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An improved algorithm for predicting free recalls

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Abstract

Laming [Laming, D. (2006). Predicting free recalls. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 32*, 1146–1163] has shown that, in a free-recall experiment in which the participants rehearsed out loud, entire sequences of recalls could be predicted, to a useful degree of precision, from the prior sequences of stimuli and rehearsals. This article describes an improved predictive algorithm, which is then used to re-analyse two further sets of free-recall data. Prediction is compared, generically, with conventional modelling, represented here by three recent models of free recall that are concerned with recalls only, not with rehearsals. Some implications are drawn, from the use of rehearsal data by the predictive algorithm, for some of the constituent assumptions embodied in those three models.

Keywords: Free recall; Prediction; Rehearsal; Retrieval from memory

1. Introduction

Participants in free recall experiments not only recall, they also, commonly, rehearse the words they are asked to remember as those words are being presented. The idea that the process that generates rehearsals is the same process that subsequently retrieves words for possible recall was first mooted long ago[1] and, more recently, Tan and Ward (2000) have analysed rehearsal as a series of interim recalls. But how can such an idea be tested? If it

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[1] J. Metcalfe, unpublished research note, 27th December 1975.

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can be shown that rehearsal and recall are based on the same underlying process, then the study of free recall can be enriched and our collective understanding deepened by the analysis of rehearsal data. But the relationship between rehearsal and recall must be established first.

The existence of such a relationship can be demonstrated by using the rehearsals, from experiments in which participants have rehearsed aloud, to predict the subsequent recalls. Envisage a model that generates a sequence of rehearsals. Set that model to run on beyond the point at which the participant is asked to begin recall, retrieving further words for rehearsal. That sequence of model rehearsals is then compared with the observed sequence of recalls. If the two match, the relationship is established.

I have recently (Laming, 2006) re-analysed the raw data from the overt rehearsal condition of Murdock and Metcalfe (1978) and shown that entire sequences of recalls can be predicted in this way from the sequence of stimuli and rehearsals uttered during presentation of the list. The predictions take the form of multinomial distributions prescribing a probability for each word still available for recall (e.g., Fig. 2 below), such that recalls occur with frequencies proportional to the predicted probabilities (Exact predictions, identifying the recalls uniquely, are not at present achievable).

This amounts to a new technique for studying free recall and, indeed, any memory task in which participants can be induced to verbalise their thoughts during completion. At present studies of free recall and other tasks are hindered by a lack of access to internal mental operations. It has long been known that there are thoughts and ideas passing through participants' minds that do not immediately issue in a response. Hitherto study of these internal processes has amounted to little more than informed conjecture. The utilisation of rehearsals in predicting recalls places the study of free recall on a more detailed footing.

Prediction is possible because there is a high-level relationship between the sequence of stimuli and rehearsals during presentation of the list and the subsequent sequence of recalls. I assert that that relationship exists, first, because there is a similar relationship between the sequence of thoughts and ideas in participants' minds and the subsequent sequence of recalls and, in free recall experiments, the sequence of stimuli and rehearsals is a copy, though possibly an incomplete copy, of that sequence of thoughts and ideas; and, second, because the process that generates recalls is the *same* process that generates rehearsals, subject only to the constraint that recalls are seldom repeated. Prediction succeeds when the high-level relationship is approximated with sufficient numerical accuracy. Accurate approximation requires a suitable model of the rehearsal process, and in this way we can study the internal process that retrieves words for both rehearsal and recall.

But reanalysis of just one set of data is hardly sufficient to establish such a relationship. As a matter of principle, the exercise needs to be repeated. So, in this article, I reanalyse two further sets of data: (a) some hitherto unpublished data by Metcalfe, preliminary to the overt recall data in Murdock and Metcalfe (1978) and (b) half of the data from Experiment 1 (the 24 participants from the University of Toronto) by Brodie and Murdock (1977). Moreover, success with one set of data might be dependent on particular properties of that dataset that are not shared with other sets of data. What is needed is a predictive algorithm that works with many different sets of data. These two further re-analyses force several changes in the original algorithm to enable it to accommodate all three sets of data.

In case this exercise of predicting free recalls should seem remote from current theoretical issues, I explain why it matters. Ever since Murdock's (1962) exploration of the serial