SPATIAL MEMORY IN CANADIAN AND INDIAN YOUNG AND OLDER ADULTS: THE EFFECTS OF AGE, CULTURE AND CULTURAL ORIENTATION

by

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Master of Arts 2017

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Abstract

Cross-cultural research suggests that individualistic Americans have a tendency to process focal objects; in contrast, collectivist Asians have a tendency to bind objects and context (Park & Huang, 2010). However, little is known whether the reported cultural differences are moderated by cultural orientation. In light of these results and the well-reported age-related decline in binding abilities, the current study examined cultural and age differences in cultural orientation, spatial memory and strategy use with young and older Canadian and Indian adults. There was little difference between Canadian and Indian participants' cultural orientation. While cultural orientation did not moderate the relationship between culture and spatial memory, spatial memory and strategy use differed as a function of age. The use of context-specific strategies resulted in performance gains in older adults, however overall older adults had poor spatial memory, with Indian older adults scoring significantly lower than Canadian older adults on the courtyard task.

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TABLE OF CONTENTS

List of Tables

List of Figures

List of Appendices

Spatial Memory in Canadian and Indian Young and Older Adults:

The Effects of Age, Culture and Cultural Orientation

Cross-cultural research suggests that different cultures focus on distinct aspects of environmental information and use different strategies to process information (Masuda & Nisbett, 2001; Park & Gutchess, 2002). More specifically, it has been documented that individualistic Westerners (i.e., North Americans) value independence and have a self-based focus. As a result, they have a tendency to process focal objects more than background information. In contrast, collectivist East Asians (i.e., Chinese) value interdependency and view themselves as a part of a larger whole, resulting in holistic information processing and a tendency to bind objects with background information (Park & Huang, 2010; Park et al., 1999). The ability to perceptually and mnemonically bind objects is crucial in way finding. Prior research shows that binding landmarks found within an environment leads to faster and successful way finding, however the ability to bind has been shown to decline with age (Konishi, et al., 2013). The main objectives of the present study were: 1) to examine the difference in cultural orientation (i.e., individualism/independent versus collectivism/interdependent) between Caucasian Canadians and Indians, and address whether cultural orientation varies with age. 2) To determine whether the ability to bind and remember objects within a virtual environment differ as a function of culture and age, and whether this effect is moderated by cultural orientation. Lastly, 3) to investigate whether the choice of specific spatial strategy differs between the two cultures and the two age groups, and if there is a relationship between specific strategy use and spatial memory performance.

Cultural Orientation: Individualistic and Collectivist Cultures

Culture consists of customs, values, beliefs, experiences and behavioural patterns shared by a group of people living in a particular society. It has been proposed that Western culture is adapted from Ancient Greece with a focus on processing information with a more analytical, scientific, goal-oriented and individualistic approach (Nisbett, Peng, Choi, & Norenzayan, 2001; Park & Huang, 2010). On the other hand, East Asian culture is based on the ancient philosophical traditions of Taoism, Buddhism and Confucianism (Nisbett et al., 2001). These philosophical traditions are considered collectivist, in that these cultures value social harmony and balance within the environment. As a result, compared to individualistic, collectivist cultures tend to view themselves as interdependent entities and have a tendency to process information holistically (Park & Huang, 2010).

Factors such as differences in cultural values and experiences, social structures, language, parenting practices, academic systems and learning style contribute to the differences in cognitive processing observed in different cultures (Hedden et al., 2002; Nisbett et al., 2001). Masuda and colleagues (2008) suggest that due to the importance of maintaining harmony in social groups, focusing on social relationships becomes crucial in East Asians. This cultural habit of focusing on social relationships flows into information processing, thus East Asians develop a tendency to process relationships between object and context while organizing their environment. While in independent Western cultures the focus is on autonomy, therefore Westerners are more likely to attend to focal objects and utilize categorization to organize the environment (Masuda et al., 2008; Nisbett et al., 2001).

Cultural orientation is the inclination to think and act in culturally favoured ways that define the basis of an individual’s self-identity, interpersonal relationships, and conflict resolution abilities. Cultural differences in values and experiences form individualistic and collectivist orientations. However, individualistic and collectivist orientations are not mutually exclusive; they are multi-dimensional constructs that may co-exist within a single culture and are susceptible to change (Triandis & Gelfland, 1998).

According to Triandis and Gelfland (1998) cultural orientation constructs can exist on four dimensions-orientations; vertical-individualism, horizontal-individualism, vertical-collectivism, and horizontal-collectivism. Horizontal and vertical patterns differ mainly on the view of self. The horizontal patterns emphasize the similarities between oneself and others, in contrast, vertical patterns consist of hierarchies, assuming that oneself is different from other selves (Triandis & Gelfland, 1998). More specifically, both horizontal and vertical individualists are highly independent and view the self as fully autonomous; however, horizontal-individualists believe in equality among individuals, while vertical-individualists recognize and accept inequality between individuals. In contrast, both horizontal and vertical collectivists emphasize interdependency and view the self as a part of a collective, however horizontal-collectivists view all members of that collective as equal; whereas vertical-collectivists accept hierarchy and inequality within the collective (Triandis & Gelfland, 1998). For example, cultures (i.e., United States, France) that value freedom but not equality score high on the vertical-individualism dimension, while cultures (i.e., India, China) that do not value equality and freedom score high on vertical-collectivism (Cozma, 2011). Nevertheless, any given culture may include individuals across different individualistic and collectivist dimensions (Cozma, 2011).

Nevertheless, the majority of the previous cross-cultural studies have recruited participants born and raised in collectivist cultures, assuming that all East Asians are collectivists. For example, East Asian participants in Chua, Boland and Nisbett’s (2005) study were Chinese graduate students who were born and had completed their undergraduate degrees in China. Japanese participants in Kitayama, Duffy, Kawamura and Larsen (2003) were recruited from Kyoto University in Japan. Similarly, East Asian participants in Evans, Rotello, Li and Rayner (2009) study were either born in mainland China or Taiwan, and South Asian participants in the Mendel, Jeykumar, Parthasarathy and Duchowski (2009) study were born in South Asia and lived in the US for less than one year. However, none of the cross-cultural studies discussed in the following paper assessed the cultural orientation of their participants. It is important to address this as more recent research has shown that urbanization and economic growth in Asian societies has led to internalization of Western values, due to which the display of behavioural patterns that are characteristic of collectivist cultures has decreased in Asians (Sun & Wang, 2010; Zhang & Shavitt, 2003). Since the open-door policy in China, economic and technological growth has resulted in a shift towards individualistic values in Chinese younger adults (Zhang & Shavitt, 2003). Sun and Wang (2010) also found that Chinese younger adults (age 14-34 years) exhibited a shift from traditional collectivist to individualistic values mainly due to the changes in their own life experiences resulting from the recent social transformation.

In addition, a classical study Hofstede (1980) examined several countries on the collectivism and individualism scale (e.g., 1 = highly collectivist, 100 = highly individualistic). Highly collectivist nation China scored 20 on a 100-point scale, however, India’s score of 48 on a 100-point scale indicated that individualistic and collectivist tendencies overlap with each other within the Indian society (Hofstede, 1980; Sinha, Sinha, Verma & Sinha, 2001). Some researchers argue that the Indian culture is neither predominantly individualistic nor purely collectivist, instead Indians tend to incorporate elements of both individualism and collectivism dimensions (Sinha & Tripathi, 1994; Sinha et al., 2001; Sinha, Vohra, Singhai, Singh & Ushashree, 2002). In a research study, Verma and Triandis (1998) presented a number of social scenarios to Indian (Patna, India) and American (Illinois, USA) students, and found that 53% Indian students opted for collectivist alternatives, while 47% chose individualistic options, in contrast only 39% of American students opted for collectivist alternative and 61% individualistic alternatives (Verma & Triandis, 1998). This shows that perhaps India may not be a purely collectivist culture; people belonging to largely collectivist East Asian cultures can exhibit individualist as well as collectivist behaviour patterns contingent to situation and time (Cozma, 2011; Green, Deschamps, & Paez, 2005; Singelis, 1994; Sinha et al., 2001).

Cultural Differences in Attention Allocation and Memory

Many studies have investigated the differences in cognitive processing between Western (i.e., American) and East Asian (i.e., Chinese, Japanese) young adults. Kitayama et al., (2003) presented American and Japanese participants with a square frame consisting of a vertical line in the center of the frame. Participants were then presented with an empty square frame of the same or different size as the first square frame, and were asked to draw a line first in the same length as seen in first square (absolute task), and then in proportion to the size of the frame (relative task). American participants were found to be more accurate in absolute task, whereas Japanese were more accurate in the relative task (Kitayama et al., 2003).

Masuda and Nisbett (2001) examined cultural differences between Americans and Japanese young adults' attention allocation to contextual information. In study 1, both groups of participants watched videos of animated underwater scenes that consisted of "focal fish" (target) and background objects (smaller fish, planktons). Later all participants were asked to verbally describe the scenes and recognize the objects presented in original or novel scenes. Similar recognition task was repeated in study 2 with wildlife photographs instead of the underwater scene. It was found that Japanese participants described the background scenes as well as the relationships between focal and background objects more than Americans. Additionally, relative to Americans, Japanese participants also recognized a greater number of previously seen objects when they were presented on the original background relative to novel background. In contrast, Americans reported paying more attention to the focal object, and their memory for the previously seen objects was not affected by the change in background scene or contextual information (Masuda & Nisbett, 2001).

Some researchers have used eye tracking to demonstrate that compared to Westerners, Asians' perception is more influenced by contextual cues. Chua and colleagues (2005) monitored eye movements of Westerners (i.e., American citizens of European descent) and East Asians (i.e., Chinese born graduate students residing in the United States). Participants' eye movements were monitored while they viewed images of focal objects on complex backgrounds. The results showed that compared to Chinese students, European Americans looked at the focal object more quickly and fixated on it for longer durations. In contrast, Chinese students had increased saccades to the background and equal number of fixations towards the background as well as the focal object (Chua et al., 2005). Furthermore, similar to Masuda & Nisbett (2001) findings, it was also found that compared to European Americans, Chinese students were less likely to accurately recognize focal objects when presented on new backgrounds. These findings suggest that relative to Westerners, East Asians tend to pay more attention to the contextual information and create relationships between focal objects and background information.

However, other eye movement studies have failed to find support for the influence of culture on scene processing. Rayner, Li, Williams, Cave and Well (2007) compared the eye movements of native English speakers, native Chinese speakers and bilinguals (English/Chinese speakers) on tasks such as reading, face processing, scene perception, and visual search.

Differences in eye movements were only found for the reading task, which was thought to be the result of the differences between English and Chinese writing systems (Rayner et el., 2007). However, no differences in fixation durations on the focal object or background were found between the two cultural groups during face processing, scene perception and visual search tasks.

Chua and colleague's (2005) findings were not replicated in other studies even when the exact same stimuli were used. Evans et al. (2009) examined eye-movements of American and Chinese participants while they viewed the same stimuli used by Chua et al. (2005), and Masuda and Nisbett (2001). It was found that although Americans fixated on the focal objects more quickly than Chinese participants, there were no significant differences in eye movement patterns or recognition memory performance between the American and Chinese groups. Mendel et al. (2009) also used Chua and colleagues (2005) paradigm to examine the cultural differences in visual attention allocation between South Asian and American young adults. Compared to Americans, South Asians exhibited significantly more fixations across the images (Mendel et al., 2009). However, contradictory to Chua et al. (2005) and Masuda et al. (2008), this study found that compared to Americans (M= 6508 milliseconds), South Asians spent more time fixating on the focal object (M=10,723 milliseconds; Mendel et al., 2009).

While most cross-cultural researchers suggest that differences in social values and learning systems between the two cultures are responsible for differences in visual information processing. Miyomoto, Nisbett and Masuda (2006) argue that the differences in visual information processing are due to the differences in physical environment. In their experiments, when primed with densely packed Japanese scenes, both Japanese and American participants attended more to contextual information (Miyamoto et al., 2006). This raises the importance of measuring cultural orientation of participants in cross-cultural studies, particularly when studying the effects of cultural orientation on spatial scene perception. Given the lack of cultural orientation assessment in previous cross-cultural literature, it is unclear whether the observed cultural differences in object-background processing are contingent to the cultural orientation (i.e., individualism-collectivism) or other culturally different factors (i.e., environmental layout, urban sprawl).

