave informed consent and were reminded they were free to withdraw from the study at any time. Due to data protection issues at Sunway University, age and gender was not recorded for East Asian participants but for Western participants this data was recorded (38 Females, Mean age = 19.28, SE = 0.03). Participants were fully debriefed and informed as to the study’s purpose after completion. Sunway students identifying as Eastern cultures were asked whether they were born/raised in Malaysia. If they were, they would then be asked about their ethnicity. If participants indicated they weren’t born in Malaysia they were considered East Asian Other.

Table 2.1. Table showing the total participants in each study by culture and ethnicity

|  |  |  |  |
| --- | --- | --- | --- |
|  | Ethnicity | Action-Scene Task | Object-Scene Task |
| Western Cultures | American | 6 | 8 |
| European | 47 | 39 |
| Slavic/Eastern European | 1 | 6 |
| Western Other | 8 | 8 |
| East Asian  Cultures | Malay | 24 | 17 |
| Chinese/Chinese Malay | 27 | 32 |
| Indian/Indian Malay | 7 | 5 |
| East Asian Other | 9 | 3 |
| Other | 19 | 13 |
| Total | 148 | 131 |

2.1.1.2 Stimuli

The stimuli consisted of 40 animated objects and 40 images of scenes combined to create a unique object-scene composite. The object-scene composites were taken from an unpublished paper by Urgolites and Wood (unpublished). Each composite consisted of an object performing a 360° rotation for 1 second within one scene (see Figure 2.1) in the centre of the scene. All of the objects had the same duration (1000 ms) and frame rate (30 frames per second), with each object rotating 180° from the starting position at the 15th frame.

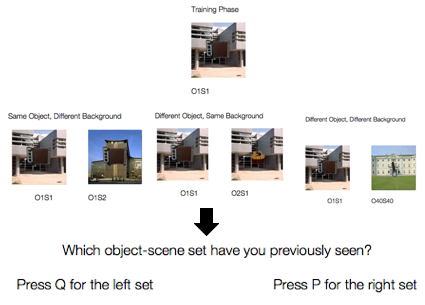


Figure 2.1 Image demonstrating the study and test phase of the object-scene composite recognition task.

2.1.1.3 Procedure

In the study phase participants viewed 40 object-scene composites in a randomised order. Each trial started with a 1000 ms black screen followed by the object-scene composite for 1000 ms, where the object rotated once and after the object-scene composite had been displayed a second 1000 ms black screen was displayed.

In order to ensure participants were maintaining concentration during the study phase after each object-scene composite was displayed, participants performed a repeat-detection task where every 4th novel object-scene composite was repeated at intervals of zero, one, two, three or four trials between the initial presentation and the repeated composite. After each object-scene composite was presented participants were instructed to indicate whether the previous scene had been displayed before with ‘Has this object-scene composite been presented before? Press Z for Old and M for New’ being displayed centrally and ‘Old’ appearing in the left half of the screen and ‘New’ appearing in the right half of the screen, counterbalanced across participants. Participants were able to respond to this without time pressure but were asked to respond quickly and accurately.

The test phase started 2 minutes after the initial training phase. For each trial participants performed a two-alternative forced choice task. Two object-scene composites were presented on a screen: one previously seen ‘old’ composite and one new, foil composite. Participants saw 40 test trials which began with a 1,000 ms black screen, a composite was presented on the left half of the screen for 1000 ms, an interval of 1000 ms with a black screen followed by a second composite presented on the right half of the screen for 1000 ms. After this, a black screen was presented for 1000 ms, then participants were asked which composite had previously been displayed, pressing Q for the left composite and P for the right composite. Both the old composite and the foil composite were only presented once for the full duration of the object’s rotation and were hidden immediately after the rotation had completed. The side in which the old composite was displayed was counterbalanced so it appeared equally across both the left and right sides of the test phase.

