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Culturally driven biases in preschoolers' spatial search strategies for ordinal and non-ordinal dimensions

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ABSTRACT

Culturally driven spatial biases affect the way people interact with and think about the world. We examine the ways in which spatial presentation of stimuli affects learning and memory in preschool-aged children in the USA and Israel. In Experiment 1, preschoolers in both cultures were given a spatial search task in which they were asked to utilize verbal labels (letters of the alphabet) to match the hiding locations of two monkeys. The labels were taught to the children in either a left-to-right or a right-to-left fashion to assess whether performance on this task is affected by directionality of labeling. English-speaking children performed better on the spatial search task when locations were labeled in a left-to-right fashion, while Hebrew-speaking children exhibited higher performance when labels were taught in a right-to-left fashion. In Experiment 2, English-speaking preschoolers were given a modified task in which the verbal label was a non-ordinal stimulus type (colors). These children showed no subsequent advantage on the task for spatial presentations which were culturally consistent (left-to-right) relative to culturally inconsistent (right-to-left). These findings support the hypothesis that culturally consistent spatial layout improves learning and memory, and that this benefit is reduced or absent when information lacks ordinal properties.

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The provocative idea that language influences thought (Sapir, 1929; Whorf, 1956) has prompted much research focusing on the intersection of language, culture and cognition, which in turn has revealed that the surrounding environment and its accompanying language influences fundamental psychological capacities such as spatial processing and numerical cognition (Boroditsky, 2001 – but see Chen, 2007 and January & Kako, 2007; Bowerman, 1996; Levinson, 1996; McDonough, Choi, & Mandler, 2003; Pica, Lemer, Izard, & Dehaene, 2004). For example, English-speaking adults respond to linguistic stimuli in a spatially biased manner; they tend to draw trajectories of actions along the horizontal plane in the left-to-right direction, draw agents of an action to the left of where they draw objects of actions, and are significantly faster at matching sentences to pictures if the pictures follow these same patterns (Chatterjee, Southwood, & Basilico, 1999). Arabic-speaking adults, whose language is presented in a right-to-left direction, exhibit opposite spatial biases in these tasks, suggesting that a linguistically driven deployment of attention when reading is responsible for these effects (Maas & Russo, 2003).

Studies like these support the idea that spatial associations affect the way we think, and that this influence is a reflection of both our language and the way our cultures orient us toward the world. Further evidence for the strong influences of culture and language has been found in the way that both spatial–temporal and spatial–numeric mappings are modulated by cultural factors. People graphically lay out time in a way that is consistent with the directionality of the language they speak (Tverskey, Kugelmass, & Winter, 1991). Furthermore, people's implicit spatial representations of time vary across languages (Furhman & Boroditsky, 2010). When English speakers were asked to make rapid temporal order judgments, they were faster to make "earlier" judgments when the "earlier" response was made with the left response key than with the right response key while Hebrew speakers showed the opposite pattern.

The SNARC (Spatial Numerical Association of Response Codes; Dehaene, Bossini, & Giraux, 1993) effect, in which lateralized behavioral responses differ depending upon the numerical magnitude presented, is another example of spatial associations influenced by cultural factors. This lateral mapping is seen in studies that support the existence of a conceptual spatial–numerical continuum, or 'mental number line' (Fischer, 2003; Priftis, Zorzi, Meneghello, Marenzi, & Umilta, 2006; Zorzi, Priftis, & Umilta, 2002; see Göbel, Shaki, & Fischer, 2011; Hubbard, Piazza, Pinel, & Dehaene, 2005; Wood, Willmes, Nuerk, & Fischer, 2008 for reviews). Experiments manipulating different factors in an attempt to impact the SNARC effect showed that although the direction of the effect did not vary with handedness or hemispheric dominance, it was influenced by the direction of writing; Iranian-French subjects, whose first Persian language is one written in a right-to-left fashion, showed a faded SNARC effect commensurate with the amount of time spent in a French culture (Dehaene et al., 1993), indicative that the SNARC effect is mediated by degree of literacy in a language. Indeed, a study of multiple populations with varying degrees of Arabic and English literacy showed that the SNARC effect was reversed in Arabic speakers, lessened in bilinguals, and not present in an illiterate population (Zebian, 2005; see also Shaki, Fischer, & Göbel, 2012, for similar results with literate Arabic, Hebrew, and English speakers, and illiterate Amharic-speakers from Ethiopia). Furthermore, individuals bilingual in Hebrew (written right-to-left) and Russian (written left-to-right) exhibited a SNARC effect specific to whichever language had been primed directly before the critical task, demonstrating that cultural frame of mind impacts the manner in which space and number are linked (Fischer, Shaki, & Cruise, 2009; Shaki & Fischer, 2008).

The differences in the SNARC effect as a result of reading directionality (Dehaene et al., 1993; Shaki & Fischer, 2008; Zebian, 2005), as well as the finding that this effect in traditional SNARC tasks does not come about until middle childhood (Berch, Foley, Hill, & Ryan, 1999), are generally taken as evidence that these spatial biases require many years of enculturation. Further, Tverskey et al. (1991) found no consistent impact of language directionality or culture on elementary school children's choice to present information about increasing quantity in a left-to-right or right-to-left manner, although they did find evidence for cultural impacts on time/space mapping by 5 years of age (see also Koerber & Sodian, 2008). However, these findings have been challenged by de Hevia and Spelke (2009), who showed conceptual interference of number during a spatial line bisection task as early as five years of age. Additionally, Opfer and colleagues (Opfer & Furlong, 2011; Opfer, Thompson, & Furlong, 2010) examined spatial–numeric associations in 4-year-olds and showed that even preschoolers expect numbers to be ordered from left to right during both a counting task and when adding or subtracting