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# Right: Left:: East: West. Evidence that individuals from East Asian and South Asian cultures emphasize right hemisphere functions in comparison to Euro-American cultures

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ABSTRACT

We present evidence that individuals from East or South Asian cultures (Japanese college students in Japan and East or South Asian born and raised college students in the USA) tend to exhibit default thinking that corresponds to right hemisphere holistic functions, as compared to Caucasian individuals from a Western culture (born and raised in the USA). In two lateralized tasks (locating the nose in a scrambled face, and global-local letter task), both Asian groups showed a greater right hemisphere bias than the Western group. In a third lateralized task, judging similarity in terms of visual form versus functional/semantic categorizations, there was not a reliable difference between the groups. On a classic, ambiguous face composed of vegetables, both Eastern groups displayed a greater right hemisphere (holistic face processing) bias than the Western group. These results support an "East - Right Hemisphere, West - Left Hemisphere" hypothesis, as originally proposed by Ornstein (1972). This hypothesis is open as to the degree to which social-cultural forces were involved in hemispheric specialization, or the opposite, or both. Our aim is to encourage a more thorough analysis of this hypothesis, suggesting both lateralization studies corresponding to documented East-West differences, and East-West studies corresponding to lateralization differences.

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## 1. Introduction

As Morris Moscovitch's PhD sponsor (PR), it is a particular pleasure to make a contribution in the area of his PhD thesis. His thesis was one of the first in the modern era to use RT to measure interhemispheric communication and hemispheric specialization in neurologically intact people. To carry through the Moscovitch theme, if a person in Toronto stands facing North, her right hemisphere will be on the East side of her head, and her Left Hemisphere will be on the West side of her head. This "alignment" of hemispheres may be more than a spatial trick.

From the early unilateral lesion studies in the 19th century (e.g. by Hughlings Jackson) to the present, the left hemisphere (of right handers) has often been described as more analytic and verbal, and the right hemisphere, as more holistic (among other things, more context sensitive) and spatial (Moscovitch, 1979; Ornstein, 1972; Springer and Deutsch, 1989; Reuter-Lorenz and Miller, 1998). During the last 20 years, one of the main themes of the rising discipline of cultural psychology has been an "East" (primarily Japanese, Chinese and Koreans) versus"West" (primarily Americans and Canadians) contrast between more extensive holism, collectivism, spatial orientation and interdependence in the cultures of East and South Asia, and more emphasis on analysis, verbal formulations, individualism and independence in Euro-American ("Western") cultures (Triandis, 1995; Markus and Kitayama, 1991; Kitayama and Uskul, 2011; Nisbett, 2003). These neurological and cultural framings of mental and social life have developed independently in the academic world. A possible link between the two, with holistic processing more characteristic of individuals from East Asia and analytic processing by Western individuals, was originally suggested by Ornstein (1972), see also Springer and Deutsch (1989). Ornstein linked the left hemisphere with Western thinking, including rational processes, and argued that Western culture, to its disadvantage, downplayed right hemisphere function.

The left-right hemisphere distinction (of right handers) is very familiar in neuropsychology, deriving from discussions and evidence as far back as Jackson (1878/1932), and through work by Milner (1971) and her students (see review in Moscovitch (1979)). The distinction is most clearly illustrated by the work of Roger

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Sperry (Gazzaniga et al., 1962) and his students, including Michael Gazzaniga, Jerre Levy, Colwyn Trevarthen and Eran and Dahlia Zaidel. There is evidence for this basic lateralization from split-brain cases, unilateral brain damage, sophisticated reaction time and error analysis studies of stimuli presented to the left or right visual fields, and brain imaging (reviewed by Bradshaw and Nettleton (1981), Gazzaniga (1995), Moscovitch (1979) and Reuter-Lorenz and Miller (1998)). It is not reviewed here, but is represented by a set of results suggesting a tendency for the right hemisphere to emphasize more holistic, context sensitive processing, more spatial as opposed to verbal processing, more attention to simultaneous as opposed to sequential relations, more judgment of similarity in terms of visual formal as opposed to functional semantic criteria, and more global as opposed to local perception.

It is clear that the bold right-left- dichotomy that has been proposed, featuring the holistic vs analytic distinction, has been oversimplified. For the case of left versus right, evidence indicates that the holistic-analytic distinction is more graded than categorical (Bradshaw and Nettleton, 1981; Beaumont et al., 1984; Behrmann and Plaut, 2015), and that behind a graded holistic-analytic distinction there may be a number of relatively uncorrelated subsystems (Han and Ma, 2014; Liu et al., 2009). Even if the holistic-analytic distinction does not map neatly on to the hemispheres, and even if it is instantiated in somewhat independent systems, it is, nonetheless, pervasive in the literature because, we believe, it captures a characteristic aspect of lateralized processes. One important way that the basic holistic-analytic distinction is realized seems to be in the broader context in which events are embedded and explained in the holistic "mode".