Foils within the study were split into two categories, FC-C and FC-NC. In the FC-C category, in Binding Condition (BC) A participants were presented with the old composite whilst the foil composite had the same scene but different object (DFSB). In BC B the old composite was presented with a foil composite with the different scene but same object (SFDB). For the FC-NC category, BC C had the old composite presented with a foil composite with a different scene and different object (DFDB). All backgrounds and foregrounds were taken from stimuli seen in the training task, just in new pairings.

For all tasks participants were given verbal instructions before the experiment started and written instructions were provided on the screen before each section of the experiment. The study was created on Psychopy 1.83.05 (Peirce, 2009).

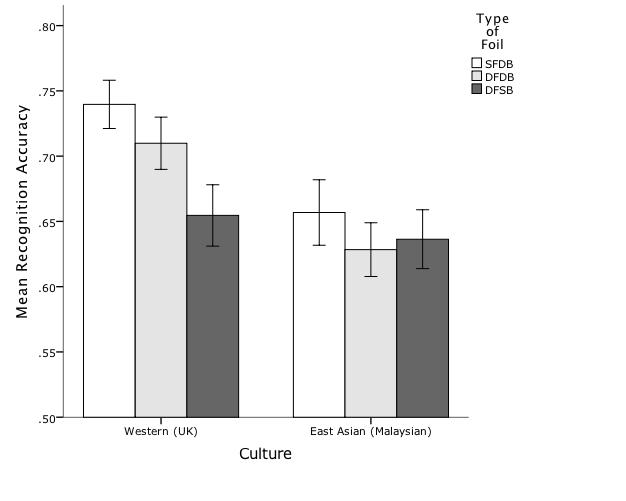
**2.1.2 Results and Discussion**

The dataset was initially filtered by proportion of items correctly identified in the training phase so that only results higher than 50% were included in the dataset as any data below that would be less than chance and indicates participants may not have fully understood the instructions. This left 126 participants (55 East Asian, 58 Western, 13 Other), further analysis found that the Other category lead to no significant difference and as such was removed from further analysis leaving 113 participants (55 East Asian, 58 Western). Analysis of ethnicity also led to no significant difference and as such there was no further analysis on this.

Linear mixed effects (LME) modelling was conducted in order to allow us to account for random effects between item and participants. In the analysis the model was initially fitted with a base model of participant number composite to measure random effects, Model AIC = -239.353. We then added the experimental conditions gradually over a series of models. Introducing Culture led to a significant difference compared to the previous model, χ2 = 6.2288, p = 0.012, Model AIC = -252.945, suggesting that culture had a significant impact on the ability to recognise object-scene composites. Introducing Foreground/Background foils as a factor also increased the model fit, χ2 = 10.405, p = 0.005, Model AIC = -247.210, suggesting that Foreground/Background foils had a significant influence on recognition. Adding in the interaction between Culture and Foil led to a better model fit but was only borderline significant, compared to the previous model, χ2 = 5.0834, p = 0.078 (see Table 2.2 for full LME information, Figure 2.2 for visual representation of results).

Table 2.2. Summary of the Linear Mixed Effect Model for the Object-Scene Recognition Task.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Fixed Effects | Estimate | Standard Error | | t value | | p value |
| Intercept | 0.822 | 0.048 | | 17.028 | | *p < 0*.001 |
| Culture | -0.082 | 0.031 | | -2.690 | | *p* = 0.007 |
| Type of Foil | -0.149 | 0.068 | | -2.191 | | *p* = 0.029 |
| Culture \* Type of Foil | 0.064 | 0.043 | | 1.483 | | *p* = .139 |
|  | AIC= -234.384 | | BIC = -230.575 | | LogLik = -236.384 | |



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Figure 2.2. Graph showing the average proportion of items correctly identified for each culture. Bars indicate accuracy by type of foil, SFDB- Same Foreground Different Background; DFSB- Different Foreground Same Background; DFDB- Different Foreground, Different Background. Errors Bars represent ± 1 SEM

The result appeared to support our initial hypotheses; holistic processing used by East Asian cultures reduces proportion of items correctly identified of specific object-scene composites compared to Western cultures that employ analytical processing. Although there were differences based on foil type with SFDB significantly more accurate than other foil types, this was not found to interact with culture, suggesting this was an overall effect. However, as previous studies have observed differences based upon stimuli type, with familiarity to stimuli affecting the results (Masuda & Nisbett, 2001, 2006), it was unclear if these results were due to a difference in culture or a difference in familiarity to the object stimuli. In order to control for any cultural differences in familiarity to object stimuli, the following study examined exposure and familiarity to the target objects between East Asian and Western cultures.

