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Postscript: Through TCM, STM Shines Bright

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We find the reply by Kahana, Sederberg, and Howard (2008) helpful in clarifying the temporal-context model (TCM) function, in particular with regard to the elimination of the recency effect by a difficult distractor under parameters that still enable long-term contiguity effects to emerge. We agree with Kahana et al. that what matters most to the understanding of memory is the testing of models against actual data, while attempting to maintain the criterion of parsimony. We welcome, therefore, the challenge offered by this exchange, which has produced quite a number of novel predictions (see below). Still, we are not convinced that TCM has been successful in offering a satisfactory account for memory dissociations between long- and short-term recency, that it is able to flexibly discriminate and recall items from different lists, or that it is more parsimonious than is our dual-store model. Our arguments have implications for the wider debate about short-term memory (STM) and long-term memory (LTM).

TCM is unsuccessful in providing an accurate account of the data in several ways. First, out of a number of dissociations between immediate and continuous-distractor free recall (CDR), TCM was able to produce a good account for, at best, one dissociation (the interaction of lag recency with output order) and a partial account for two others (amnesia and proactive interference). In both of these cases, TCM accounts for the immunity of only one recency item (from proactive interference or amnesia), rather than an immunity over an extended range of three to four recency items, as found in the data; this is so even if one assumes that, contra the experimental data of Greene (1986), proactive interference is equivalent to a longer list. Other dissociations, such as semantic contiguity effects (Davelaar, Haarmann, Goshen-Gottstein, & Usher, 2006; Howard & Kahana, 2002b), negative recency, and directed output order (discussed in Davelaar, Goshen-Gottstein, Ashkenazi, Haarmann, & Usher, 2005), have not been addressed by TCM. In addition, recent data present a further dissociation between immediate free recall and CDR: in a measure of conditional recency, the likelihood of reporting the last item, if it was not yet reported, as a function of output (Farrell, 2008; available online at http://seis.bris.ac.uk/~pssaf/publications.html). Accounting for this dissociation should be an important test for memory models. Second, TCM needs to invoke an unspecified rehearsal (or strategy) mechanism (which has been associated with STM since the advent of dual-memory models) to account for non J-shaped (or sigmoidal) serial-position functions in paradigms that examine only one item per list (first-recall immediate free recall and cued recall, the latter being used precisely in order to minimize the use of strategies). Third, to account for the increased primacy with presentation rate, Kahana et al. (2008) explicitly enhanced TCM's primacy gradient, which differentially affects the learning rate of the early items but does not affect the evolution of context. This seems to imply two processes: a recency-based process for context and a primacy-based process for episodic learning, which is (again) reminiscent of dual-memory models. Finally, contra to what Kahana et al., claimed, a dual-store simulation of presentation rates provides fits to the serial position functions, which are at least as good as the TCM ones, with no change in parameter values other than presentation duration across conditions (for details, see http://www.bbk.ac.uk/psyc/staff/academic/eddyjdavelaar/postscript).

We agree with the proponents of TCM that context is essential to memory function. Various types of context have been intensively discussed in the traditional literature, from list context (Anderson & Bower, 1972; Raaijmakers & Shiffrin, 1981) to task context (Cohen & Servan-Schreiber, 1992) or to the context of spontaneous thoughts (which could map onto random fluctuation models; e.g., Mensink and Raaijmakers, 1988). The TCM context is similar to the latter but with context driven by the presented-list material. As TCM context is not independent of the items presented in the memory test but, rather, is a recency-based weighted average of the item information (Howard & Kahana, 2002a; Sederberg, Howard, & Kahana, 2008), we have argued that it is more similar to a type of short-term store, although of a different type than the traditional one. Although such a temporal context (or buffer) allows one to make recency discriminations, this is unlikely to be flexible enough to perform source discrimination and recall from multiple (nonrecent) lists. This is because the temporal-context mechanism does not contain list-context representations and does not possess independent access to such representations. For example, although TCM could try to account for source-memory discrimination on the basis of recency, this would make the counterintuitive prediction of increased confusion errors at the first item of a current list and at the last item of a previous list. Furthermore, as it does not contain independent access to list-context representations, it would not be able to differentially retrieve items from different lists subject to task demand (see the nested modeling approach by Jang & Huber, 2008, which converged on separate list contexts to account for their data). We look forward to seeing how the TCM will be extended to perform list discriminations (Polyn, Norman, & Kahana, 2008). Our main point is that, because other types of (nontemporal) context will doubtless be added to provide a full account of recall from multiple lists, one gains conceptual clarity by distinguishing—as dual-store models do—between these more traditional types of context and the temporal one (which is equivalent to an STM buffer). To summarize, unlike TCM, dual-store models of the type we presented (Davelaar et al., 2005), where there is an item-independent access to context, may be in a better position to mediate both list discrimination and recall while also accounting for encoding effects, such as the presentation rate, as a result of the buffer dynamics.

We do not wish to conclude that TCM is not a helpful model. Indeed, perhaps it will be possible to extend the model to deal with all the issues we raised. What we want to argue is that, even if this were the case, there is very little to convince us that it would help to demonstrate the redundancy of a dual-store approach in memory. To make the case for redundancy, Kahana et al. (2008) conceived of the STM/LTM distinction, in terms of retrieval rules, with dual-store models committed to separate retrieval rules, whereas TCM is committed to a single, cue-driven rule. Although separate retrieval rules (e.g., first unload items from the buffer and then retrieve from LTM) provide a helpful heuristic employed in the early dual models, no one—not even the most ardent dual-store purists—would ever dispute that all retrieval is cue driven (otherwise, one would continuously say aloud whatever is within one's conscious span). Moreover, the idea that STM is subject to control is a main theme of the dual-store model (Atkinson & Shiffrin, 1971), and surely, a cue-driven process is necessary to mediate performance in cued recall, even for recency items (Altmann & Schunn, 2002; Shiffrin, 1993; Usher & Davelaar, 2002). Moreover, we have demonstrated in Appendix B of Davelaar et al. (2005, p. 38) that a cue-driven retrieval validates the classical retrieval rule (retrieve first the items in the buffer) and does so in an order (starting with earlier ones) that helps to account for the interaction between lag recency and output order. So, if the cue-driven retrieval is not a core distinction for the dual-store theory, what do these distinctions involve? We suggest that the important distinction between items in the short-term store and those in the long-term store is one of accessibility (including consciousness) and of encoding operations. It is indeed an assumption of dual-store models that encoding operations can be made on items coactive in the buffer (Raaijmakers & Shiffrin, 1981). To the extent that relations between words affect the encoding in immediate or delayed free recall differently from in CDR (Davelaar et al., 2006; Howard & Kahana, 2002b), this supports the core dual-memory assumption. In this spirit, we predict stronger effects of semantic clustering and of semantic isolates in free recall, compared with CDR (see also Howard & Kahana, 2002a). Furthermore, the dual-memory approach has received converging evidence from neuroimaging studies that show different brain areas activated during the retrieval of early, compared to late, list items (Talmi, Grady, Goshen-Gottstein, & Moscovitch, 2005).

To conclude, we believe that the field has evolved substantially since the early days when dual-store models were first presented (Atkinson & Shiffrin, 1968; Waugh & Norman, 1965), provoking a reaction from single-memory theorists (Crowder, 1982; Melton, 1963). During this time, research has been ongoing, which was inspired by both approaches. Although we found our inspiration in the dual-store approach, TCM has been framed within the single-store framework. The fact that these models now share quite a number of commonalities demonstrates that the field has reached some maturity and convergence, so that the existence of some type of short-term store is not really under dispute, but its functional properties are.

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