Taken together, existing evidence for the cultural differences in information processing lacks consistency. Although individualistic and collectivist behavioural patterns (i.e., cultural orientation) are socialized and susceptible to change, in cross-cultural research it is a common practice to assume the cultural orientation of participants based on their ethnicity (i.e., all East Asians are collectivists, and all Americans are Individualists). Given that none of the cross-cultural studies described above measured the level of individualism-collectivism in participants, little is known whether the observed cultural differences in scene processing in the cross-cultural literature could be attributed to the cultural orientation adopted by individuals.

Aging and Culture Interaction on Memory Binding

Prior research suggests that prolonged exposure to certain cultural values (i.e., interdependency among family members) and behavioural practices (i.e., binding contextual information in collectivist East Asians) may affect the function and structure of the brain, and this cultural effect is thought to be magnified with age (Goh et al., 2004; Park & Huang, 2010).

Recent neuroimaging evidence supports the presence of cultural differences in neural activation patterns involved in object-background memory binding. Adaptation in fMRI studies refers to the reduced neural response to repeated information compared to the response elicited by novel information (Goh et al., 2007). In an experiment conducted by Goh and colleagues (2007), 75 young and old adults (half East Asian and half Western) completed an fMRI-adaptation task that required single object processing, and object-background binding. No significant differences in single object processing adaptation magnitudes were found between Chinese and American young adults, however, in line with the culture specific scene perception theory, compared to American older adults, Chinese older adults exhibited significantly less adaptation response in single object processing areas (i.e., fusiform gyrus, inferior occipital gyrus; Goh et al., 2007). This suggests that perhaps prolonged cultural practice and experience with processing a single cue or focal object led to more adaptation responses in Americans. Which means compared to East Asian, Western older adults were better at detecting change in single objects due to sustained cultural practice of organizing the environment based on categories and increased attention allocation to focal objects. Nevertheless, during the object-background task less adaptation responses were observed in the hippocampi of older relative to young adults in both Chinese and American cultures (Goh et al., 2007). The results of this study suggest that not only cultural exposure, but perhaps age-related changes in the hippocampus might also play a role in the binding process.

Binding ability, which is what the holistic information processing hinges on, is affected by aging. Binding of the information during encoding as well as retrieval relies on the hippocampus (Etchamendy, Konishi, Pike, Marighetto & Bohbot, 2011; Henke, Weber, Kneifel, Wieser, & Buck, 1999; Kroll, Knight, Metcalfe, Wolf, & Tulving, 1996; Kumaran & Maguire, 2005; Sadeh, Maril, Bitan, & Goshen-Gottstein, 2012). However, previous research has shown that as we age our ability to bind objects and create relationships or associations between different objects deteriorates. Compared to younger adults, older adults often exhibit deficits in associative memory (Cohn, Emrich, & Moscovitch, 2008; Naveh-Benjamin, 2000; Naveh-Benjamin, Guez, & Shulman, 2004; Naveh-Benjamin, Hussain, Guez, & Bar-On, 2003). It has been suggested that due to age-related changes in the brain (i.e., loss in neuronal connections, decrements in hippocampal volume), older adults become less able to bind and create relationships between discrete units of information, which in turn leads to poor memory performance (Konishi et al., 2013; Naveh-Benjamin, 1999). To our knowledge, very few cross-cultural studies have compared young and older Western and East Asian adults on object-background binding ability during scene perception. Interestingly, more recently researchers have attempted to broaden the application of culture bias by examining the effect of culture on binding abilities specifically in the context of spatial memory performance and spatial navigation strategy use.

Spatial Memory and Spatial Memory Strategies

The ability to remember the location of objects in the environment is a cognitive skill essential for everyday life. The hippocampus is involved in spatial memory performance; more specifically, it plays a major role in binding and forming relationships between environmental landmarks (Bohbot, Lerch, Thorndycraft, Iaria & Zijdenbos, 2007; Etchamendy et al., 2011). According to the relational memory theory, the hippocampus mediates relationship representations, in that it supports the ability to bind, compare and contrast information acquired from different sources (Etchamendy et al., 2011; Kumaran & Maguire, 2005). For example, the hippocampus mediates relational frameworks such as relationship between several landmarks as well as among members of the family, which allows us to create detours throughout the city or make inferences regarding the relationships between our family members (Eichenbaum, 2000). Thus, the role of hippocampus is crucial in binding, whether concerned with social relationships or creating relationships between objects within an environment.

Allocentric and egocentric are two main strategies spontaneously utilized in order to remember objects and adaptively navigate within an environment (Bohbot et al., 2007). Allocentric strategy is supported by the hippocampus and involves forming relationships between different landmarks in the environment (Bohbot et al., 2007; Konishi et al., 2013). In contrast, egocentric strategy involves using a single landmark cue and following a pattern of body based left-right turns (Bohbot et al., 2007; Konishi et al., 2013). This strategy is supported by the caudate nucleus, the area of the brain critical for response learning and habit formation by making rigid stimulus-response associations. Additionally, caudate nucleus activation has also been found during categorization tasks. In a study conducted by Seger and Cincotta (2005) participants were asked to categorize visual stimuli by classifying images while they received feedback for their responses. Activity associated with successful classification learning (correct categorization: weather prediction task in which participants were asked to use visual stimuli to predict rain or sun) was found in the body as well as the tail of the caudate nucleus, while activity associated with feedback (processing incorrect categorization) was found only in the head of the caudate nucleus (Seger & Cincotta, 2005).

Prior research has demonstrated that compared to egocentric strategy use, allocentric strategy use leads to faster and more accurate way finding performance in a virtual navigation task (Konishi et al., 2013). Experiments conducted with North American participants have revealed age differences in the type of spatial navigation strategy spontaneously utilized while navigating in a given environment (Konishi et al., 2013). More specifically, research with Westerners has demonstrated that younger adults are more likely to use allocentric strategy, while older adults use egocentric strategy (Konishi et al., 2013). However, a small number of older adults continue to use allocentric strategy, and as a result show greater hippocampal activation during the spatial navigation task compared to older adults who utilize egocentric strategy to solve the spatial navigation task (Konishi et al., 2013).

Furthermore, studies have found that sustained spatial memory experience protects hippocampal integrity against age-related decline (Lovden, Wenger, Martensson, Lindenberger & Backman, 2013). More specifically, gains in performance and stable hippocampal volumes have been found in younger and older adults who completed a four-month spatial navigation training that demanded binding several environmental cues for successful task completion (Lovden et al., 2013). In light of these findings, Balram, Etchamendy and Bohbot (poster presented, Society of Neuroscience, 2010) hypothesized that due to increased sensitivity to central objects and prolonged practice with categorization during perceptual organization, individualistic Westerners will be more likely to spontaneously adopt an egocentric strategy that involves processing a single environmental cue and body-based turns. Whereas due to culture based experience with holistic performance and binding, collectivist Asians will be more likely to spontaneously adopt allocentric strategy that involves binding several environmental cues. In this study, 35 Japanese and 35 Caucasian Canadian healthy older adults were tested on the 4-on-8 virtual maze and concurrent spatial discrimination-learning task to determine whether prolonged cultural exposure can influence spontaneous use of spatial navigation strategies. In support of the hypothesis, the results showed that 86% of Japanese participants spontaneously utilized allocentric strategy, while only 34% of the Caucasian Canadians utilized allocentric strategy to solve the 4-on-8 virtual maze task (Balram et al., poster presented, Society of Neuroscience, 2010). Nevertheless, other studies failed to find this effect of cultural bias on processing visual information during navigation task. For example, Goeke et al. (2015) used an online virtual reality star-field path integration task to assess spontaneous use of spatial navigation strategy in North Americans and European (i.e., individualistic), Latin Americans and

Asian population (i.e., collectivist). The results showed that North Americans use allocentric strategy, and Latin Americans use egocentric strategy, however, Asians and Europeans did not show such particular preference for a specific spatial navigation strategy (Goeke et al., 2015).

Like the cross-cultural studies on scene perception discussed above (e.g., Chua et al., 2005, Evans et al., 2009; Mendel et al., 2009), both Balram et al. (2010) and Goeke et al. (2015) did not measure cultural orientation of their participants. In addition, all participants (Canadian and Japanese) in Balram et al. (2010) study were Canadian residents, and thus it is difficult to gauge whether Japanese participants living in Canada had adopted individualistic Western values or adhered to collectivist values during the time of the experiment. Thus, the results of these studies cannot be directly attributed to the cultural orientation of the participants. Furthermore, the spatial navigation tasks used in these studies (i.e., 4-on-8, concurrent spatial discrimination learning, and star-field path integration) involve forming a cognitive map while navigating in a virtual environment, and these tasks are more complex than the object-background binding tasks that involve recognizing object-background pairing via a static visual image.

In sum, considering the inconsistency in the current literature, it is unclear whether the observed cultural differences in object-background binding and spatial information processing can be fully attributed to differences in cultural orientation (i.e., individualism versus collectivism and independent vs. interdependent) adopted by individuals. According to the individualism-collectivism dimensions, cultural orientation can be a function of exposure to specific cultural experiences and values, and the differences in perceptual and cognitive processes might be the byproduct of the orientation adopted by an individual (Markus & Kitayama, 1999; Masuda & Nisbett, 2001; Park & Gutchess, 2002; Park & Huang, 2010; Park et al., 1999). However, the majority of cross-cultural studies treat nations and ethnic groups as homogenous entities. According to Green et al. (2005), diversity in individual backgrounds and social positions exists within all nations; and failure to acknowledge the within-country individual variations can lead to overgeneralization of personality attributes. Therefore, the discrepancy observed in the literature discussed above could be partially due to the neglect of individual differences in cultural orientation even within the same culture. To fill in this gap in literature, two cultural orientation scales were used in the present study to measure and compare the cultural orientations adopted by Caucasian Canadians residing in Canada, and Indians born and residing in India. Most previous cross-cultural studies have compared North Americans and Asians (i.e., Chinese, Japanese). We chose India for this project because it was once considered to be a collectivist culture, however, more recent research suggested that individualistic and collectivist orientations may coexist in India, which might in turn help us better decipher the effect of culture (Canada vs. India) and cultural orientation (Individualism vs. collectivism). We also predicted that perhaps the task (i.e., single objects presented on complex background) used in previous studies were not sufficiently sensitive to capture differences in perceptual-cognitive processes, specifically binding abilities (i.e., binding focal object with background information). In the present study, the virtual courtyard task developed by King, Burgess, Hartley, Vargha-Khadem and O'Keefe (2002) was employed to provide a precise assessment of spatial memory and spatial object-location binding strategies (i.e., allocentric versus egocentric. See Measures section for detailed description of the task) in participants. This task does not require forming a cognitive map per se; instead participants must bind objects with the available landmarks in order to accurately recall the to-be-remembered objects.

The Present Study

The main objectives of the present study were to examine the difference in cultural orientation between Caucasian Canadians and Indians, and whether the ability and strategies used to bind and remember objects within a spatial environment differed as a function of culture and cultural orientation. Furthermore, the present study aimed to investigate whether prolonged cultural practice in older adults is associated with enhanced effects of culture or cultural orientation on spatial memory performance.

Specifically, this study addresses the following three research questions: 1). Are there differences in the cultural orientations of Caucasian Canadians and Indians? Are these differences affected by age? It was predicted that Caucasian Canadians will score higher on the independent and individualism measures, whereas, Indians will score higher on the interdependent and collectivism measures. Furthermore, due to prolonged exposure to specific culture and cultural values, it was predicted that compared to young adults in both culture groups, older adults in both culture groups will score higher on their respective measures (i.e., Caucasian Canadian older adults will score higher on individualism measures, and Indian older adults will score higher on the collectivism measures). 2). Does spatial memory performance differ between Caucasian Canadians and Indians and is it predicted by cultural orientation, and if so, whether the effects will be enhanced in older relative to young adults? We predicted that regardless of cultural orientation, Caucasian Canadians' and Indians' performance on same-view virtual courtyard condition will not differ significantly. However, the shifted-view virtual courtyard condition requires participants to use allocentric processing (i.e., create relationships and bind objects and landmarks). Therefore, it was hypothesized that compared to individualistic Caucasian Canadian participants, collectivist Indian participants will score higher on the collectivist measure and perform better on the shifted-view virtual courtyard condition relative to their culture counterparts. 3). Does the use of specific spatial strategies vary by age and culture?

It was predicted that Indians will use allocentric spatial binding strategy more often and Caucasian Canadians will use egocentric strategy more often during the virtual courtyard task. Furthermore, due to their prolonged cultural practice with spatial binding, it was predicted that the cultural effects on the use of the allocentric vs. egocentric strategies would be enhanced in older, relative to young adults.

