# *A Review of Lynn C. Robertson's (2004) "Space, Objects, Minds, and Brains"*

Space, Objects, Minds, and Brains. New York, NY: Psychology Press, 2004, 263 pages (ISBN 1-84169-042-2, US$ 55.00 Hardcover)
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As Dr Robertson alludes to despite the fact that *"what"* and *"where"* have entered colloquial language surprisingly little has been published on how these 2 pathways could possibly interact to define space and objects. Moreover, this well-accepted dichotomy is questioned implicitly from a functional standpoint. Robertson's theoretical text proposes that spaces and objects are nested within hierarchical space-object representation reference frames that interact at the most basic levels of perception. Her thesis is that contemporary understanding of object and space perceptual organization continuums and processes should be redefined. Her treatise is convincingly presented through selective review of the literature pertaining to functional neuroimaging, single, and group lesion analysis studies highlighting the rich explanatory role of Balint syndrome in particular.

In Chapter 1, Balint syndrome is examined. Balint syndrome consists of the triad of ocular apraxia, optic ataxia, and simultanagnosia symptoms. This unique and rare syndrome is currently being reevaluated in the literature as an important means of studying object-based and space-based attentional systems with contemporary cognitive neuropsychologic paradigms and techniques. In this situation an object can be perceived however it may not be able to be located such that the external space outside of bodily awareness seems fragmented to the patient. We are presented with a theory that Cartesian reference frames of objects and spaces do not necessarily follow the isomorphic rule of 3-dimensional invariants of the outside world modeled one-to-one to the space-object representations of ones mind. Difficult concepts are well depicted by the inclusion of diagrammatic Gestaltist visual illusion examples and illustrations repeatedly presented throughout the text in tutorial format. Robertson introduces us to a new paradigm in part based on Ivry and Robertson's (1998) popular *The Two Sides of Perception* in which global-local frames act as "channel selectors" between hierarchical object-space reference frames.

In Chapter 2, orientation of the viewer with respect to a display, sense of direction, and gravity-based frames are described as quasi object/space attributes. These attributes contribute to the structure of multiple spatial reference frames nested in a hierarchy of top-down and bottom-up influences. For instance object reference frames include elongation, symmetry, base, proximity, grouping, common fate which collectively together can change the referent orientation. Origin of a reference frame, reflectional symmetry, unit size, and spatial scales are described as the building blocks of these Cartesian frames. The center of mass principle illustrates how much of a display can be encoded implicitly before visual search is initiated. Orientation within a reference frame is thus discussed as an example of an object-spatial attribute that is represented at initial levels of visual processing. In this context the enlargement of receptive fields, concrete → abstract continua and feedback loops to lower level cortex along the caudal to rostral frontotemporal cortices seem to play an important role in higher-order object perception and identification mechanisms.

In Chapter 3, serial and conjunctive search are contrasted and Kinsbourne's early model of linguistic modulation of the rightward attentional bias is discussed in the context of collicular mutual inhibition and facilitation by ipsilateral parietal and frontal regions. The case is compellingly presented that space has both spatial and representational attributes and that viewer-, gravity-, object-, and scene-centered spaces all interact. Internally generated and purely representational spatial reference frames can readily account for the diversity of such findings. The zoom lens model of spatial reference frame construction and "channel selection" between such relational nested hierarchical space-object representations on the basis of specific task parameters fits the pattern of performance of relevant neuropsychologic case studies.

In Chapter 4, Egly's rectangle experiments are reviewed. These were among the first to demonstrate unambiguous object-based attention effects. Subsequent studies then showed us that these effects were modified by object-based attributes such as connectedness, coherency of reference frames, and closure. Inhibition of return is argued to be a space as opposed to object-based characteristic and object-based attention effects at both long and short stimulus onset asynchronies seem to facilitate priming. Finally, on the basis of early studies of callosal subject's localization of object-based versus space-based attentional effects hemispheric differences in function are reviewed by Robertson. She questions then whether the right dorsal stream is dominant in the right hemisphere and/or if the ventral stream is dominant in the left hemisphere.

In Chapter 5, the case of RM is reviewed as an example of how Balint syndrome results in disruptions of both space and awareness. The difficulty in selecting between global and local elements in a display seems to co-occur with problems in colocating 2 simultaneously presented objects in this disorder. Therefore, although these patients can "see" an object or part of an object their visual resolution mechanisms seem to randomly focus in and out of view. At the same time the ability to describe in detail an object without knowing its location provides us with a glimpse of a pure dissociation between functioning of object and space-based attention

systems. Finally Robertson reiterates that there are many ''where systems'' involved in representing viewer, retinotopic, and extrapersonal space and that these maps are integrated within the posterior parietal cortex with lower-order spatial/object representations nested within higher-order representations.

Illusory conjunctions involve combinations of items such as shape and color detected independently and misconjoined—Chapter 6. Because Balint's patients produce elevated rates of illusory conjunctions these subjects provide a natural opportunity to study mechanisms of binding in the brain. Convergent studies demonstrate that the parietal lobes are involved in feature integration and that distance manipulations between items in an array affect the magnitude of illusory conjunctions. The latter effect demonstrates that top-down effects influence processing in early visual cortices and that parsing of an array seems then to be strongly influenced by information from higher-level object-recognition systems. Robertson then reviews some evidence for the interaction of the 2 processing streams and connectivity patterns between the dorsal stream parietal cortex and the ventral stream occipitotemporal cortex. Current techniques such as diffusion tensor imaging could be a useful structural adjunct in addition to cognitive neuropsychologic investigations of putative individual differences in intrahemispheric and interhemispheric connectivity between these regions (eg, see Ref. 1).

In Chapter 7, Robertson summarizes for us a number of key findings: the parietal cortex is necessary for conscious spatial maps; many features and/or their conglomerations can be detected without conscious awareness; with damage to the parietal cortex attentional change over between local and global frames is severely disrupted; and that ventral stream-parietal interactions are necessary for the location of objects. We are repeatedly reminded throughout the text that modifications of Posner's original cueing paradigms have been used for quite some duration now and that everything from figure-ground organization, to semantics, to procedural memory can be represented below the level of awareness and that there is as yet much to know.

The task which Robertson has undertaken in this text was quite ambitious however I think that with her systematic and careful review of the literature she has succeeded in her goal. Recent evidence is emerging that the intraparietal sulci do in essence function as ''channel changers'' whether selecting between objects or spaces.[2] Some of the interesting theoretical implications of Dr Robertson's text are that identity of objects and perhaps events could possibly be determined from multiple sightings of where. The inverse function, that being, that location could be approximated from multiple determinations of the identities of objects or events also seems plausible in this hybrid model of the interaction of object/space systems. This is an excitingly written, well-illustrated and highly accessible text that every neuropsychologist, behavioral neurologist, and cognitive neuroscientist interested in object recognition and/or visual attention should have on their bookshelf.

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## REFERENCES

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