A SIMPLE Account of Baddeley & Scott (1971)

IAN NEATH
Memorial University of Newfoundland

The data reported by Baddeley and Scott (1971) is usually interpreted as showing forgetting in short-term memory in the absence of interference. Given the absence of interference, the cause must be decay. SIMPLE (Brown, Neath, & Chater, 2007), a local distinctiveness model of memory, was able to fit the data quite well with no difference in the parameters for the 3, 5, and 7 item lists ($R^2 = 0.937$). Given that the only difference in the three conditions is the number of items in the list and the relative temporal distinctiveness, this account attributes forgetting in the absence of proactive interference to intra-sequence interference.

Forgetting in the Brown-Peterson paradigm (after Brown, 1958, and Peterson & Peterson, 1959) has long been used as evidence for rapid rate of information decay in short-term memory.

In most versions of the task, the subject sees three items (usually consonants) and is asked to recall all three items in the correct order. The subject engages in a distractor task between the end of presentation and recall to prevent rehearsal; the delay is typically between 3 to 30 s. The typical result is that after a relatively short delay (e.g., 20 s), recall of the items is close to floor.

Keppel and Underwood (1962) demonstrated, however, that if you examined performance on the very first trial of Brown-Peterson task, there was no difference in performance in the various delay conditions: it did not matter whether you had counted backward for 3 s or 18 s, performance was equal in the two conditions.

This suggests that forgetting in the Brown-Peterson paradigm is not due to decay of information in short-term memory but rather is due to the build-up of proactive interference (PI).

One problem with this interpretation comes from a study by Baddeley and Scott (1971). They tested 424 undergraduates on a single trial in a Brown-Peterson paradigm but with delays up to 36 seconds. Some subjects received 3 items, some 5 items, and some 7 items. The data are shown in the Figure 1 as the open symbols. Baddeley and Scott argued that the figure shows clear evidence of decay. Proactive interference could not be causing the forgetting, because there were no previous trials. Similarly, retroactive interference from the distractor task could not be causing the forgetting because Baddeley and Scott used a letter copying task and letters are sufficiently different than digits, the to-be-remembered items (Wickens, Born, & Allen, 1963).

The final possible source of interference would be intra-sequence effects (Melton, 1963). Baddeley and Scott (1971) argued against this view due to lack of empirical support in the literature. Given that these three sources of interference have been ruled out, all that remains to explain the forgetting is decay.

The purpose of the current paper is to see if a model that does not include temporal de-
cay can fit the data.

SIMPLE

SIMPLE (Scale Invariant Memory and Perceptual Learning) has been described in detail elsewhere (Brown, Neath, & Chater, 2007; Neath & Brown, 2006). Here, the purely temporal version of the model is used.

Items are represented as the log-transformation of the time of presentation relative to the time of recall. The similarity, $\eta_{i,j}$, between two memory representations with values $T_i$ and $T_j$ on a particular psychological dimension is given by Equation 1:

$$\eta_{i,j} = e^{-c|T_i - T_j|}$$

The main free parameter in SIMPLE is $c$: Higher values of $c$ correspond to greater distinctiveness of memory traces, i.e., less influence of more distant items.

The probability of producing the response associated with item $i$, $R_i$, when given the cue for stimulus $j$, $C_j$, is given by Equation 2, in which $n$ is the number of items in the set:

$$P(R_i \mid C_j) = \frac{\eta_{i,j}}{\sum_{k=1}^{n} \eta_{j,k}}$$

A sigmoid function is used to implement output interference by increasing recall probabilities that are already high, and reducing recall probabilities for items whose recall probabilities are already low. Equation 3 shows the implementation, which calculates output probability, $P_o$, based on the estimated recall probability, $P$, from Equation 3:

$$P_o = \frac{1}{1 + e^{-s(P-t)}}$$

The parameter $t$ is the threshold and parameter $s$ is the slope of the transforming function (which can be interpreted as the noisiness of the threshold). For example, if $t$ is set to 0.8 and $s$ is very large, the transformation will approximate a system that recalls all items with relative strengths greater than 0.8, and omits all items with strengths less than 0.8. As $s$ becomes smaller, the transition from low to high recall probabilities becomes more gradual.

There are thus 3 free parameters: $c$, the main parameter; $s$, the slope; and $t$, the threshold.

SIMULATION

The basic assumptions underlying the simulation are the same as those used by Brown et al. (2007) to model other Brown-Peterson data.

Baddeley and Scott (1971) presented the 3, 5, or 7 digits at a rate of 1 s per item. Then, 1 s following this, there was a distractor period that lasted 0, 3, 6, 9, 18, or 36 seconds. For the 3 item list in the 0 s delay condition, the temporal values would have been 3, 2, and 1, respectively, for items 1, 2, and 3. In the 3 s delay condition, the same values would be 6, 5, and 4. It was further assumed that it took 1 s to output each response at the time of recall; therefore, 1 s was added to these values when calculating the probability of recalling the second item, an addition 1 s was added when calculating the probability of recalling the third item. The temporal values underwent a log transformation (see Brown et al., 2007, for rationale).

The parameters were set to the following values: $c = 0.547$, $s = 23.131$, and $t = 0.139$. Note: the same parameter values were used for all three list lengths and all delays. The results are shown as the lines in Figure 1. For this particular fit, $R^2 = 0.937$. 
Clearly, the model is capturing the appropriate pattern of results. More importantly, it does so using the same parameter settings for all conditions. The worst fit is for the 5-item condition. However, it is not clear from the data whether the final point (36 s delay) really should be as low as it is, or if the 9 and 18 s points are too high.

Why is SIMPLE producing the appropriate pattern? The only difference between the conditions in the model is the number of items in the list. The more items, the less relatively distinct each particular item is (other factors being equal). This can be viewed as a form of intra-sequence interference proposed by Melton (1963) as an explanation.

GENERAL DISCUSSION

The data reported by Baddeley and Scott (1971) have been interpreted as showing that items in short-term memory decay if they are not rehearsed. The simulation reported here shows that it is possible to produce the same results entirely through interference. Thus, the data do not provide good evidence for the existence of time-based decay.

Note

Source code for running the simulation in MATLAB is available at http://memory.psych.mun.ca/models/simple/

REFERENCES