Method

Participants

Four groups of participants, young (aged 18-30) and older (age 65+) Caucasian Canadian of European descent and Indian participants were included in this study. Participants were excluded if they had the following conditions: (1) vision problems (i.e., cataracts, glaucoma) or colour blindness, (2) any history of neurological (i.e., Parkinson's disease, Alzheimer's) and psychological (i.e., depression) disorders that might cause cognitive impairment, (3) severe losses in communicative abilities, (4) were knocked unconscious, and (5) older adults who scored below 26 on the Mini-Mental State Examinations, signaling dementia-related cognitive impairment (MMSE; Folstein, Folstein, & McHugh, 1975).

Thirty-one Caucasian Canadian young participants (ages 18-30, M = 21.05, SD = 2.95; 16 females) were recruited from the Ryerson University undergraduate psychology student participant pool (SONA) and through recruitment posters posted on Ryerson University campus. Students recruited from SONA were compensated with 1.5 course credits, whereas students recruited via posters received $18 as compensation. Eleven SONA participants were replaced as they did not fit the cultural background criteria (i.e., non-Caucasians). Twenty-four Caucasian Canadian older adults (ages 65+, M = 72.90, SD = 4.82; 15 females) were recruited from the Ryerson senior participant pool (RSPP) in the Department of Psychology at Ryerson University, and they received a compensation of $18 for their participation. Four Caucasian Canadian older participants were replaced; two for being unable to understand the courtyard task instructions, one for serious head injury as a result of a car accident at age 16, and one for colourblindness.

Twenty-four Indian young adults (ages 18-30, M = 20.25, SD = 1.33; 8 females) were recruited via posters posted at Indian Institute of Technology, Guwahati, India (IIT-G). Indian young adults were tested in the Sleep and Cognition lab at IIT-G. Four Indian young participants were replaced; three for failure to follow task instructions and one for colorblindness. Twenty-six Indian older adults (age 65+, *M* = 75.15, *SD* = 6.92, 9 females) were recruited from the senior citizens' homes and surrounding communities in India. All participants in India received a compensation of Rs900 for their participation (equivalent of CAD $18). Six Indian older participants were excluded and replaced; four due to colorblindness and two for failure to understand the courtyard task instructions. The two culture groups did not differ in mean age for both young $t(26.46) = 1.11$, $p = .279$ and older groups $t(38) = -1.19$, $p = .240$. Similarly they did not differ in the level of education for both young $t(26.35) = 1.80$, $p = .084$, and older groups $t(38) = .348$, $p = .730$ (see Table 1). Furthermore, compared to Indian sample, Canadian sample consisted of more females than males (see Table1).

Table 1.

Demographic characteristics for participants

	Canadian YA (n = 20)	Canadian OA (n = 20)	Indian YA (n = 20)	Indian OA (n = 20)
Age	21.05 (2.95)	72.90 (4.82)	20.25 (1.33)	75.15 (6.92)
Gender				
Female	16	15	8	9
Male	4	5	12	11
Education	15.05 (2.16)	17.45 (3.06)	14.10 (.97)	17.13 (2.84)
MMSE	N/A	29.25 (.85)	N/A	27.85 (1.27)

Measures

Cognitive assessment: *Mini-Mental State Examination (MMSE;* Folstein et al., 1975; Appendix A*)*

MMSE is a screening test for potential dementia-related cognitive impairment. The test includes questions that assess orientation of time and place, arithmetic and language skills, attention and recall abilities, and complex commands that involve drawing a figure. The test is scored out of 30 (score 24-30 = no cognitive impairment; 18-23 = mild cognitive impairment; 0-17 = severe cognitive impairment=0-17). A score greater than or equal to 26 is considered normal cognition. Only older adults (Caucasian Canadians and Indians) completed this task.

Cultural Orientation: *Individualism and Collectivism Cultural Orientation scale, INDCOL (Triandis & Gelfland, 1998;* Appendix B*)*

This is a 16-question scale designed to measure 4 dimensions of collectivism and individualism: horizontal-individualism, vertical-individualism, horizontal-collectivism and vertical-collectivism. All questions were answered using a 9-point scale, ranging from 1 = never or definitely no, and 9 = always or definitely yes. Questions pertaining to each dimension were added separately resulting in 4 scores (i.e., one score for each dimension) for each participant.

Self-Construal: *Self-Construal scale (SCS, Singelis, 1994;* Appendix C*)*

This scale consists of 30 questions and it measures the degree of independency (15 items) and interdependency (15 items) of an individual's self-construal (Singelis, 1994). All questions were answered based on a 7-point scale, ranging from 1= strongly disagree to 7 = strongly agree. Higher scores indicating higher cultural values.

Spatial Memory: *The Virtual Courtyard task (King et al., 2002)*

The virtual environment for the courtyard maze task is a modified version of the computer game Quake2 (© Id Software; King et al., 2002). The environment consists of a courtyard surrounded by visually distinct buildings on all sides, and 21 randomly distributed placeholders inside the courtyard, upon which the test stimuli appear (see Figure 1). The maze was presented in a first-person perspective on Asus 16-inch widescreen high definition display laptop.

First, all participants received 5-minutes free exploration time during which they were instructed to freely explore and familiarize themselves with the virtual environment by navigating along the perimeter walls at rooftop level using the assigned keys (i.e., left, right, front and back arrow keys) on the keyboard. Next, to ensure the task demands were fully understood, all participants completed 10-15 practice trials that consisted of both same-view (i.e., test phase starting point same as study phase) and 140° shifted-view trials (i.e., test phase starting point is different than study phase, with a 140° viewpoint shift during test phase).

During the study phase, 21 red placeholders were randomly distributed in the center of the courtyard, and to-be-remembered objects were presented one by one above the red placeholders (see Figure 1). There were two different starting points identified by orange cones (see Figure 1). Participants were instructed to walk to the starting point using the assigned arrow keys on the keyboard. Once the participants made contact with the orange cone, their viewpoint automatically adjusted to a standard view (i.e., complete view of the courtyard with all the placeholders visible), and to-be-remembered objects (i.e., turtle, hammer) appeared on randomly chosen placeholders one by one. To-be-remembered objects were presented for 3000 ms, with an interval of 1000 ms between each presentation. Task difficulty level varied (i.e., 3, 6, or 9 to-be-remembered objects were presented at study phase), and the level of difficulty changed randomly throughout the experiment. Participants were instructed to remember the original locations (i.e., exact placeholder on which each object appeared).

The study phase was followed by an immediate recognition memory test. Participants were either probed from the same-viewpoint or the 140° shifted-viewpoint locations. Each target object was presented with three replicates placed in foil locations, in random order and the participants were asked to identify the original location of the target object as seen during the study phase. Participants had to identify the correct locations for all objects presented during study phase and provide a verbal response. All participants completed a total of 24 trials; four trials for each difficulty level (i.e., 3, 6 and 9 objects) and once per view (i.e., same and 140° shifted view condition). Spatial memory scores were determined by the number of correct responses in same-viewpoint and shifted- viewpoint conditions across the three difficulty levels.

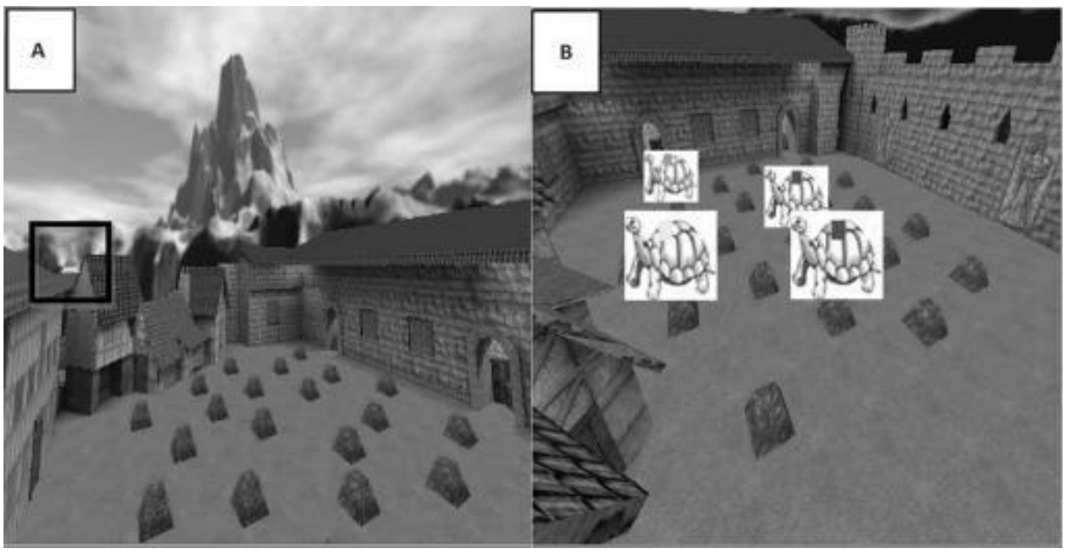


Figure 1. (A) The Virtual Courtyard task environment with 21 placeholders randomly distributed in the center of the courtyard. The orange cone in the bolded frame on the rooftop is one of the two starting points. (B) Example of test stimuli (one target object, three replicates) positioned on top of the orange placeholders. Participants were asked to pick the tortoise that is in the exact same location/on the same placeholder as presented during study phase.

Spatial strategy: *Spatial Strategy Questionnaire (*Appendix D*)*

This questionnaire was designed in the Cognitive Aging lab to assess participants' awareness of change in viewpoints during test and study phase, and the strategies they used during both conditions of the courtyard task to remember and recognize the location of the target objects. Participants rated, using a 0-10 Likert scale, how often they used each of the following strategies during the study phase, the test phase in the same-view condition, as well as in the shifted-view condition: 1) Egocentric strategy – remember and recall the location of each object based on its spatial relation relative to self (e.g., the tortoise is on the second placeholder in the first row to my right), 2) Single Landmark strategy – remember and recall the location of each object based on its spatial relation relative to a single landmark (e.g., Tortoise is on the placeholder right in front of the window in the first row, and flashlight is on the first placeholder two rows away the window), 3) Allocentric strategy – remember and recall the location of each object based on its relative spatial relation to the layout of multiple landmarks or other objects/placeholders in the courtyard (e.g., Tortoise is on the placeholder right in front of the doorway and it is three placeholders away from the chimney), and 4) for the shifted-view condition, recall the location of each object by mentally rotating the viewpoint of the courtyard arena to match with the study phase viewpoint (e.g., if I imagine looking from the initial study phase viewpoint, then I remember the Tortoise is in the first row away from me and on the second placeholder from my left).

Design

All four groups of participants completed the same experimental procedure. There were four independent variables in the present study: culture (i.e., Caucasian Canadian vs. India), age (young vs. older), and cultural orientation (individualistic vs. collectivist and independent vs. interdependent), and Courtyard task conditions (same-view vs. shifted-view), while the number of correct responses in the two courtyard task conditions (same-view vs. shifted-view) and the types of spatial strategies used during the courtyard task were our dependent variables.

Procedure

Caucasian Canadian young and old participants were tested in a quiet testing room at Ryerson University. Indian young adults were tested in a testing room in the Sleep and Cognition Lab at IIT-G, India, and Indian older adults were tested in a quiet room at their homes. Before beginning the experiment, informed consent was obtained from all participants.

Then all participants were asked to complete the INDCOL which took about 10 minutes to complete. Next, the participants were given detailed instructions for the courtyard task, and 5 minutes exploration period to familiarize themselves with the virtual environment by using the assigned arrow keys on the keyboard. To ensure that the participants fully understood the task, all participants completed 10-15 practice trials before the experimental block, where participants were asked to remember and recall the locations of either1, 2 or 3 objects. During the practice trials, participants were informed whether their responses were correct or incorrect. Following the practice trials, experimental block was administered, where participants were asked to remember and recall the locations of either 3, 6 or 9 objects at a time in same-view and shifted-view conditions. The participants were asked to complete 24 trials across three difficulty levels (i.e., 3, 6 or 9 objects) and two viewpoint conditions (i.e., same or shifted-view). The participants were asked to take a short break (2-3 minutes) after 12 trials. The courtyard experimental block took about 30 minutes to complete. During the courtyard test phase, the test stimuli were marked with coloured squares (i.e., red, yellow, green and blue), and participants were asked to provide a verbal response using those coloured squares (e.g., blue is in the correct answer, see Figure 1). To screen for color blindness, all participants then completed the Ishihara Colourblindness test, which took about 2 minutes to complete.

