Letters Response

Response to Altmann: Adaptive forgetting by decay or removal of STM contents?

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Altmann raises two objections to our conclusion that short-term forgetting is caused by interference rather than decay [1]. He (i) makes the functional argument that decay is needed for cognitive ‘garbage collection’ and (ii) offers supporting task-switching data that show that responding to an identical task slows over trials in a run, ostensibly because the task set decays.

We agree with Altmann on several points but disagree with his principal conclusion. We agree that (i) functional approaches to forgetting are important; (ii) no model of short-term memory (STM) is viable without a mechanism to purge outdated contents and (iii), interference is very potent. We also agree that Altmann’s findings require an explanation, and we applaud his rigorous modeling [2]. We disagree, however, that Altmann’s arguments and results implicate decay, for three reasons:

First, the mere presence of forgetting when it is functionally beneficial (e.g. Ref. [3]) neither justifies nor mandates an appeal to decay, as opposed to some other source of forgetting (as acknowledged by Ref. [3]). Can functional arguments at all illuminate the causes of forgetting? There is a very strong functional case for the selective and rapid removal of STM representations that have become irrelevant (e.g. intermediate sums during mental arithmetic). We know that people can remove STM contents rapidly (1–2 s; [4]) and selectively [5]. Non-selective and slow decay as envisioned by Altman cannot serve this purpose – as evidenced by the fact that Altmann’s own model [2] needs self-priming to counteract the corrosive effects of decay on the current task set. By contrast, the response suppression mechanism embodied in some interference models (e.g. Ref. [6]) is perfectly suited for instant and selective removal.

Second, slowing across trials within a run is of limited generality. In object-switching paradigms, the opposite happens: access to the same memory object accelerates within a run and slows after switching to another object [7]. In Altmann’s own data [8], ‘acceleration’ is initially observed and slowing emerges only after considerable practice, suggesting that slowing is tied to people learning that runlengths are predictable. In support, acceleration rather than slowing is observed when runlength is unpredictable (Experiment 2 in Ref. [9]).

Finally, when slowing does occur, is decay required to explain it? One alternative explanation is that competing task(s) are inhibited and gradually recover from inhibition. Direct evidence for inhibition and recovery from it is provided by the finding that reverting to an earlier task becomes easier as time passes [10]. This runs counter to a decay explanation, and it is therefore unsurprising that Altmann’s model [2] cannot explain these crucial results. Further direct evidence against decay in task switching was provided by Logan [11].

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Box 1. Modeling runlength effects without decay

Faster forgetting over trials when runs are short need not implicate adaptive decay because run length and memory interact in temporal distinctiveness models (SIMPLE: Ref. [12]) without assuming decay or changing parameters. In SIMPLE, confusability of memories i and j is a power function of the ratio of their temporal distances t_i and t_j at retrieval time: $(t_i/t_j)^c$; $t_i < t_j$. An item’s distinctiveness (and hence retrievability) is inversely related to its summed confusability with other items. Consequences include (i) better memory of recent material (current task instructions) when interfering material is temporally distant (long runs condition) and (ii), relative recovery (of previous task instructions) over time (see Figure I).

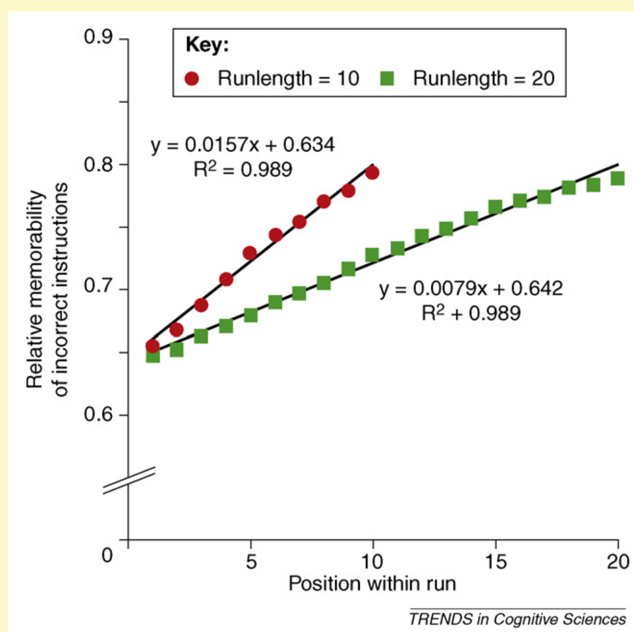

Figure I. The figure shows simulation results of SIMPLE, plotting the predicted memorability of all instances of incorrect instructions relative to equivalent memorability of correct (current) instructions. (Simulation of 20th run; runlength 10 or 20; $c = 1.5$; task instructions in random order; inter-trial interval 0.5 s.) The relative availability of the incorrect set increases over trials, and does so twice as fast for short runs. Thus, temporal distinctiveness allows faster forgetting for short runs without invoking decay or parameter adjustment.

A second alternative perspective on the results, particularly on the interaction with run length, is provided by a temporal distinctiveness model (Box 1).

In summary, forgetting is adaptive and functionally necessary but its function over the short term is best served by active removal of STM contents, which can be selective and rapid. Trace decay is unsuitable for its presumed functional purpose and it is unsupported by the task-switching data.

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