**2.2 Experiment 2: Cultural Familiarity of Object Stimuli**

**2.2.1 Method**

2.2.1.1 Participants.

A total of 31 participants (15 East Asian, 16 Western) were recruited from Sunway University Psychology club and Lancaster University Psychology Society. Participants were given full information of the study before completing and were free to withdraw from the study at any time.

2.2.1.2 Stimuli.

A total of 40 objects were taken from experiment 1. Objects had the background removed so participants could only focus on the object. Static objects were presented in the centre of the screen with no time restriction.

2.2.1.3 Procedure.

Participants completed this study online and were free to do so without experimenter supervision. Like the previous experiments, before starting participants supplied some cultural/ethnicity information. Participants were given the choice between classifying themselves as Western, East Asian or Other. As this questionnaire was more interested in cultural familiarity rather than ethnicity, no questions were asked about ethnicity. Participants then saw an object and had to indicate whether they had seen the object before (Yes/No) and how familiar the object was on a 6-point Likert Scale, from Extremely Familiar (1) to Not Familiar at all (6).

**2.2.2 Results and Discussion**

The proportion of familiar objects and average familiarity rating were calculated for each culture (see Table 2.3). A between-subjects ANOVA with Culture as the independent variable and mean proportion recognised and average familiarity rating as dependent variables was conducted. There was no significant difference between cultures in proportion recognised, *F* <1, or average familiarity ratings, *F* <1. The result suggested that there was no difference in object exposure based upon culture, thus the results of experiment 1 were legitimate and that there was a significant cultural difference in specific object-scene composite recognition.

Table 2.3. Table showing mean proportion of objects recognised and average familiarity rating by culture.

|  |  |  |
| --- | --- | --- |
|  | Mean proportion of objects recognised | Average Familiarity Rating |
| East Asian | 0.975 (0.025) | 1.598 (0.058) |
| Western | 0.981 (0.006) | 1.583 (0.059) |

**2.3 Experiment 3 Action-Scene Composite Recognition**

In the previous experiment it was demonstrated that Western cultures were significantly more accurate than East Asian cultures in proportion of items correctly identified of specific object-scene composites. Within the current experiment, we sought to extend this result by changing the stimuli to action-scene composites, as used by Urgolites & Wood (2013b). Within their study, they observed that proportion of items correctly identified was only just above chance levels, averaging 56%. As the study used an American sample, it was unclear if the accuracy level was due to the type of visual processing or due to the complexity of the stimuli. Our first hypothesis was Western participants would replicate the results of Urgolites & Wood (2013b); proportion of items correctly identified would be significantly above chance, albeit only slightly. Our second hypothesis was that based upon the results of experiment 1a, there would be no significant difference between Western and East Asian cultures for specific action-scene composite recognition.

**2.3.1 Method**

2.3.1.1 Participants.

Before the experiment started participants indicated some cultural/ethni- city information. Participants were given the choice between classifying themselves as Western, East Asian, or Other (pilot study data indicated that Russian participants did not identify as either Western or East Asian). For those that Identified as Western, they were then given the option to identify themselves as American, European, Slavic, or Western Other. Those identifying as Eastern were given the option as identifying as Malay, Chinese/Chinese Malay, Indian/Indian Malay, or East Asian Other.