To assess the types of strategies used by participants to remember and recall the locations of the objects in same and shifted view conditions, all participants were asked to complete a spatial strategy questionnaire. This questionnaire took about 5 minutes to complete. Next, the level of independency and interdependency was measured with SCS, which took about 10 minutes to complete. According to Singelis and Brown (1995), collectivism measures are positively correlated with interdependency and negatively related to independency SCS scores. Past research showed that compared to Westerners, East Asians scored higher in interdependency and lower in independency (Singelis & Brown, 1995; Yang, Chen, Ng & Fu, 2013). Therefore, the use of SCS in the present study will not only help to validate the cultural orientation scale, but also to further determine which dimension of cultural differences - independency versus interdependency, or individualistic versus collectivist orientation or both - are related to spatial memory performance and the spatial navigation strategies. Lastly, only older adults in both cultures completed the MMSE. All participants completed a background questionnaire that included health and demographic questions. Finally, all participants were debriefed and compensated.

RESULTS

All statistical analyses for the present study were conducted using SPSS 19. The significance level was set at .05 for all analyses. The results were reported in the following three sections: 1) Cultural orientation; 2) spatial memory performance; 3) spatial strategy use.

Cultural Orientation

The results on the two measures of cultural orientation, INDCOL and SCS, were analyzed and reported separately below, followed by a validation correlation analysis between the two measures.

Individualism Collectivism Cultural Orientation Scale (INDCOL)

A 2 (age: younger vs. older) x 2 (culture: Canadian vs. Indian) x 2 (Dimension: horizontal vs. vertical) x 2 (Orientation: individualism vs. collectivism) mixed model ANOVA was conducted on the INDCOL scores, with Age and Culture as two between-subjects variables, dimension and orientation as two within-subjects variables. This analysis revealed a significant main effect of dimension, $F(1, 76) = 6.02$, $p = .02$, $\eta^2 = .07$, orientation, $F(1, 76) = 5.39$, $p = .02$, $\eta^2 = .07$, as well as a dimension by orientation interaction, $F(1, 76) = 48.19$, $p = .001$, $\eta^2 = .39$ (see Table 2). The follow-up analyses revealed a higher score on individualism ($M = 29.86$; $SD = 4.29$) than collectivism ($M = 25.60$, $SD = 3.93$) for the horizontal dimension, $t(79) = 6.48$, $p = .001$; whereas there was a lower score on individualism ($M = 25.68$, $SD = 5.88$) than collectivism (M = 27.33, SD = 4.83) for the vertical dimension, $t(79) = -2.97$, $p = .004$ (see Table 2).

Table 2.

Mean scores on the Individualism Collectivism Cultural Orientation Scale (INDCOL) across the four age by culture groups.

	Canada		**India**	
	Younger Adults	**Older Adults**	**Younger Adults**	**Older Adults**
Horizontal-individualism	27.80 (4.91)	31.60 (2.66)	29.40 (3.87)	30.65 (4.65)
Horizontal-collectivism	26.85 (3.63)	26.05 (2.48)	24.95 (3.85)	24.55 (5.17)
Vertical-individualism	23.45 (5.07)	22.75 (4.72)	27.70 (4.13)	28.80 (7.05)
Vertical-collectivism	26.55 (4.81)	28.10 (4.85)	25.80 (4.99)	30.80 (4.65)

Note: The data in each cell were presented in *M(SD)* format, unless specified otherwise. Mean average scores of younger and older Caucasian Canadian and Indian adults on Individualism Collectivism Cultural Orientation Scale (INDCOL) dimension-orientations: horizontal-individualism, horizontal-collectivism, vertical-individualism, and vertical collectivism. Standard deviations presented in the parentheses.

There was also a significant orientation by culture interaction, $F(1, 76) = 11.48$, $p = .001$, $\eta^2 = .13$. The follow-up analysis showed that Indians ($M = 29.14$, $SD = 4.07$) scored higher on individualism orientation compared to Canadians ($M = 26.40$, $SD = 3.22$), $t(78) = -3.34$, $p = .001$. However, the two cultures did not differ in collectivism orientation scores, $p > .67$ (see Figure 2).

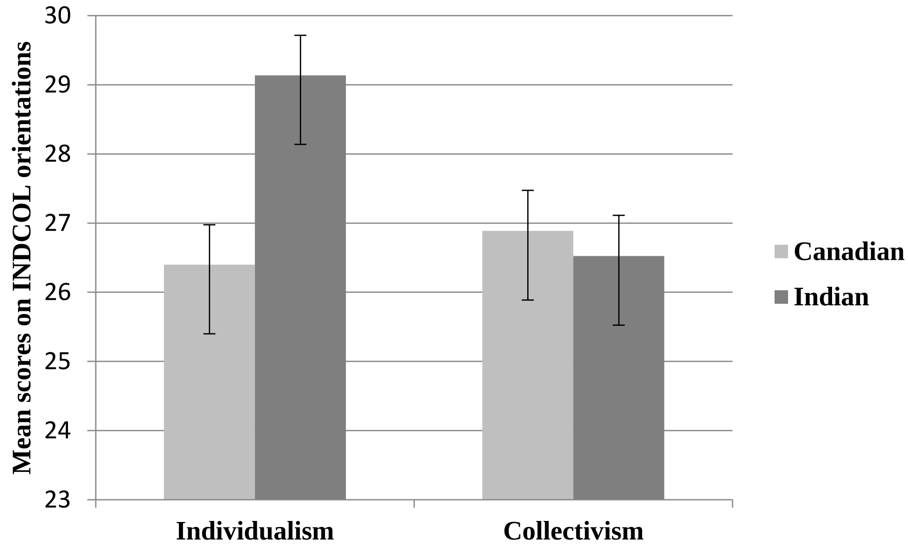


Figure 2. Mean INDCOL orientation scores across the two cultures. The error bars represent the standard errors of the means.

There was also a significant dimension by age by culture interaction *F*(1, 76) = 5.28, *p* = .02, η^2= .07. To decipher this interaction, a 2 (dimension) x 2 culture (Canadian vs. Indian) ANOVA was conducted separately for young and older adults. The results showed that the dimension by culture interaction was only significant for older adults, *F*(1, 76) = 26.66, *p* = .001, η^2= .41. Indian participants scored significantly higher on the vertical dimensions (*M* = 29.80, *SD* = 5.34) than their Canadian counterparts (*M* = 25.43, *SD* = 3.49), *t*(38) = -3.07, *p* = .004, but the two cultural groups did not differ on horizontal dimension, *p* = .203 (see Figure 3). The culture by dimension interaction was not significant for young adults, *p* = .119.

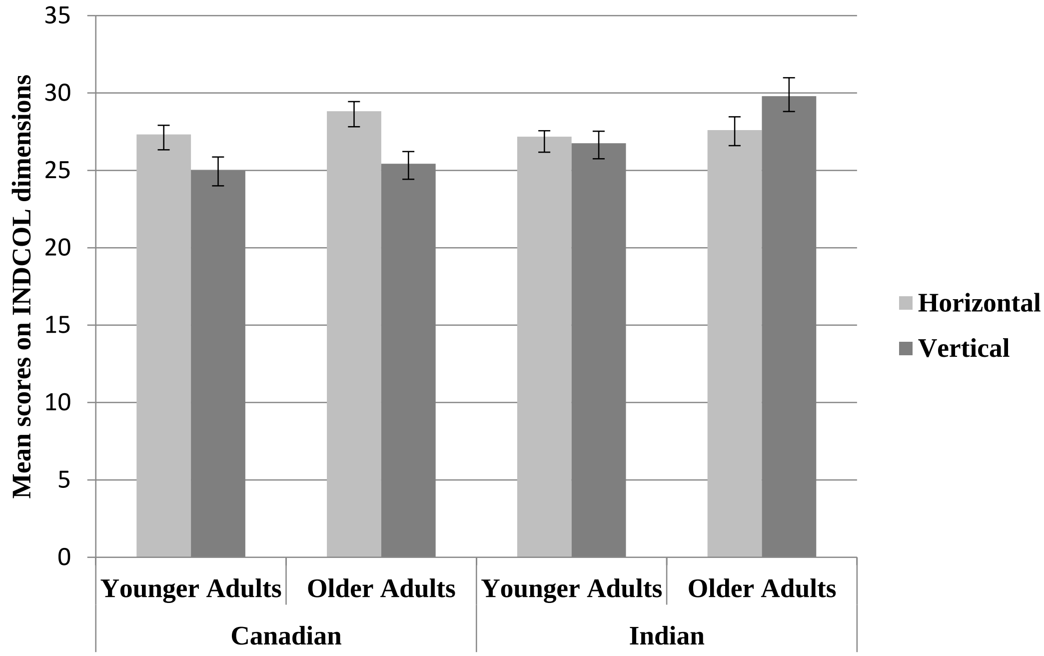


Figure 3. Mean INDCOL dimension scores across the four age by culture groups. The error bars represent the standard errors of the means.

Lastly, there was a significant dimension by age by orientation 3-way interaction, *F*(1, 76) = 11.31, *p* = .001, η^2= .13. To follow up this interaction, a 2 (age) x 2 (orientation) ANOVA was conducted for each of the horizontal and vertical dimensions. For the horizontal dimension, there was a significant orientation by age interaction, *F*(1, 78) = 6.01, *p* = .016, η^2= .07. A follow-up analysis showed that older adults scored significantly higher on the horizontal-individualism measure (*M* = 31.13, *SD* = 3.77) than younger adults (*M* = 28.60, *SD* = 4.44), *t*(78) = -2.74, *p* = .008, but there was no significant difference in their horizontal-collectivism scores, *p* =.500. For vertical dimension, there was also a significant orientation by age interaction, *F*(1, 78) = 4.79, *p* = .03, η^2= .06. A follow-up analysis showed that older adults scored significantly higher on vertical-collectivism (*M* =29.45, *SD* = 4.89) relative to younger adults (*M* = 26.18, *SD*

= 4.85), $t(78) = -3.01$, $p = .004$, but there was no difference in their vertical-individualism scores, $p = .88$ (see Figure 4).

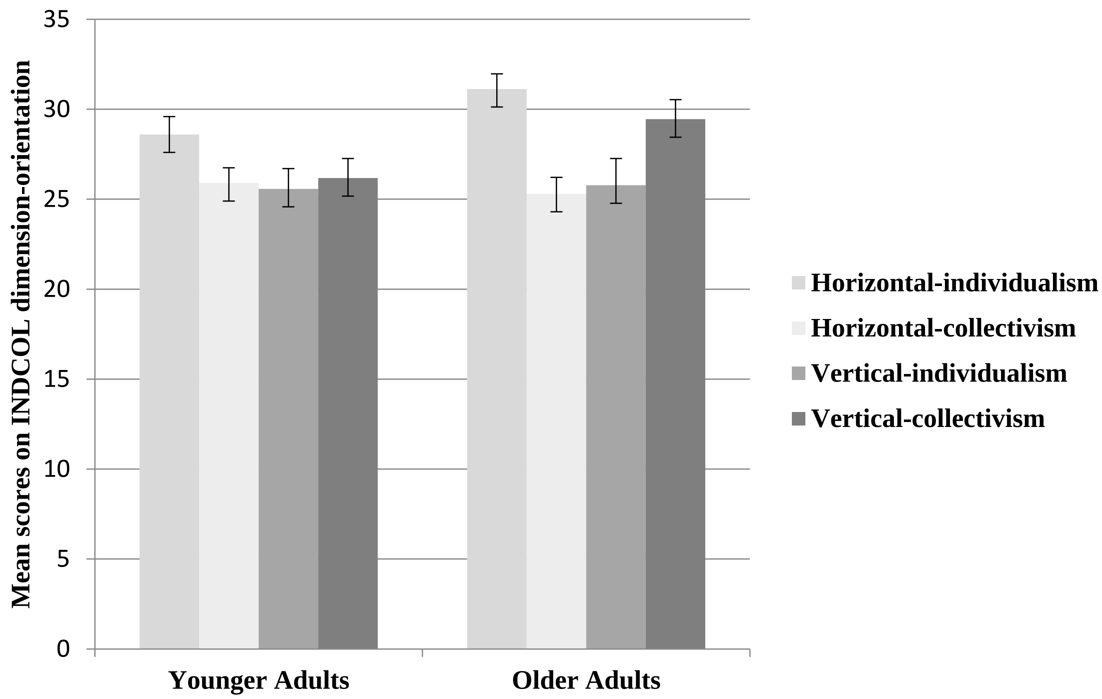


Figure 4. Mean INDCOL dimension and orientation scores of young and older adults. The error bars represent the standard errors of the means.

Overall, in terms of the cultural difference in orientation, contradictory to our predictions, we found that Indians were more individualistic than Canadians. Furthermore, regarding age differences in dimension-orientation, our results suggest that older adults across both cultures are not only more horizontally-individualistic, but they are also vertically-collectivist. This means not only do they see the self as autonomous and value equality between individuals, but they also view the self as a part of a collective and accept hierarchy within that collective.