Cultural psychologists have independently arrived at a basic formulation that also emphasizes holistic versus analytic modes of processing, in both the social and cognitive worlds (Markus and Kitayama, 1991) along with an associated broad array or related East-West differences (e.g. Nisbett, 2003; summarized more recently by Kitayama and Uskul (2011) and Varnum et al. (2010)). Just as the left-right hemispheric distinction, the East-West distinction can be formulated in terms of a more holistic tendency in the organization of the world by East Asians (primarily Koreans, Japanese, Chinese; and to some extent South Asians, notably Indians), and a more analytic tendency in Westerners (primarily in the USA and Canada). This cultural holistic-analytic East-West difference is a matter of emphasis, or default modes of responding (Rozin, 2003). More of the holistic-analytic variation in studies carried out so far is within than between culture (Rozin, 2003), and the presumed components of the holistic view may not always hang tightly together. For example, only a minority of standard tests used to measure the holistic approach reliably characterize each of Koreans, Japanese and Taiwanese, as opposed to Americans (Klein et al., 2009). Brain imaging data suggests that holistic-analytic cultural differences may encompass a set of rather independent systems (Han and Ma, 2014). Nonetheless, just as with the brain "dichotomy", holistic and analytic modes of processing keep emerging in the cultural contrasts between East Asian and Euro-American cultures. There is evidence for a similar holistic emphasis, at least in social domains, in Hindu India (e.g., Rozin, 2003). Cultural data also suggest that the holistic-analytic difference is often accompanied by a greater emphasis on spatial frameworks in the "East" and verbal frameworks in the "West".

There is some existing culture-difference literature that relates to the spatial-verbal distinction. One of the best documented East-West differences has to do with spatial superiority in East Asians. Lesser et al. (1965) looked at the profiles of scores on subareas of intelligence tests in New York children of different ethnic backgrounds, and noted a superiority in spatial performance in children of Chinese origin. In a book centered on intelligence in "oriental" Americans, Vernon (1982), observed that "there is the curious but unanimous finding that Orientals of all ages in any cultural setting score higher relative to Euro-Americans on spatial, numerical, or nonverbal intelligence tests, and less well on verbal abilities and achievements." (p. 271). Flynn (1991), in another book, focused on the same issue, and noted this same difference.

There is other cultural evidence indicating a greater reliance on spatial processing in East Asians. Kim (2002) examined performance on the Ravens Progressive Matrices Test in Asian- or Euro-Americans. Instructions to think out loud interfered more with Asian Americans, suggesting that verbal processing interfered with their normal, non-verbal/spatial approach. Other findings from this study indicated greater reliance on "inner speech" in solving potentially spatial problems by Westerners. Tang et al. (2006) showed that in performing digit processing tasks (such as addition), there was greater left perisylvian activation in fMRI images in Westerners, as opposed to Easterners.

Another feature sometimes referred to in the lateralization literature is the dichotomy between "intuitive" approaches (related to holistic), and rational/logical approaches (related to analytic). For a cultural parallel, Buchtel and Norenzayan (2008) reported that East Asians show a preference for intuitive as opposed to rational (logical) accounts, that is East Asians judge intuitive explanations as better. There is other evidence for an association between intuitive processing and East Asian cultures (Norenzayan et al., 2002; summarized in Nisbett (2003)).

Although the culture and brain lines of work have developed quite different and sophisticated paradigms and measures, the same holistic-analytic distinction, with appropriate limitations, arose from both of them. With the hope that these similarities are more than superficial and, therefore, can profit from each other, we propose here a simple and schematic mapping, admittedly in broad strokes, linking the holistic-analytic (and spatial-verbal) dichotomies that were developed separately in the two different fields. A major difference in the approaches is that the cultural approach has paid much more attention to holism in the social domain, illustrated by the notion of the East Asian interdependent self (Markus and Kitayama, 1991; Nisbett, 2003). It has been suggested that social orientation may be the original domain in which holistic/analytic distinction emerged cross-culturally (Varnum et al., 2010), from whence it influenced cognition more broadly.

It is an open question where and when the cultural distinction arises, and what caused it. On a number of different accounts, the cultural difference is a product of different ecologies. For example, rice agriculture requires much more sharing than wheat agriculture, and rice agriculture is associated with more holistic tendencies (Talhelm et al., 2014). It is also possible that the social distinction was prompted by protection against pathogens (Fincher et al., 2008) or that the communal, interdependent social pattern is basic, and that the move to more individualistic pattern reflected in analytic processing has been motivated by a set of ecological changes that can be described as modernization (Greenfield, 2009). Holistic tendencies are notably higher in older as opposed to younger Americans, such that the grandparents of undergraduates are distinctively more holistic and interdependent than their grandchildren, and fall clearly between contemporary Hindu Indian students and American students (Rozin, 2003).

Then, of course, there is the fascinating question about the degree to which brain lateralization has shaped culture, and the degree to which the opposite is the case. Almost certainly, these have been biologically and culturally co-evolving systems. Indeed, as shown elegantly by Behrmann and Plaut (2015) and Dehaene et al. (2010), lateralization of written word recognition, at least in alphabetic languages, is established substantially as reading is acquired; and reading is, of course, a culturally determined event. On Behrmann and Plaut's view, holistic facial processing becomes

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