A total of 148 participants took part in the study (62 Western, 67 East Asian and 19 Other, see Table 2.4). Western participants were students from Lancaster University who were set to conduct the research at Sunway University and undergraduate psychology students completing the task for a course credit. Participants completed the study before travelling and had no prior knowledge as to what the study consisted of so as to prevent demand characteristics but were fully informed as to the study’s purpose both after completing the study and before administering the test at Sunway University. East Asian and Other participants were recruited from Sunway University using an opportunity sampling method. All students who attend Sunway University require an English language requirement to IELTS minimum band 5.5, defined as a modest English Language User fully detailed on the website. To mitigate any confound of lack of comprehension within the research team, two research assistants were fluent in Mandarin and one in Malay speakers in order to ensure participants fully comprehended the instructions. Participants gave informed consent and were reminded they were free to withdraw from the study at any time. Due to data protection issues at Sunway University, age and gender was not recorded but this information were obtained from the Western sample, (33 Females, Mean age = 18.97, SE = 0.14), however research from a secondary study has indicated no gender or age differences (Shaw, Monaghan, & Urgolites, in draft). Sunway students identifying as East Asian cultures were asked whether they were born/raised in Malaysia. If they were, they were then asked about their ethnicity. If they indicated they weren’t born in Malaysia, they were considered East Asian Other. Participants were fully debriefed and informed as to the study’s purpose after completing the study.

Table 2.4. Table showing total participants in each study by culture and ethnicity.

|  |  |  |  |
| --- | --- | --- | --- |
|  | Culture | Action-Scene Task | Object-Scene Task |
| Western Cultures | American | 6 | 8 |
| European | 47 | 39 |
| Slavic/Eastern European | 1 | 6 |
| Western Other | 8 | 8 |
| East Asian  Cultures | Malay | 24 | 17 |
| Chinese/Chinese Malay | 27 | 32 |
| Indian/Indian Malay | 7 | 5 |
| East Asian Other | 9 | 3 |
| Other | 19 | 13 |
| Total | 148 | 131 |

2.3.1.2 Stimuli.

The stimuli consisted of 40 animated actions and 40 images of scenes combined to create an action/scene composite. The actions were taken from a previous paper that had examined fidelity of actions in VLTM by Urgolites and Wood (2013a) whilst the scenes were taken from a study examining the fidelity of scene representations in VLTM by Konkle et al. (2010). The combined composites were taken from a previous study by Urgolites and Wood (2013b). Each composite consisted of an action being performed for 1000 ms within one scene (see Figure 2.3). The actions appeared in the centre of the scene. All of the actions had the same duration (1000 ms) and frame rate (30 frames per second) with each action reaching its maximum deviation from the neutral standing position at the 15th frame.  The action stimuli included jumps, turns, bends and crouches. The stimuli set included mountains, beaches, oceans, forests and cities. The study was created on Psychopy 1.83.05 (Peirce, 2009)

2.3.1.3 Procedure.

Procedure for this study was the same as the experiment 1 (See figure 2.3).

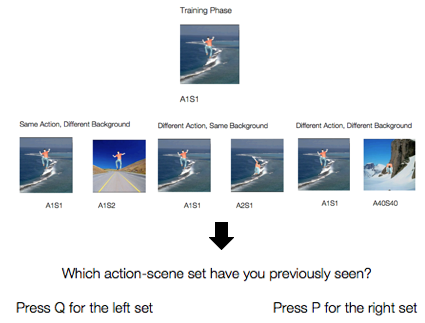


Figure 2.3 Image demonstrating the study and test phase of the action-scene composite recognition task.

**2.3.2 Results and Discussion**

The dataset was initially filtered by proportion of items correctly identified in the training phase so that only results higher than 50% were included in the dataset as any data below that would be less than chance and indicates participants may not have fully understood the instructions, removing 3 participants. This left 145 participants, (65 East Asian, 61 western, 19 other, accuracy M = 97.6%, SE = 0.05). Further analysis found that the Other category lead to no significant difference and as such was removed from further analysis leading 126 participants to be analysed. Analysis of ethnicity also led to no significant difference and as such there was no further analysis.

Linear mixed effects (LME) modelling was conducted in order to allow us to account for random effects between item and participants. In the analysis, we used a series of models

Model 1. A model with just random effects (Participant ID and action-scene pairing)

Model 2. A model introducing Culture as a factor

Model 3. A model introducing Culture and Foils as factors

Model 4. A model introducing Culture and Foils as factors along with the corresponding interaction.