Self-Construal Scale (SCS: independent and interdependent)

A mixed-factors 2 (age: young vs. old) × 2 (culture: Canadian vs. Indian) × 2 (SCS dimension: independent vs. interdependent) analysis of variance (ANOVA) was conducted to investigate the effects of age and culture on the self-construal structure. A significant main effect of SCS dimension was revealed $F(1, 76) = 11.54$, $p = .001$, $\eta^2 = .13$, with a higher score on independent ($M = 78.46$, $SD = 11.27$) than interdependent ($M = 74.05$, $SD = 10.59$) dimension.

There was a significant SCS dimension by age interaction $F(1,76) = 5.99$, $p = .017$, $\eta^2 = .07$. A follow-up analysis showed that older adults scored significantly higher on the SCS-independent ($M = 84.08$, $SD = 9.12$) than SCS-interdependent dimensions ($M = 76.38$, $SD = 12.04$), $t(39) = 4.16$, $p = .001$, but this dimension effect was not found in young adults (independent: $M = 72.98$, $SD = 10.51$; interdependent: $M = 71.73$, $SD = 8.42$), $t(39) = .59$, $p = .560$ (see Figure 5).

Furthermore, there was a significant SCS dimension by culture interaction $F(1, 76) = 12.33$, $p = .001$, $\eta^2 = .14$. A follow-up analysis showed that compared to Canadians ($M = 70.10$, $SD = 9.84$), Indians scored higher on the SCS-interdependent dimension ($M = 78.00$, $SD = 9.92$), $t(78) = -3.56$, $p = .001$. However, there was no significant difference between Canadian and Indians' score on SCS-independent dimension, $t(78) = .53$, $p = .530$. Lastly, there was no significant SCS dimension by age by culture interaction effect $F(1, 76) = .19$, $p = .660$, $\eta^2 = .003$ (see Figure 5). Overall, we found that Indians value interdependence more than Canadians.

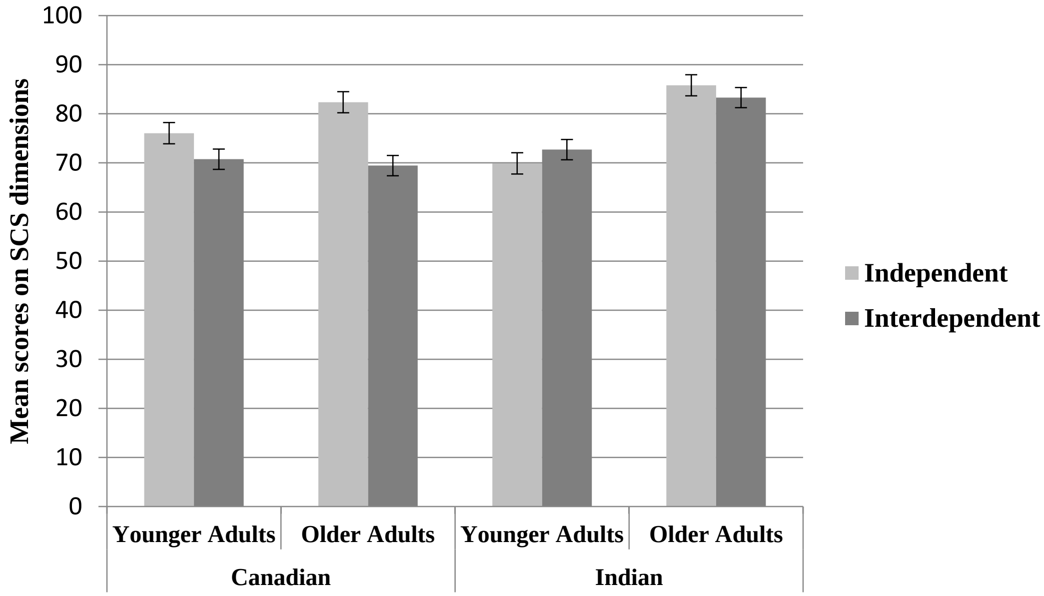


Figure 5. Mean SCS scores across the four age by culture groups. Error bars refer to standard errors of the means.

Correlations between INDCOL and SCS

Previous studies have used either SCS or INDCOL to measure cultural orientation (Singelis & Brown 1995; Sinha et al., 2001). In the present study, both measures were adopted to assess cultural orientation (see Table 3 for mean scores). For validation purpose, scores from SCS and INDCOL were submitted to correlation analysis (see Table 3).

Table 3.

Mean scores of participants on INDCOL and SCS measures

Measures	Canada		India	
	Young (n = 20)	Old (n = 20)	Young (n = 20)	Old (n = 20)
INDCOL				
Horizontal individualistic	27.80 (4.92)	31.60 (2.66)	29.40 (3.87)	30.65 (4.65)

Vertical individualistic	23.45 (5.07)	22.25 (4.72)	27.70 (4.13)	28.80 (7.05)
Horizontal collectivist	26.85 (3.63)	26.05 (2.48)	24.95 (3.85)	24.55 (5.17)
Vertical collectivist	26.55 (4.81)	28.10 (4.85)	25.80 (4.99)	30.80 (4.65)
SCS				
Independent	76.05 (11.18)	82.10 (6.25)	69.90 (9.05)	85.80 (11.34)
Interdependent	70.75 (9.83)	69.45 (10.05)	72.70 (6.86)	83.30 (9/78)

Note: The data in each cell was presented in *M(SD)* format, unless specified otherwise. Each statement on Individualistic and Collectivist scale (INDCOL; 4 statements for each dimension-orientation) was rated on a scale of 1 to 9. Scores for each dimension were added resulting in 4 grand scores (one for each dimension). Higher scores on horizontal and vertical individualistic dimensions indicating more individualistic cultural values, and higher scores on horizontal and vertical collectivistic measures indicating more collectivistic cultural values. Each statement on the Self-Construal Scale (SCS) was rated on a scale of 1 to 7, with higher scores on independent dimension indicating stronger independent values, and higher scores on interdependent dimension indication interdependent cultural values. Mini-Mental State Examination (MMSE) scores range from 0 to 30. Participants with MMSE scores lower than 26 were replaced.

Overall, INDCOL and SCS measure cultural orientations at different levels. INDCOL measures whether the self is being viewed as autonomous or as a part of a collective (i.e., individualism vs. collectivism), and the perception of hierarchy and equality (i.e., vertical vs. horizontal) among individuals. On the other hand, SCS measures the level of independency and interdependency in individuals. Prior research suggests that individualism orientations positively correlate with SCS-independent measure, while collectivism orientations positively correlate with SCS-interdependent measure (Singelis & Brown, 1995). In line with our predictions, both INDCOL horizontal-collectivism and vertical-collectivism positively correlated with SCS-interdependent scores. However, only the INDCOL horizontal-individualism scale positively correlated with the SCS-independent dimension.

In contrast to our predictions, the vertical-individualism scores positively correlated with SCS-interdependent scores. Additionally, vertical-individualism scores correlated with the collectivism INDCOL dimensions; horizontal-collectivism and vertical-collectivism. It is also important to note that the relationship between these dimensions were almost as strong as the relationship between the two collectivism dimensions (i.e., horizontal-collectivism and vertical-collectivism). Even with the current sample size, this raises the question regarding the construct validity of the INDCOL questionnaire, as well as the structure of the factors present in the INDCOL measure.

To further examine whether the relationships between INDCOL and SCS dimensions differ by culture and age, we ran four separate correlation analyses for each of the age by culture groups. Overall, a positive correlation between INDCOL vertical-collectivism and SCS-interdependent dimensions was found consistently across all groups except the Indian older adults group. It is possible that the INDCOL and SCS questionnaires measure two different social constructs, or perhaps the structure of the questions in these measures are such that they demand subjective interpretation scale.

Table 4.

Pearson correlations between INDCOL and SCS.

	Horizontal-individualism	**Vertical-individualism**	**Horizontal-collectivism**	**Vertical-collectivism**	**SCS-independent**	**SCS-interdependent**
INDCOL						
Horizontal-individualism						
Vertical individualism	.156		.			.
Horizontal-collectivism	-.022	.315**		.		
Vertical-collectivism	.185	.321**	.356**		.	

SCS					
SCS-independent	.253*	.064	.121	.288**	
SCS-interdependent	-.097	.473**	.303**	.528**	.306**

**p < .01 (2-tailed); *p < .05 level (2-tailed).

Spatial Memory Performance

Spatial memory performance was indexed by the accuracy score, calculated as the total number of objects with their locations correctly identified for two virtual courtyard task conditions: same-view and shifted-view. The accuracy scores were submitted to a mixed-factors 2 (age) x 2 (culture) x 2 (condition: same-view vs. shifted-view) ANOVA, with age and culture as between-subjects variables, and condition as a within-subjects factor. There was a significant main effect of condition $F(1, 76) = 174.80$, $p = .001$, $\eta^2 = .69$, with a higher accuracy in same-view ($M = 49.61$, $SD = 9.28$) than the shifted-view condition ($M = 38.18$, $SD = 16.81$). There was a significant condition by age interaction $F(1, 76) = 94.00$, $p = .001$, $\eta^2 = .55$. Relative to same-view condition, both younger as well as older adults scored lower on the shifted view condition. A follow-up analyses indicated that this condition effect was larger for older (same-view: M = 44.03, SD = 6.78; shifted-view: $M = 24.20$, $SD = 10.64$), $t(39) = 13.15$, $p = .001$, $d = 2.28$ than young adults (same-view: M = 55.20, SD = 8.03; shifted-view: $M = 52.15$, $SD = 7.65$), $t(39) = 3.44$, $p = .001$, $d = 0.39$ (see Figure 6). Contrary to our hypothesis, there was no effect of culture or culture-related interactions, ps > .05.

Driven by our main interest in age and cultural differences in spatial memory, we conducted a 2 (age) x 2 (culture) ANOVA for each of the same and shifted view conditions. For the same-view condition, young adults ($M = 55.73$, $SD = 8.03$) outperformed older adults ($M = 48.50$, $SD = 6.78$), $F(1, 76) = 51.01$, $p = .001$, $\eta^2 = .40$. The age by culture interaction was also significant, $F(1, 76) = 9.91$, $p = .002$, $\eta^2 = .115$. Indian older adults scored ($M = 47.60$, $SD = 6.01$) lower than Canadian older adults ($M = 40.45$, $SD = 5.60$), $t(38) = 3.89$, $p = .001$. Young adults did not differ across the two cultures, $p > .05$. For the shifted-view condition, young adults ($M = 52.15$, $SD = 7.65$) again outperformed the older adults ($M = 24.20$, $SD = 10.64$), $F(1, 76) = 223.87$, $p = .001$, $\eta^2 = .75$. The main effect of culture was also significant $F(1, 76) = 7.45$, $p = .01$, $\eta^2 = .09$, which was qualified with an age by culture interaction $F(1, 76) = 12.48$, $p = .001$, $\eta^2 = .14$. Similar to the same-view condition, Indian older adults scored ($M = 18.35$, $SD = 7.96$) significantly lower than Canadian older adults ($M = 30.05$, $SD = 9.84$), $t(38) = 4.13$, $p = .001$. Young adults, however, did not differ between the two cultures, $p > .05$.

To examine the relationship between cultural orientation and spatial memory performance, correlation analyses were conducted between spatial memory scores and cultural orientation scores (INDCOL and SCS scores) for each condition (i.e., same-view and shifted-view). Results showed significant negative correlations between spatial memory scores and vertical-collectivism (same view: $r = -.27$, $p < .01$; shifted view: $r = -.38$, $p < .01$), SCS-independent (same view: $r = -.30$, $p < .01$; shifted view: $r = -.39$, $p < .01$) and SCS-interdependent scores (same view: $r = -.26$, $p < .01$; shifted view: $r = -.28$, $p < .01$). To further examine whether those cultural orientation dimensions that showed significant correlations with spatial memory might moderate or mask the cultural or age differences in spatial memory, two 2 (age) x 2 (culture) analyses of covariance (ANCOVAs) for each of the same-view and shifted-view conditions were conducted, including vertical-collectivism and the two SCS scores (i.e., independent and interdependent) as covariates. The results showed that the main effect of age remained significant in both same-view $F(1, 75) = 43.88$, $p = .001$, $\eta^2 = .37$, and shifted-view conditions, $F(1, 75) = 190.01$, $p = .001$, $\eta^2 = .72$. So did the age by culture interaction in both the same-view, $F(1, 75) = 9.20$, $p = .003$, $\eta^2 = .11$, and the shifted-view conditions, $F(1, 75) = 10.74$, $p = .002$, $\eta^2 = .13$. There was neither a significant effect of vertical-collectivism, nor SCS-independent or SCS-interdependent on either same-view or shifted-view scores, all *p*s > .05.

