When Facts Go Down the Rabbit Hole: Contrasting Features and Objects as Indexes to Memory

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Contrasting Features and Objects

When asked to recall semantic information, our participants attempted to fixate the same object they had seen before, not another object that looked the same. This suggests they do not primarily associate a fact with a set of visual features, but rather with a specific object. On the basis of spatiotemporal continuity, an object is tracked as it moves around the world and refixated when relevant. We have mounting evidence that people do attach non-visual semantic information to objects in the world (Richardson & Spivey, 2000; Richardson & Kirkham, 2004). What purpose does this serve?

Object tracking is explicitly irrelevant to our task, and indeed, looking at certain locations rather than others does not seem to confer a performance advantage. One interpretation of this puzzling behaviour on the part of our participants draws on the notion of 'external memory'.

The external memory model holds that we do not attempt to store an accurate or exhaustive memory of the world, rather we keep in mind only information that is related to the task at hand. If more information is needed, we can access it from the external world (Ballard, Hayhoe, Pook, & Rao, 1997). In other words, we use the world as an 'external memory' store (O'Regan, 1992), looking up information in the world rather than looking it up in our memory (Clark & Chalmers, 1998).

One source of evidence for this claim comes from studies of change blindness (Hayhoe, Bensinger & Ballard, 1998; Rensink, O'Regan & Clark, 1997; Simons & Levin, 1998), in which large changes made to the external world by experimental sleight of hand go unnoticed. The participants do not detect the sudden discrepancy between the world and their memory of it, because, the argument goes, they do not maintain such a memory. Rather, they use the external world as a memory store, accessing information in its 'own best representation' (Brooks, 1991) if and when it is required. Despite these impressive change blindness demonstrations, it is clear that we are capable of remember a large amount of visual (Standing, 1973) and non-visual information (Bahrick, Bahrick & Wittlinger, 1975). How do we reconcile the brain's vast capacity for information in some tasks, with its apparent willful disregard of details in change blindness paradigms?

Hollingworth (2005) argues that standing between the transient perception of a scene and long term memory is a mechanism of object-based attention. In a series of experiments, he finds that participants are carrying more than the gist of a scene across observations; they are capable of detecting slight changes to specific objects. This memory for detailed visual scenes can be robust, even after substantial delays (up to 24 hours). Why do we retain some aspects of a scene in these experiments, but not in other change blindness paradigms? Hollingworth (2005) argues that during scene perception, an object-based attention mechanism activates higher-level representations. These are retained briefly in visual short-term memory (VSTM) and then consolidated into visual long-term memory (VLTM). While information in VSTM is quickly overridden, robust, detailed memory for visual scenes can be stored in VLTM. Participants will not detect changes to information that was only present in VSTM, but will retain information passed onto VLTM. This object- based attentional mechanism is essential to achieving the pragmatic balance between exhaustively representing all details of a visual scene and retaining nothing in long-term memory.

What Hollingworth (2005) argues for scene perception, we argue for semantic memory. A mechanism of object-based attention stands between information in the external world and information in memory. It might be the case that we use the world as its own best representation, but every system of information storage needs a system of information retrieval. We claim that sources of external memory are indexed, tracked using spatiotemporal continuity, and refixated as necessary. This object-based attentional mechanism allows external memory to function in a world where objects move and visual features shift and change.

In our paradigm, refixating areas of the screen does not appear to help participants answer the factual questions. This is because, at test, there is no visual information available to provide contextual support for memory. This is a (deliberate) quirk of our design: in the real world, objects tend not to disappear and a refixation would bring in useful information. The fact that participants continue to fixate particular, uninformative mounds of earth in our paradigm reveals the robust nature of spatial indexing, and suggests that it is drawn from both the "what" and "how" systems of processing (Goldman-Rakic, 1993; Landau & Jackendoff 1993; Milner & Goodale, 1995). This indicates that encoding location information with semantic information is not simply crosstalk between these two systems, but rather a deliberate, intentional behaviour that allows us to recall information in its richest level of detail: the external world.