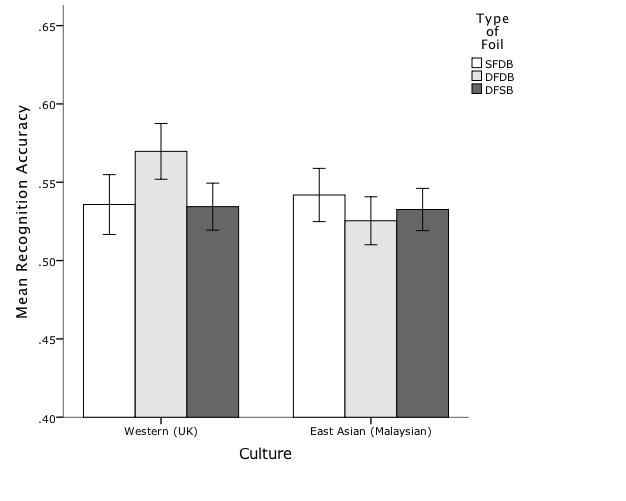
It was observed that each increment in complexity did not differ significantly from the previous model, comparing Model 1 and 2 χ2 = 1.0014, p = 0.317; comparing Model 2 and 3, χ2 = 1.918, p = 0.5895, comparing Models 3 and 4, χ2 = 2.7883, p = 0.248. The results suggested that culture and foil did not significantly affect proportion of items correctly identified of action-scene composites. Although different from the results of experiment 1, the result was consistent with previous literature on specific recognition of action-scene composites (Urgolites & Wood, 2013b), suggesting that the reduced proportion of items correctly identified for action-scene composites was not unique to Western culture, but is generally more difficult than recognition of object-scene composites.

Table 2.5. Summary of the Linear Mixed Effect Model for the Action-Scene Recognition Task.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Fixed Effects | Estimate | Standard Error | | t value | | p value |
| Intercept | 0.569 | 0.016 | | 34.303 | | *p <* 0.001 |
| Culture | 0.006 | 0.023 | | - 1.915 | | *p* = 0.056 |
| Type of Foil | -0.035 | 0.023 | | -1.503 | | *p* = 0.133 |
| Culture \* Type of Foil | 0.042 | 0.032 | | 1.299 | | *p* = 0.194 |
|  | AIC= -437.016 | | BIC = -433.097 | | LogLik = -439.016 | |

Table 2.6. Table showing the average proportion of items correctly recognised for Western and East Asian cultures split by Task and foil type. SE in parentheses.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | Action-Scene Task | | | Object Scene Task | | |
| Culture | SFDB | DFDB | DFSB | SFDB | DFDB | DFSB |
| Western (UK) | 0.536 (0.019) | 0.570 (0.018) | 0.534 (0.015) | 0.740 (0.018) | 0.710 (0.020) | 0.655 (0.024) |
| East Asian (Malaysian) | 0.542 (0.017) | 0.525 (0.015) | 0.533 (0.014) | 0.657 (0.025) | 0.628 (0.021) | 0.636 (0.023) |



Mean Proportion of Composites Recognised

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Figure 2.5. Graph showing the average accuracy for each culture. Bars indicate accuracy by type of foil, SFDB- Same Foreground Different Background; DFSB- Different Foreground Same Background; DFDB- Different Foreground, Different Background. Errors Bars are ± 1SEM.

**3. General Discussion**

Within the current study we sought to extend the previous literature that has demonstrated cultural differences between East Asian and Western cultures in separate item (Chua et al., 2005; Masuda & Nisbett, 2001), and context (Millar et al., 2013) recognition to see if this would also apply to specific item-context composites. In Experiment 1, there was a significant difference in specific object-scene composite recognition based on culture; UK participants were significantly more accurate than Malaysian participants. Experiment 2 revealed that this difference was not due to cultural differences in object familiarity. When extended to action-scene composite recognition, the result of Experiment 3 replicated the results previously observed by Urgolites & Wood (2013b) that action-scene composite recognition is above chance, albeit only slightly, in a UK sample, but also demonstrated the same effect in a Malaysian sample, suggesting that culture is not a significant factor in difficulties associated with action-scene composite recognition.