Our results suggest a better spatial memory performance in the same-view than shifted-view condition, particularly for older adults. Young adults outperformed older adults. However, cultural orientation did not moderate the relationship between culture and spatial memory. Although young adults did not show cultural differences, Canadian older adults performed significantly better than Indian older adults in both the same-view and the shifted-view conditions. These group differences were significant even after controlling for the related cultural orientation scores.

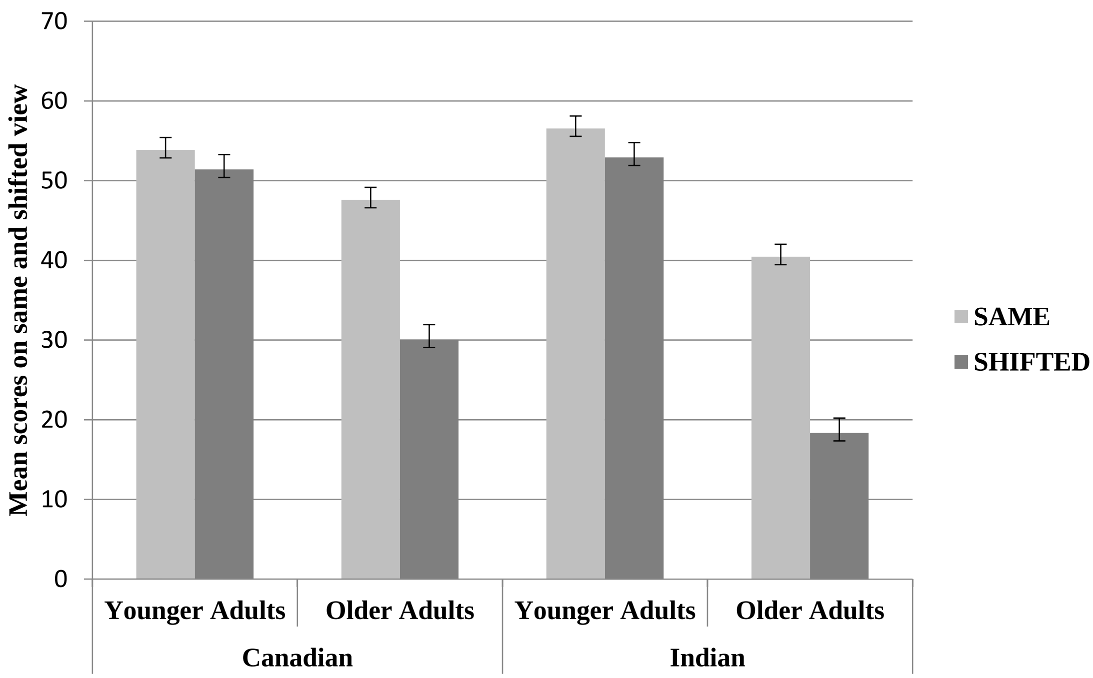


Figure 6. Mean spatial memory accuracy scores on the same-view and shifted-view virtual courtyard conditions across the four age by culture groups.

Spatial Strategy

In this section, the results were reported on whether the frequency of each spatial strategy differed as a function of age, culture, and task condition. A mixed-factor 2 (age) × 2 (culture) × 2 (condition) ANOVA was conducted on the frequency of each strategy being used, except for the mental rotation strategy for which a 2 (age) × 2 (culture) ANOVA was conducted because this strategy was only applied to the shifted view condition.

The ANOVA on the egocentric strategy revealed a significant main effect of the task condition, $F(1, 76) = 33.78$, $p = .001$, $\eta^2 = .31$. A follow-up analysis showed a more frequent use of egocentric strategy in same view ($M = 5.81$, $SD = 3.50$) compared to shifted view trials ($M = 3.21$, $SD = 3.40$; see Figure 7), $t(79) = 5.74$, $p = .001$. Other effects were not significant, *ps* > .05. The ANOVA on the single landmark strategy revealed a significant effect of age $F(1, 76) = 3.87$, $p = .05$, $\eta^2 = .04$, with a more frequent use in young adults than older adults (see Figure 5). All the other effects were not significant, *ps* > .05. The ANOVA on the allocentric strategy use frequency revealed a significant main effect of task condition, $F(1, 76) = 33.78$, $p < .001$, $\eta^2 = .31$. This was qualified with an age by condition interaction, $F(1, 76) = 44.44$, $p = .001$, $\eta^2 = .37$, with older adults using allocentric strategy less during shifted-view condition, while younger adults increasing their use of allocentric strategy during shifted-view condition (see Figure 7). The ANOVA on mental rotation strategy in the shifted-view condition revealed a significant main effect of age, $F(1, 76) = 5.98$, $p = .02$, $\eta^2 = .07$, with young adults ($M = 6.50$, $SD = 3.32$) using mental rotation strategy more often than older adults ($M = 4.60$, $SD = 3.97$; see Figure 7), $t(78) = 2.35$, $p = .02$. However, against our hypothesis, there were no significant cultural differences in the use of any of these strategies (*p*s > .05).

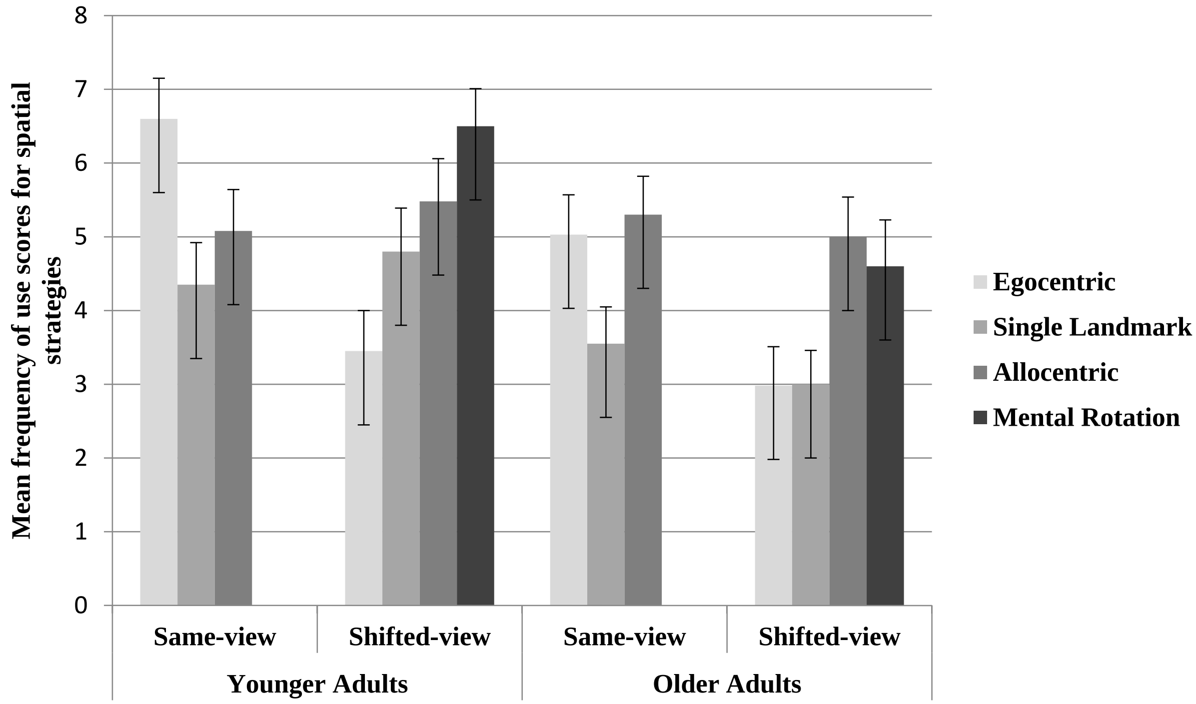


Figure 7. Average frequency of egocentric, single landmark, allocentric and mental rotation spatial strategy in same and shifted-view virtual courtyard condition across the four age by culture groups.

A simple regression model was conducted to determine whether using a specific spatial strategy can predict the spatial memory performance on same-view and shifted-view conditions. Given the lack of cultural effect, four separate regression analyses were conducted for same-view and shifted-view accuracy for younger and older adults scores. For the same-view condition, young adults did not show any significant prediction of any spatial strategies (i.e., egocentric, single landmark, allocentric) to spatial memory accuracy, all *p*s > .05. However, a significant regression effect was found for older adults, $F(3, 39) = 2.92$, $p = .05$, with an R^2 of .20. Both single landmark, $\beta = .35$, $t(36) = 2.19$, $p = .04$, and allocentric, $\beta = .36$, $t(36) = 2.31$, $p = .03$, strategies were found to be significant predictors of spatial memory. For the shifted-view condition, again, young adults did not show any significant prediction of any spatial strategies (i.e., egocentric, single landmark, allocentric and mental rotation) to spatial memory accuracy, all *p*s > .05. However, a significant regression effect was found for older adults, $F(4, 39) = 8.24$, $p = .001$, with an R^2 of .49. Both allocentric, $\beta = .48$, $t(35) = 3.86$, $p = .001$, and mental rotation $\beta = .44$, $t(35) = 3.39$, $p = .002$, strategies were found to be significant predictors of spatial memory.

Discussion

The main objective of the current study was to examine the age and cultural differences in cultural orientation, to determine the role of culture, age, and cultural orientation on spatial memory and spatial memory strategy use in Canadian and Indian younger and older adults. The results showed some interesting age and cultural differences in cultural orientation and spatial memory. Cultural orientation did not moderate the relationship between culture and spatial memory. Only older adults benefited from using task-specific spatial memory strategies to improve their spatial memory. In that those who used more specific spatial memory strategies also had better spatial memory performance.

Specifically, the cultural effects in these results suggested that: 1) Indian participants value individualism and interdependence more than their Canadian counterparts; 2) Indian participants were less accurate in spatial memory relative to Canadian participants, but this effect was specific to older adults; 3) the two cultures did not differ in frequency of spatial memory strategy use. In terms of age differences, the results suggested that: 1) Older adults value horizontal-individualism (i.e., assuming independence among people of social equality) and independence more than young adults; 2) Older adults were more sensitive to view point (same-view vs. shifted-view) change and less accurate in spatial memory than young adults; 3) Compared to older adults, young adults tend to use some context-specific (i.e., allocentric) strategy more in shifted-view condition. Cultural orientation, specifically the SCS independent and interdependent and vertical-collectivism neither predicted spatial memory nor moderated the cultural differences in spatial memory. Finally, older adults, but not young adults, benefitted from using context-specific strategies. The results were discussed in terms of cultural differences in lifestyle and urban sprawl, and age-related changes at a neuronal level.

Culture and age differences in cultural orientation

Although Indians scored higher on the horizontal-individualism and vertical-individualism dimensions, overall both cultures did not differ very much on INDCOL measures. Culture consists of customs, values, beliefs, experiences and behavioural patterns shared by a group of people living in a particular society. It has been theorized that Western culture is adapted from Ancient Greece with a focus on processing information with a more analytical and individualistic approach (Nisbett et al., 2001; Park & Huang, 2010). In contrast, East Asian culture values social harmony and balance within the environment. As a result, compared to individualistic, collectivist cultures tend to view themselves as interdependent entities and have a tendency to process information holistically (Park & Huang, 2010). Furthermore, research suggests that prolonged exposure to certain cultural values (i.e., interdependency among family members) and behavioural practices (i.e., binding contextual information in collectivist East Asians) may affect the function and specific structures of the brain, and this cultural effect is thought to be magnified with age (Goh et al., 2004; Park & Huang, 2010). Therefore, in the present study we hypothesized that Canadians will score higher on individualism INDCOL and SCS-independent dimensions, and Indians will score higher on collectivism INDCOL and SCS-interdependent dimensions. It was predicted that older adults will score higher than younger adults on culture specific dimensions (i.e., Canadian older adults higher on individualism and independency, and Indian older adults higher on collectivism and interdependency). Contradictory to our predictions, we found that compared to Canadians, Indians scores higher on INDCOL individualism dimensions (i.e., horizontal-individualism, vertical-individualism), and SCS-independent as well SCS-interdependent dimensions. Cultural orientations are social constructs that can be constructed, deconstructed and modified by an individual's experiences and environmental or cultural changes. For example, industrialization, economic and technological growth in Asian societies has led to internalization of Western values, due to which Asians no longer display behavioural patterns characteristic of collectivist Asian cultures, and a shift in individualistic values has been observed in Asians, especially in Chinese younger adults (Sun & Wang, 2010; Zhang & Shavitt, 2003). According to Hofstede (1980), India did not qualify as a truly collectivist culture. Instead India's score of 48 on a 100-point Hofstede's cultural orientation measure indicated that individualistic and collectivist tendencies overlap with each other within the Indian society. Technological and economical advances in India, exposure to Western values through media, and the availability of job and academic opportunities outside India may have resulted in Indians valuing individualistic orientations more than collectivist.

