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Fast mappers, slow learners: Word learning without hippocampus is slow and sparse irrespective of methodology

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Abstract

Rapid word learning without hippocampus is an alluring prospect — it holds the promise of remediating a common learning deficit associated with aging (healthy or pathological) and certain neurological conditions. Despite recent reports indicating rapid, non-hippocampal word learning by amnesic adults after contrastive “fast-mapping” exposure, several replications have failed. These failures stand in contrast to successful but slow learning by amnesic patients under other conditions, and this pattern suggests that rapid word learning in adulthood is hippocampus-dependent and relational irrespective of learning format. However, much remains to be studied, and important methodological and theoretical considerations are highlighted here.

Keywords

Fast mapping; hippocampus; relational memory; amnesia; word learning

Commentary

Word learning requires binding arbitrarily-related auditory, object, orthographic, and conceptual information, and learning new arbitrary relations requires the hippocampus (Davachi & Dobbins, 2008; Eichenbaum & Cohen, 2001; Ranganath, 2010). A prediction which follows is that adult word learning will be severely disrupted by hippocampal damage, and this prediction is upheld by neuropsychological studies of patients with hippocampal amnesia and severe word learning deficits (Duff, Hengst, Tranel, & Cohen, 2006; Gabrieli, Cohen, & Corkin, 1988). When amnesic patients did learn new words, the learning was slow and attenuated relative to healthy individuals. Thus, the finding that amnesic patients learned new words from a contrastive, fast-mapping format (and not from an explicit encoding format) (Sharon, Moscovitch, & Gilboa, 2011) generated great excitement, but failures to replicate that finding raise questions about the generalizability of fast word learning without hippocampus. We agree with Cooper et al. (2018) who suggest much remains to be studied in this domain, and we highlight terminological, conceptual, and methodological issues that

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we believe are critical to improving reproducibility and developing consensus regarding fast mapping.

Using precise terminology to discuss fast mapping is important because the literature has applied certain labels inconsistently. Here, we describe the immediate association of an unfamiliar word (often auditory) with an unfamiliar stimulus (often visual) as fast mapping (FM) to distinguish that on-line process from putative word learning from fast mapping (WL_{FM}) or other means (e.g., explicit encoding, WL_{EE}). In studies of rapid WL by amnesic adults, FM has frequently implied WL, and moreover, a less efficacious form of WL (i.e., $WL_{FM} < WL_{EE}$). This appropriation belies FM's origins in the literature of language development (Carey & Barlett, 1978) and the inclusive application of FM to describe various contrastive learning paradigms and behavioral effects (Carey, 2010). We suggest that FM be reserved to describe on-line processes of referent selection.

Having established a terminology, we note that studies of FM often focus on WL outcomes, but FM paradigms offer multiple measurement opportunities. While new word knowledge is always measured during a test phase, FM paradigms also tax existing word knowledge during referent selection — successful task performance depends on applying existing knowledge to discriminate familiar from unfamiliar stimuli. Critically, behavior during referent selection and test phases provide unique insight into the contents and plasticity of participants' lexicons; both should be carefully measured.

Furthermore, employing multiple measures in each phase is important because learning can occur in distinct brain systems which support different types of expression (Cohen & Squire, 1980). Using explicit and implicit measures is especially important for studies of WL_{FM} because — if memories produced by FM and EE are supported by different brain systems — those memories may afford different degrees of explicit expression. Measures of response time, eye movements, brain activity, and other variables alongside traditional explicit measures may provide useful insight into putatively dissociable brain systems for WL.

Beyond enriched measurement, FM paradigms should also avoid common methodological confounds. First, because outcome measures often include explicit tests of WL, prior knowledge of words putatively learned intraexperimentally is a potential confound. This can be addressed by measuring familiarity with words before and after learning exposures or by using pseudoword stimuli. Second, there is potential for intraexperimental inference during test phases which could make chance performance an inappropriate baseline for comparison. This confound can be addressed by testing naïve participants with the same materials (see Warren & Duff, 2014; Warren, Tranel, & Duff, 2016).

The allure of WL_{FM} is clear: adults with memory impairments attributable to hippocampal damage/dysfunction could learn words with one contrastive exposure (Sharon et al., 2011). Unhappily, failed replications suggest the early promise of WL_{FM} will not be fulfilled (Table 1, Cooper et al., 2018). Disappointment with this outcome should be tempered, however, by recognition that other learning techniques for memory-impaired groups have replicated across studies, labs, and populations. For example, errorless learning and collaborative referencing have produced potent, durable, and/or explicitly-expressed associations between

unfamiliar stimuli and specific keywords or behaviors in amnesic samples (Baddeley & Wilson, 1994; Duff et al., 2006; Glisky, Schacter, & Tulving, 1986). However, these findings also have important limitations that are consistent with relational memory theory (Eichenbaum & Cohen, 2001) — learned associations are non-arbitrary and/or learning by amnesic patients is slow and sparse. Thus, empirical findings in amnesic WL support a necessary role for the hippocampus in WL specifically and semantic memory broadly (Duff et al., 2006; Klooster & Duff, 2015).

In conclusion, we note that FM did not initially describe a phenomenon yielding full-fledged word learning. Instead, FM represented one means of incrementally updating an individual's lexicon. We suggest that: 1) findings reported over the intervening decades affirm this perspective; 2) current evidence for specialized, latent, non-hippocampal word-learning brain systems in adults is not convincing; and 3) WL_{FM} is broadly similar to word learning by other means.

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