The question then becomes why are Western cultures more accurate in recognising specific object-scene composites compared to East Asian cultures, and why this effect seems specific to object-scene and not action-scene? The latter may be more easily explained; One explanation is the differences in complexity of the foreground stimuli and processing it in the time frame given. Within all experiments reported, participants saw the action-scene/object-scene pairs for 1000 ms. Whilst object recognition is fast, with brain responses associated with visual discrimination of objects occurring around 150ms (Allison, Puce, Spencer, & McCarthy, 1999; Thorpe, Fize, & Marlot, 1996), action recognition within the current study is not possible until 500ms (where the action reaches maximum deviation from the neutral standing position, making what action it is clearest), leaving less time to process the background information, thereby potentially reducing the fidelity any bound representation. As participants only had 1000 ms to process all this information, it could be that any potential cultural differences in the action-scene task did not have enough time to manifest. In Urgolites & Wood’s (2013b) study there was a small but significant increase in accuracy when the action was repeated three times against the same background. While this was not conducted here, it would be interesting to see if any cultural effects could be replicated if there was more exposure to the focal foreground item. In addition to this, differences in encoding requirements could be linked to this difference; object-scene composites only require encoding over space, whereas for actions, long-term memory must encode dynamic information distributed over space and time, thus any bound representation may be more fragile.

For the former, it may be that the cultural differences in visual processing also lead to cultural differences in visual binding. One theory suggested by Chalfonte and Johnson (1996) suggests there are at least two ways that feature binding may be expressed. Features may be independently represented but associated or features may form a blended representation, distinct from processing the two features separately (Chalfonte & Johnson, 1996; Graf & Schacter, 1989). When applied to the results of Experiment 1, it appears that Western participants employ this independent but associated representation; analytical processing ensures high-fidelity representations of the visual features are encoded and the association between the elements is maintained, consistent with existing literature (Millar et al., 2013; Urgolites & Wood, 2013b). In contrast, East Asian participants that engage in holistic processing, encoding the entire visual scene as one contextualized representation, result in a blended representation with reduced visual fidelity of each feature, making it difficult to correctly recognize specific composites. This explanation would also appear consistent with the previous literature as to why East Asian participants respond quicker than Western participants but are also typically less accurate in recognition tasks (Masuda & Nisbett, 2001); by having a blended representation of the entire visual scene it allows judgement based on familiarity but the reduced fidelity makes the judgement more prone to errors. In contrast, having independent but associated high-fidelity representations would allow a more accurate recognition judgement but at the expense of a longer reaction time, as seen in Masuda and Nisbett (2001).

Alternatively, the observed cultural difference may be due to issues regarding visual incongruity. Memory for scene items has previously been demonstrated to be diminished when object-background pairs are semantically incongruent due to required interactive processing of object and background (Davenport & Potter, 2004). Jenkins et al. (2010) demonstrated in an fMRI study that Chinese participants demonstrated a heightened response to semantically incongruent scenes compared to American participants. The style of the composites, with the object rotating above the visual scene, it may have facilitated the object-based analysis favoured by Western cultures (Jenkins et al., 2010). Further studies could attempt to address this by measuring recognition of specific item-background photographs.

A second consideration for future studies could be extending the East Asian sample to multiple countries. The current study, for design reasons, was primarily focused upon a Malaysian sample. As Malay is a latin-based language, it was chosen in order to account for any potential confounds a pictographic language may have in visual memory, with previous studies highlighting this importance (Kühnen et al., 2001). As a result, it may be that this sample is not wholly representative of the larger East Asian culture, such as Chinese, Japanese, or Korean cultures that use a pictographic language. As such, further studies may want to focus on these cultures in order to see if the effect can be replicated. It may be the case that cultures with a pictographic language may be able to process the intricate details of an item-context scene better, due to having to identify the various specific differences between language characters (Kühnen et al., 2001).