Furthermore, regarding the effect of prolonged exposure to cultural specific values, we found that Indian older adults scored high on vertical-individualism and vertical-collectivism INDCOL dimensions as well as on the SCS-independent and SCS-interdependent dimensions. We assume that the changes in social structure (i.e., education and job opportunities outside of India could have led to an increase in nuclear families and older adults living independently in India) that may have resulted in Indian older adults exhibiting an overlap in individualistic-collectivist orientations. Nevertheless, relative to young, older adults across both culture groups scored higher on horizontal-individualism and vertical-collectivism dimensions in INDCOL and higher on independence on the SCS, suggesting that older adults value autonomy/individualism among people of same social status but assume interdependence/collectivism among people of hierarchical social status. Overall, our results show that individualism-collectivism can coexist to varying degrees in individuals belonging to any given culture, and depending on the context, autonomy and collectivism are valued equally, specifically in the older adults.

It is important to note that relative to Canadians, Indians scored higher on both SCS dimensions, due to which there was no significant difference in their SCS-independent and interdependent scores. Thus, there might be a response bias in the Indian older adults group using the higher end of the Likert scale to rate each statement on the SCS measure. Therefore, it is possible that Indian older adults' scores skewed the results, and the observed culture by dimension interaction might not be reflecting the true difference between the two cultures.

According to Singelis and Brown (1995), collectivism is positively correlated with SCS-interdependence, and negatively correlated with SCS-independence. In the present study, positive correlation was found only between INDCOL vertical-collectivism and SCS-interdependent dimensions consistently across all groups except for Indian older adults group. This may have resulted from Indian older adults' significantly high scores on SCS, which resulted in restricted ranges in their responses and thus may have masked the correlations. Nevertheless, it is also possible that the INDCOL and SCS questionnaires measure two different social constructs, or perhaps the structure of the questions in these measures are such that they demand a higher degree of subjective interpretation. For example; some question on INDCOL and SCS required respondents to imagine a friend or a family member; it is very much likely that the response on such questions depend on the person being imagined by the respondent and the relationship they share. Furthermore, these results challenge the validity of the INDCOL as a cultural orientation scale, and establishes a need for the creation of a cultural orientation measure that allows less subjection interpretation.

Cultural and age differences, and the relation of cultural orientation in spatial memory

Previous studies suggest that due to increased sensitivity towards processing central objects and prolonged practice with categorization during perceptual organization, individualistic

Westerners are more likely to spontaneously use an egocentric strategy that involves processing a single environmental cue and body-based turns (Balram et al., 2010). Whereas due to culture based experience with holistic performance and binding, collectivist Asians are more likely to spontaneously adopt an allocentric strategy that involves binding several environmental cues. These effects are thought to be enhanced with age and prolonged culture specific experience (Balram et al., 2010; Goeke et al., 2015; Park & Huang, 2010). Therefore, in the present study it was hypothesized that collectivist Indians will outperform individualistic Canadians on the shifted-view virtual courtyard condition, as higher accuracy scores in this specific condition rely heavily on the use of binding (i.e., allocentric strategy use).

We found that cultural orientation neither predicted, nor moderated group differences in spatial memory performance. Prior research has demonstrated that due to self based focus independent Westerners remember focal objects more than background information, collectivist Asians on the other hand process their environment holistically and tend to bind objects with contextual cues (Chua et al., 2005; Kitayama et al., 2003; Masuda & Nisbett, 2001). In support of these behavioural findings, some researchers have also found differences in eye-movement of Westerners and Chinese participants during visual spatial memory tasks (Chua et al., 2005). However, majority of the cross-cultural studies examining the effect of cultural values on visual processing do not measure cultural orientation, thus the findings of these studies that associate the differences in visual processing to differences in cultural values and orientations are lacking valid support. Based the results of the present study, scores on individualism-collectivism or independent-interdependent are not systematically related to scores on spatial memory of objects. However, we believe that this discrepancy between the existing literature and our findings could also be the result of cultural orientation scale validation issue. We found that compared to other groups, Indian older adults scored significantly higher on some INDCOL and SCS dimensions, which in turn could have probably overpowered the true effect of cultural orientation on spatial memory.

On the other hand, we found a strong relationship between age and object location memory. Compared to young adults, older adults recalled significantly fewer object locations in both same-view as well as shifted-view courtyard conditions, particularly Indian older adults were differentially more sensitive to view point (same-view vs. shifted-view) change. The effect of age on spatial memory performance replicated the well-documented age-related deficits in spatial memory and binding abilities (Konishi et al., 2013, Lovden et al., 2012; Naveh-Benjamin et al., 2004; Naveh-Benjamine et al., 2003). Based on the findings from previous spatial navigation studies, we believe that age related decrements in the hippocampal volumes were associated with the deficits in spatial memory observed in older adults (Konishi et al., 2013; Lovden et al., 2013). Furthermore, the shifted-view virtual condition is more cognitively demanding, and we believe that given the age-related changes at a neuronal level, especially the changes within the hippocampus (i.e., greater loss in hippocampal volume and gray matter) older adults lack the resources required for binding, which resulted in overall poor virtual courtyard performance and particularly in the shifted-view condition.

Although age has been shown to be a dominant factor that influences spatial memory performance and binding abilities, sustained spatial memory experience has been presumed to play a role in hippocampal integrity (Lovden et al., 2012). More specifically, gains in performance and stable hippocampal volumes have been found in older adults who completed a four-month spatial navigation training that demanded binding several environmental cues for successful task completion (Lovden et al., 2012). Navigating within a familiar or new environment could be considered one way of practicing spatial memory or navigation skills. In the present study, all Indian older adults were tested in a quiet room at their homes mainly because they either did not drive or preferred to avoid commute. The urban sprawl and design of the local areas in India are such that all the necessities are available within the vicinity of the residential areas. For example, grocery stores, drug stores, temples and libraries are all usually within walking distance from home, and often vendors provide home deliveries. Due to such convenient arrangements, older adults in India often do not have to navigate a far distance from their homes, which probably results in lack of navigation practice. In contrast, Canadian older adults are more independent; in that a majority of them either used the public transit or drove to our lab to participate in this study. It is possible that these differences between our Indian and Canadian older adults could have been responsible for lower spatial memory performance in Indian older adults.

Cultural and age differences in spatial strategy: Who benefit most from it?

The results showed little cultural difference in spatial strategy, suggesting that Indian and Canadian participants used same sets of strategy in performing the spatial memory task. The prediction that Indians will use more allocentric strategies, and Canadians will use more egocentric strategy was based on the theory documented in previous cross-cultural research (i.e., Chua et al., 2005; Balram et al., 2010). Spontaneous use of specific spatial strategies is dependent on specific regions of the brain. Allocentric strategy is supported by the hippocampus and involves forming relationships between different landmarks in the environment (Bohbot et al., 2007; Konishi et al., 2013). In contrast, egocentric is supported by caudate nucleus, and involves using a single landmark cue and following a pattern of body based left-right turns (Bohbot et al., 2007; Konishi et al., 2013). Hippocampus is involved in relationship formation, while caudate nucleus is critical for response learning and habit formation by making rigid stimulus-response associations and categorization. Based on our findings it possible that perhaps spatial strategy use is not dependent on culture and cultural orientation, instead strategy is more affected by the age-related changes in these specific regions.

More specifically, our results indicated that young adults use some context-dependent strategies (i.e., allocentric) for shifted-view condition more often than their older counterparts. However, older adults, but not young adults, benefit from using task-specific strategies. It is very likely that younger adults' performance on virtual courtyard task is suggestive of ceiling effects, therefore using specific strategy does not add any further benefit. It is also possible that this ceiling effect is masking the effects of specific strategy use on spatial memory performance in younger adults. However, compared to younger adults, older adults often exhibit deficits in associative memory, mainly because they fail to self-initiate a more cognitively demanding binding strategy that helps to remember the associations between unrelated information (Cohn et al., 2008; Naveh-Benjamin, 2000; Naveh-Benjamin et al., 2004; Naveh-Benjamin et al., 2003). Nevertheless, performance gains have been observed in associative memory when older adults are prompted to use appropriate strategies (Cohn et al., 2008; Naveh-Benjamin, 2000; Naveh-Benjamin et al., 2004; Naveh-Benjamin et al., 2003). Thus, older adults' spatial memory performance is probably more sensitive to proper and effective strategy use relative to young adults.

According to Park et al (1999), compared to tasks that require more cognitive resources, cultural differences in the cognitive processes that are less resource-demanding should not be affected by the normal aging process. Due to age-related changes at neuronal level, older adults must allot more cognitive resources to accomplish cognitively challenging tasks. As tasks become more cognitively challenging, older adults need to allocate more cognitive resources to overcome age-related cognitive constraints. Therefore, when it comes to cultural specific processing strategies (i.e., binding in Asians), older adults may have less cognitive resources to employ their well-practiced strategies or to even adopt new strategies that are not normally used in their own cultures. As a result, older adults from different cultures may show reduced cultural differences on tasks that demand effortful processing (Park et al., 1999). Our findings offer support for this theory, more importantly, it suggests that even in a virtual environment task older adults benefit from using context-dependent appropriate strategies.

Limitations and future directions

One of the major limitations of the present study was that it was a purely behavioural study with no eye tracking or neuroimaging measures. Therefore, our speculations regarding spatial memory performance are entirely based on the existing neuroimaging spatial navigation and associative memory research. Given the lack of neuroimaging measures, we cannot conclude for certain that the observed difference in young and older adults are purely the result of age related changes at the neuronal level. It is possible that differences in eye movements could have resulted in poor spatial memory performance in older adult, but this could not be determined due to the lack of eye tracking measure. Furthermore, we failed to conduct naturalistic observations of the urban sprawl and navigation habits. Majority of the Indian older adult participants in our study did not drive and avoided commuting, which in turn may have influenced the amount and degree of exploration of the environment they engaged in. We predict that perhaps this may have affected their ability to use spatial strategies and navigate especially in a new environment. This may also have contributed to the difference in the virtual courtyard task performance between Canadian and Indian older adults observed in our study. Therefore, we cannot determine specifically how much variance in the observed spatial memory scores was due to cultural differences in urban sprawl and lifestyle factors (i.e., driving experience, lack of navigation practice) and how much was due to age. Lastly, it is possible that some effects, specifically the differences in cultural orientation were not detected due to our small sample size.

Nevertheless, the findings of the present study established the importance of measuring cultural orientation in cross-cultural studies, specifically when making inferences regarding observed cognitive and behavioural cultural differences. Furthermore, the ability to bind objects and locations plays a crucial in spatial memory and our ability to navigate within our everyday environment. Prior research has demonstrated that a deficit in spatial memory is one of the first signs of normal aging process as well as dementia. The results of the present study demonstrate that although aging leads to poor spatial memory in older adults, older adults are still capable of using effective context specific strategies in a virtual environment even when they are not prompted to do so. To build upon the findings of the present study, future studies can include neuroimaging and eye tracking measures. Such measures paired with qualitative naturalistic observations will not only help to determine the neural underpinnings of age related deficits in spatial memory, but it will also allow researchers to determine the relationship between urban sprawl and spatial memory performance.

Appendix A: Mini-Mental State Examination (MMSE)

MMSE

DATE OF EXAMINATION ____/___/________EXAMINER______________________

Name: ______________________________ Age: ________ Years of school completed __________________

Instructions for EXPERIMENTER: Words in boldface type should be read aloud clearly and slowly to the examinee. Item substitutions appear in parentheses. Administration should be conducted privately and in the examinee's primary language. Circle '0' if the response is incorrect or '1' if the responses correct. Begin by asking the following two questions:

Do you have any trouble with your memory? **May I ask you some questions about your memory?**

ORIENTATION TO TIME		RESPONSE	SCORE (circle one)	
What is the..	**Year?**	______________	0	1
	Season?	______________	0	1
	Month of the year?	______________	0	1
	Day of the week?	______________	0	1
	Date?	______________	0	1

ORIENTATION TO PLACE *
Where are we now? What is the...

	State (**Province**)?	______________	0	1
	County (or **City**/Town)?	______________	0	1
	City/Town (or part of city/**neighbourhood**)	______________	0	1
	Building (name, type, or address)?	______________	0	1
	Floor of the building (Floor number or room number)	______________	0	1

*Alternative place words that are appropriate for the setting and increasingly precise may be substituted and noted.