In summary, within the current study we have empirically demonstrated that previously suggested cultural differences in visual processing can extend to feature binding. By processing scenes analytically, Western cultures are able to store high-fidelity representations of visual features and maintain an association between them. In contrast, holistic processing creates a blended representation, a reduced fidelity representation of the whole visual image that allows general familiarity, but reduced specific recognition. This difference appears to be limited to object-scene composites with no cultural difference observed for action-scene composites, possibly due to the increased complexity of the visual image.

**References**

Allison, T., Puce, A., Spencer, D. D., & McCarthy, G. (1999). Electrophysiological studies of human face perception. I: Potentials generated in occipitotemporal cortex by face and non-face stimuli. *Cerebral Cortex (New York, N.Y. : 1991)*, *9*(5), 415–430.

Boduroglu, A., Shah, P., & Nisbett, R. E. (2009). Cultural Differences in Allocation of Attention in Visual Information Processing. *Journal of Cross-Cultural Psychology*, *40*(3), 349–360. https://doi.org/10.1177/0022022108331005

Brady, T. F., Konkle, T., Gill, J., Oliva, A., & Alvarez, G. A. (2013). Visual Long-Term Memory Has the Same Limit on Fidelity as Visual Working Memory. *Psychological Science*, *24*(6), 981–990. https://doi.org/10.1177/0956797612465439

Brady, T. F., Konkle, T., & Alvarez, G. A. (2011). A review of visual memory capacity: Beyond individual items and towards structured representations. *Journal of Vision*, *11*(5), 4. https://doi.org/10.1167/11.5.4

Brady, T. F., Konkle, T., Alvarez, G. A., & Oliva, A. (2008, September). Visual long-term memory has a massive storage capacity for object details. *Proceedings of the National Academy of Sciences of the United States of America*. https://doi.org/10.1073/pnas.0803390105

Chalfonte, B. L., & Johnson, M. K. (1996). Feature memory and binding in young and older adults. *Memory & Cognition*, *24*(4), 403–416.

Chua, H. F., Boland, J. E., & Nisbett, R. E. (2005). Cultural variation in eye movements during scene perception. *Proceedings of the National Academy of Sciences of the United States of America*, *102*(35), 12629–12633. https://doi.org/10.1073/pnas.0506162102

Davenport, J. L., & Potter, M. C. (2004). Scene consistency in object and background perception. *Psychological Science*, *15*(8), 559–564. https://doi.org/10.1111/j.0956-7976.2004.00719.x

Evans, K., Rotello, C. M., Li, X., & Rayner, K. (2009). Scene perception and memory revealed by eye movements and receiver-operating characteristic analyses: Does a cultural difference truly exist? *Quarterly Journal of Experimental Psychology (2006)*, *62*(2), 276–285. https://doi.org/10.1080/17470210802373720

Goh, J. O., Tan, J. C., & Park, D. C. (2009). Culture Modulates Eye-Movements to Visual Novelty. *PLOS ONE*, *4*(12), e8238. Retrieved from https://doi.org/10.1371/journal.pone.0008238

Gutchess, A. H., Welsh, R. C., Boduroĝlu, A., & Park, D. C. (2006). Cultural differences in neural function associated with object processing. *Cognitive, Affective, & Behavioral Neuroscience*, *6*(2), 102–109. https://doi.org/10.3758/CABN.6.2.102

Jang, Y., Wixted, J. T., & Huber, D. E. (2009). Testing signal-detection models of yes/no and two-alternative forced-choice recognition memory. *Journal of Experimental Psychology. General*, *138*(2), 291–306. https://doi.org/10.1037/a0015525

Ji, L.-J., Peng, K., & Nisbett, R. E. (2000). Culture, control, and perception of relationships in the environment. *Journal of Personality and Social Psychology*. US: American Psychological Association. https://doi.org/10.1037/0022-3514.78.5.943