REGISTRATION *

Listen carefully. I am going to say three words. You say them back after I stop. Ready?
Here they are.... APPLE *[pause]*, **PENNY** [*pause*], **TABLE** [*pause*]. **Now repeat those words back to me.**
[Repeat up to 5 times, but score only the first trial.]

APPLE	______________	0	1
PENNY	______________	0	1
TABLE	______________	0	1

Now keep those words in mind. I am going to ask you to say them again in a few minutes.
*Alternative word sets (e.g. PONY, QUARTOR, ORANGE), may be substituted and noted when retesting an examinee

ATTENTION AND CALCULATION [Serial 7s] *
Now I'd like you to subtract 7 from 100. Then keep subtracting 7 from each answer until I tell you to stop.

What is 100 take away 7?	[93]	______________	0	1
If needed, say: **keep going.**	[86]	______________	0	1
If needed, say: **keep going.**	[79]	______________	0	1
If needed, say: **keep going.**	[72]	______________	0	1
If needed, say: **keep going.**	[65]	______________	0	1

*Alternative item (WORLD backward) should only be administered if the examinee refuses to perform the serial 7s task.

Substitute and score this item only if the examinee refuses to perform the serial 7s task.
Spell WORLD forward, then backward. Correct forward spelling if misspelled, but score only the backward spelling.

____	____	____	____	____	____
(D=1)	(L=1)	(R=1)	(O=1)	(W=1)	(0 TO 5)

RECALL
What were those three words I asked you to remember? [*Do not offer any hints*]

APPLE	____________________	0	1
PENNY	____________________	0	1
TABLE	____________________	0	1

NAMING *

What is this? *[Point to a pencil or pen]*	____________________	0	1
What is this? [Point to a watch]	____________________	0	1

*alternative common objects (e.g. eyeglasses, chair, and keys) may be substituted and noted

REPETITION
Now I am going to ask you to repeat what I say. Ready? .... "NO IFS, ANDS, OR BUTS." Now you say that.
[Repeat up to 5 times, but score only the first trial]

NO IFS, ANDS, OR BUTS	____________________	0	1

Detach the next page along the lengthwise perforation, and then tear it in half along the horizontal perforation. Use the upper half of the page (blank) for the Comprehension, Writing, and Drawing items that follow. Use the lower half of the page as a stimulus form for the reading ("CLOSE YOUR EYES") and Drawing (intersecting pentagons) items.

COMPREHENSION
Listen carefully because I am going to ask you to do something.
Take this paper in your right hand [*pause*], **fold it in half** [*pause*], **and put it on the floor (or** table**).**

TAKE IN RIGHT HAND	____________________	0	1
FOLD IN HALF	____________________	0	1
PUT ON FLOOR (*or* TABLE)	____________________	0	1

READING
Please read this and do what it says. [*Show examinee the words on the stimulus form.*]

CLOSE YOUR EYES	____________________	0	1

WRITTING
Please write a sentence. [*If the examinee does not respond, say:* **write about the weather.**] 0 1
Place the blank piece of paper (unfolded) in front of the examinee and provide a pen or pencil.
Score 1 point if the sentence is comprehensible and contains a subject and a verb.
Ignore errors in grammar or spelling.

DRAWING
Please copy this design. [*Display the intersecting pentagons on the stimulus form.*] 0 1
Score 1 point if the drawing consists of two 5-sided figures that intersect to from a 4- sided figure.

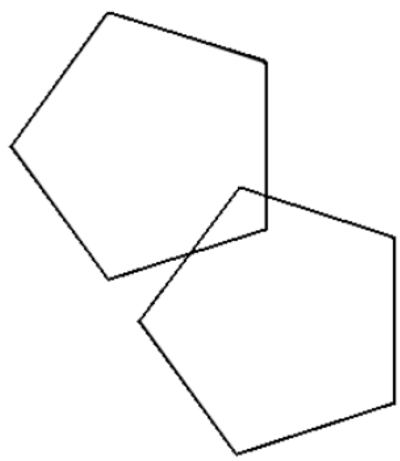
Assessment of level of consciousness

____
Alert/responsive Drowsy Stuporous Comatose/ unresponsive

Total Score = ________
(Sum all item scores) (30 points max)

CLOSE YOUR EYES

ID#________



Appendix B: Individualism-Collectivism Cultural Orientation scale

INSTRUCTIONS

This questionnaire measures a variety of feelings and behaviors in various situations. Listed below are a number of statements. Read each one as if it referred to you, and rate each statement using a 9-point ranging from **1= NEVER or DEFINITELY NO** and **9 = ALWAYS or DEFINITELY YES**.

Beside each statement write the number that best matches your agreement or disagreement. Please respond to every statement. Thank you.

_____1. I'd rather depend on myself than others.

_____2. I rely on myself most of the time; I rarely rely on others.

_____3. It is important that I do my job better than others.

_____4. Winning is everything.

_____5. If a coworker gets a prize, I would feel proud.

_____6. The well-being of my coworkers is important to me.

_____7. Parents and children must stay together as much as possible.

_____8. It is my duty to take care of my family, even when 1 have to sacrifice what I want.

_____9. I often do "my own thing."

_____10. Competition is the law of nature.

_____11. To me, pleasure is spending time with others.

_____12. Family members should stick together; no matter what sacrifices are required.

_____13. My personal identity, independent of others, is very important to me.

_____14. When another person does better than I do, I get tense and aroused.

_____15. I feel good when I cooperate with others.

_____16. It is important to me that I respect the decisions made by my groups.

Appendix C: Self-Construal scale (SCS)

<u>INSTRUCTIONS</u>

This questionnaire measures a variety of feelings and behaviors in various situations. Listed below are a number of statements. Read each one as if it referred to you. Beside each statement write the number that

best matches your agreement or disagreement. Please use a 7-point scale and respond to every statement. Thank you.

1=STRONGLY DISAGREE 2=DISAGREE 3=SOMEWHAT DISAGREE	4=DON'T AGREE OR DISAGREE	5=AGREE SOMEWHAT 6=AGREE 7=STRONGLY AGREE

____1. I enjoy being unique and different from others in many respects.
____2. I can talk openly with a person who I meet for the first time, even when this person is much older than I am.
____3. Even when I strongly disagree with group members, I avoid an argument.
____4. I have respect for the authority figures with whom I interact.
____5. I do my own thing, regardless of what others think.
____6. I respect people who are modest about themselves.
____7. I feel it is important for me to act as an independent person.
____8. I will sacrifice my self-interest for the benefit of the group I am in.
____9. I'd rather say "No" directly, than risk being misunderstood.
____10. Having a lively imagination is important to me.
____11. I should take into consideration my parents' advice when making education/career plans.
____12. I feel my fate is intertwined with the fate of those around me.
____13. I prefer to be direct and forthright when dealing with people I've just met.
____14. I feel good when I cooperate with others.
____15. I am comfortable with being singled out for praise or rewards.
____16. If my brother or sister fails, I feel responsible.
____17. I often have the feeling that my relationships with others are more important than my own accomplishments.
____18. Speaking up during a class (or a meeting) is not a problem for me.
____19. I would offer my seat in a bus to my professor (or my boss).
____20. I act the same way no matter who I am with.
____21. My happiness depends on the happiness of those around me.
____22. I value being in good health above everything.
____23. I will stay in a group if they need me, even when I am not happy with the group.
____24. I try to do what is best for me, regardless of how that might affect others.
____25. Being able to take care of myself is a primary concern for me.
____26. It is important to me to respect decisions made by the group.
____27. My personal identity, independent of others, is very important to me.

____28. It is important for me to maintain harmony within my group.
____29. I act the same way at home that I do at school (or work).
____30. I usually go along with what others want to do, even when I would rather do something different.

Appendix D: Spatial Strategies questionnaire

1) We are interested in the strategies or techniques you used to remember the location of each object during **study phase**. Using a **10-point scale**, with **0 means "never"** and **10 means "all the time"** please rate how often you used each of the following strategies to **remember the location of the objects presented during study phase**.

a) I tried to remember the location of each object based on its **relative spatial relation to me** (e.g., the tortoise in on the second placeholder in the first row to my right)

0	1	2	3	4	5	6	7	8	9	10
Never										**All the time**

b) I tried to remember the location of each object based on its **relative spatial relation to a single landmark** (e.g., Tortoise is on the placeholder right in front of the window in the first row, and flashlight is on the first placeholder two rows away the window).

0	1	2	3	4	5	6	7	8	9	10
Never										**All the time**

c) I tried to remember the location of each object based on its **relative spatial relation to the layout of multiple landmarks or other objects/placeholders** in the courtyard (e.g., Tortoise is on the placeholder right in front of the doorway and it is three placeholders away from the chimney).

0	1	2	3	4	5	6	7	8	9	10
Never										**All the time**

d) Any other strategies. Please describe below:

____

____

____

____

2) Did you notice that there were times when your starting viewpoint changed from study to test phase?

☐ Yes ☐ No ☐ Unsure

3) We are interested in knowing what strategies or techniques you used to **recall** the location of each object **<u>during test phase when your viewpoint DID NOT change</u>**. Assuming there is **no change in the viewpoint** from study to test phase (i.e., same viewpoint), please rate how often you used any of the following strategies, based on a **10-point scale**, with **0 means "never"** and **10 means "all the time".**

a) I tried to <u>recall</u> the location of each object based on its **relative spatial relation to me** (e.g., the tortoise in on the second placeholder in the first row to my right)

0	1	2	3	4	5	6	7	8	9	10
Never										**All the time**

b) I tried to <u>recall</u> the location of each object based on its **relative spatial relation to a single landmark** (e.g., Tortoise is on the placeholder right in front of the window in the first row, and flashlight is on the first placeholder two rows away the window).

0	1	2	3	4	5	6	7	8	9	10
Never										**All the time**

c) I tried to <u>recall</u> the location of each object based on its **relative spatial relation to the layout of multiple landmarks or other objects/placeholders** in the courtyard (e.g., Tortoise is on the placeholder at the corner of the courtyard in front of the doorway, and it is between the Flashlight and the Wall).

0	1	2	3	4	5	6	7	8	9	10
Never										**All the time**

d) Any other strategies. Please describe below:

4) You may have noticed that on some trials, your viewpoint changed from study to test phase. We are interested in knowing what strategies or techniques you used to **recall** the location of each object **during test phase** **<u>when your viewpoint changed</u>**. Assuming that your viewpoint changed from study to test phase, please rate how often you used each of the following strategies using a **10-point scale**, with **0 means "never"** and **10 means "all the time".**

a) When the viewpoint changed I tried to <u>recall</u> the location of each object by **mentally rotating my viewpoint of the courtyard arena to match with my study phase viewpoint** (e.g., if I imagine looking from the initial study phase viewpoint, then I remember the Tortoise is in the first row away from me and on the second placeholder from my left).

0	1	2	3	4	5	6	7	8	9	10
Never										**All the time**

b) When the viewpoint changed during test phase I tried to <u>recall</u> the location of each object based on its **relative spatial relation to me** (e.g., the tortoise in on the second placeholder in the first row to my right)

0	1	2	3	4	5	6	7	8	9	10
Never										**All the time**

c) When the viewpoint changed during test phase I tried to <u>recall</u> the location of each object based on its **relative spatial relation to a single landmark** (e.g., Tortoise is on the placeholder right in front of the window in the first row, and flashlight is on the first placeholder two rows away the window).

0	1	2	3	4	5	6	7	8	9	10
Never										**All the time**

d) When the viewpoint changed during test phase I tried to <u>recall</u> the location of each object based on its **relative spatial relation to the layout of multiple landmarks or other objects/placeholders in the courtyard** (e.g., Tortoise is on the placeholder at the corner of the courtyard in front of the doorway, and it is between the Flashlight and the Wall).

0	1	2	3	4	5	6	7	8	9	10
Never										**All the time**

e) Any other strategies. Please describe below:

5) Did you use one strategy and continued using that same strategy from the beginning to the end of the experiment/task (i.e., for all trials)?

☐ Yes ☐ No

If NO, When and why did this change occur? Pick **ONE** statement that best describes the reason behind the change in strategies

a) I changed strategies as the task progressed
b) I changed strategies as the task got difficult (i.e., when the number of objects increased from 3 to 6 and then to 9 in the courtyard)
c) I changed strategies in relation to viewpoint change (i.e., used different strategies for same view and shifted view trails).
d) I changed strategies randomly
e) I changed strategies due to fatigue
f) Other reasons, please specify below:

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