Kitayama, S., Duffy, S., Kawamura, T., & Larsen, J. T. (2003). Perceiving an Object and Its Context in Different Cultures: A Cultural Look at New Look. *Psychological Science*, *14*(3), 201–206. https://doi.org/10.1111/1467-9280.02432

Konkle, T., Brady, T. F., Alvarez, G. A., & Oliva, A. (2010). Scene memory is more detailed than you think: The role of categories in visual long-term memory. *Psychological Science*, *21*(11), 1551–1556. https://doi.org/10.1177/0956797610385359

Kühnen, U., Hannover, B., Roeder, U., Shah, A. A., Schubert, B., Upmeyer, A., & Zakaria, S. (2001). Cross-Cultural Variations in Identifying Embedded Figures: Comparisons from the United States, Germany, Russia, and Malaysia. *Journal of Cross-Cultural Psychology*, *32*(3), 366–372. https://doi.org/10.1177/0022022101032003007

Masuda, T., & Nisbett, R. E. (2001). Attending holistically versus analytically: comparing the context sensitivity of  Japanese and Americans. *Journal of Personality and Social Psychology*, *81*(5), 922–934.

Masuda, T., & Nisbett, R. E. (2006). Culture and Change Blindness. *Cognitive Science*, *30*(2), 381–399. https://doi.org/10.1207/s15516709cog0000\_63

Millar, P. R., Serbun, S. J., Vadalia, A., & Gutchess, A. H. (2013). Cross-cultural differences in memory specificity. *Culture and Brain*, *1*(2), 138–157. https://doi.org/10.1007/s40167-013-0011-3

Na, J., Grossmann, I., Varnum, M. E. W., Kitayama, S., Gonzalez, R., & Nisbett, R. E. (2010). Cultural differences are not always reducible to individual differences. *Proceedings of the National Academy of Sciences*, *107*(14), 6192 LP-6197. Retrieved from http://www.pnas.org/content/107/14/6192.abstract

Nisbett, R. E., & Miyamoto, Y. (2005). The influence of culture: Holistic versus analytic perception. *Trends in Cognitive Sciences*, *9*(10), 467–473. https://doi.org/10.1016/j.tics.2005.08.004

Nisbett, R. E., & Masuda, T. (2003). Culture and point of view. *Proceedings of the National Academy of Sciences*, *100*(19), 11163 LP-11170. Retrieved from http://www.pnas.org/content/100/19/11163.abstract

Peirce JW (2009) Generating stimuli for neuroscience using PsychoPy. Front. Neuroinform. 2:10. doi:10.3389/neuro.11.010.2008

Rayner, K., Castelhano, M. S., & Yang, J. (2009). Eye Movements When Looking at Unusual/Weird Scenes: Are There Cultural Differences? *Journal of Experimental Psychology. Learning, Memory, and Cognition*, *35*(1), 254–259. https://doi.org/10.1037/a0013508

Rayner, K., Li, X., Williams, C. C., Cave, K. R., & Well, A. D. (2007). Eye Movements during Information Processing Tasks: Individual Differences and Cultural Effects. *Vision Research*, *47*(21), 2714–2726. https://doi.org/10.1016/j.visres.2007.05.007

Schacter, D. L., & Graf, P. (1989). Modality specificity of implicit memory for new associations. *Journal of Experimental Psychology. Learning, Memory, and Cognition*, *15*(1), 3–12.

Thorpe, S., Fize, D., & Marlot, C. (1996). Speed of processing in the human visual system. *Nature*, *381*(6582), 520–522. https://doi.org/10.1038/381520a0

Urgolites, Z. J., & Wood, J. N. (2013a). Visual Long-Term Memory Stores High-Fidelity Representations of Observed Actions. *Psychological Science*, *24*(4), 403–411. https://doi.org/10.1177/0956797612457375

Urgolites, Z. J., & Wood, J. N. (2013b). Binding actions and scenes in visual long-term memory. *Psychonomic Bulletin & Review*, *20*(6), 1246–1252. https://doi.org/10.3758/s13423-013-0440-1