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Conditions for positive and negative recencies in running memory-span recognition

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ABSTRACT

A positive recency effect in a running-span recognition procedure was obtained in Experiment 1 for hits and for intratrial false alarms. In running recall procedures, recency does not fit well with an active updating hypothesis. In Experiment 2, in which the beginning of the target set was marked with a cue upon presentation, the recency effects disappeared. In Experiments 3 and 4 participants were forced to maintain 2 items in memory until the last one was presented for recognition. These three items were the target set. When the last item presentation was uncertain—because of the variable length list—an unexpected negative recency effect appeared. An explanation for this change from positive to negative recency is offered based on the sharing of attentional resources put forward by others for similar procedures.

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1. Introduction

Perhaps the main function traditionally attributed to the Working Memory System is that of updating the most accessible information. Certainly, due to the challenges imposed by the continuously changing properties of the environment, our adaptive behaviour calls for the discarding of outdated useless information, the processing of new incoming stimuli and, if necessary, the maintenance of the results of such processing, as they could be needed to process future input or to produce public responses.

In order to recreate this situation in the laboratory, following Pollack, Johnson, and Knaff (1959), a usual methodology is the so-called running memory span task. In this task participants are presented with a variable-length list of unrelated items. At the unpredicted end of the list they are asked to recall the last *n* items (typically between 3 and 6). The functional approach of Oberauer (2001, 2002, 2005, 2009; Oberauer & Lange, 2009; Oberauer & Hein, 2012) to working memory assumes that the updating tasks include two main processing components: maintenance and updating (see Oberauer, 2009, Table 3). The updating component concerns the central executive processes. In our serial updating task, upon item presentation the central executive is supposed to unbind the old target items as they become outdated, renew the binds of the remaining targets to their new positional links, and bind the incoming item in the generic mental space (for a similar view see Artuso & Palladino, 2011; Kessler & Meiran, 2008). The positional information in the mental space would be the cues through which item identities are selected for retrieval. One problem is that in a running-span procedure the position-identity binding should be weak and flexible, as for every incoming new item the old binds are to be broken and a new set of binds has to be built.

In addition to free and serial recall data, what can be said about recognition memory in a running span task? To our knowledge the running span task has not yet been properly tested with a recognition procedure. Nevertheless, we do have results with a very close updating memory procedure: the n-back task. In this task participants have to recognise every item of a sequence as coincident or not with that presented *n* positions before (usually *n* ranges between 1 and 4). Results with the n-back task seem to parallel those obtained with other working memory procedures (Schmiedek, Hildebrandt, Lövdén, Wilhelm, & Lindenberger, 2010; Shamosh et al., 2008; but see also Kane, Conway, Miura, & Colflesh, 2007, for conflicting results). In fact, Ecker, Lewandowsky, Oberauer, and Chee (2010, Table 1) have pointed out that both tasks engage basically the same component processes—retrieval and substitution. Yet, it should be noticed that, unlike other updating memory recognition procedures, what is really peculiar in both tasks is the critical need for order (i.e., the relative position)

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updating of every item in the target memory set whenever a new item is presented (for a similar view see, e.g., Schmiedek et al., 2010). That is why both n-back and running memory span recognition tasks can be considered cognate procedures.

Many authors have proposed that performance in a recognition-memory task engages two processes: recognition through recollection from memory and recognition through probe familiarity (for review, see Ruiz, 2004; Yonelinas, 2002). However, Szmalec, Verbruggen, Vandierendonck, and Kemps (2011), applying the basic assumptions of the dual process to the analysis of an n-back procedure, have proposed that in this procedure the retrieval mechanism should play an essential role, as it is the only way to discriminate between items in the target set (contextually bound items) and the outdated intralist lures (recently unbound items).

However, from our own research the supposition that active updating is taking place in a running memory span task has been constantly challenged. Indeed, Ruiz, Elosúa, & Lechuga (2005; see also Elosúa & Ruiz, 2008) have shown a recency effect on correct free recall of the target set along with recency in internal intrusion errors (i.e., recall of pretarget items from the same list). These results are considered at odds with the basic suppositions of retrieving the items from an actively updated working-memory set. Instead of active updating, they suggest that participants in a running memory span task are passively processing the incoming items, while waiting for the list end. For a similar rationale, compare the distinction proposed later by Bunting, Cowan, and Saults (2006) between lower-effort and higher-effort strategies for updating the memory set. Also, Palladino and Jarrold (2008) have shown that when participants have to serially recall the whole list (4 to 7 items) in the context of an unknown-length list procedure, an unexpected recency effect is apparent. In contrast, when the list length is known beforehand no recency effect appears.

Szmalec et al. (2011) have reported that in an n-back recognition procedure most of the false alarms are items from the two adjacent to the target positions, with a small but significant preference for the more recent one. We agree with these authors that such interference effects could be accounted for on the basis of some decaying familiarity or any other dimensional time- or order-related feature. In a sense, the asymmetry of location error around the target item could be seen as a hint of recency.

We describe four experiments to properly ascertain whether recency effects are present in an updating span recognition procedure. First, we ran an experiment with a procedure as close as possible that of canonical updating recall. In this experiment the last four items of a variable-length list were defined as the target set for recognition. As we did obtain a recognition recency effect, in a second experiment we tried to assure that participants were able to maintain four items in memory for recognition even when a few irrelevant pretarget items are presented, but without requiring updating. In our third experiment we designed a new procedure aimed to more closely control the updating behaviour. The target set contained only three items; the new procedure included the signalling of the first and second target item in the middle of the running list, and the end of the list marked the last target item. We thought that this new procedure would isolate the uncertainty of the upcoming last target item, in a way that it would be the only one in a typical running context. As we found a relatively low recognition performance of the very last item in the list, in the final experiment we tried to check whether its uncertainty as a target was the factor responsible for its hampered processing.

1.1. Experiment 1

In this experiment participants were presented with unknown-length lists of consonant letters, followed by a probe letter for recognition. Participants were asked to say if the probe item was one of the final four positions of the list. For hit rates we predicted that, if participants are effectually updating the target set, considering its short length, no serial position effect should be obtained. Additionally, as the updating processes continues to discard recently useful items, a relative low false alarm rate could be expected for items from the last pretarget positions, as they would be memories which are only just inhibited for recall (Hasher & Zacks, 1988).

2. Method

2.1. Participants

Twenty-eight students (24 females and 4 males) aged between 21 and 45 years ($M = 29$, $SD = 7.75$) of the Universidad Nacional de Educación a Distancia (UNED) received one course credit towards Experimental Psychology.

2.2. Materials and apparatus

Forty-eight lists of 6, 7, 8 and 10 consonants each were drawn up, along with forty 9-consonant lists. The 20 consonants used were: B, C, D, F, G, H, J, K, L, M, N, Ñ, P, Q, R, S, T, V, X, and Z. A computer program controlled the frequency and the position of each consonant so thay they were as homogeneous as possible. Twenty lists randomly chosen from the overall pool were used for practice trials. The experiment was carried out on a PC 286 computer, with an IBM type 8513/SDQ screen in black and white mode. The MEL (1.0) program (Schneider, 1988) was used for the design, the presentation of the stimuli, and for response registering. The consonants were presented one by one, in capital letters (in text mode 25 × 80), in row 10 and column 40. The distance between the participant and the screen was approximately 60 cm.

2.3. Procedure and design

The experiment took place in the laboratories of the Department of Psicología Básica I at the UNED. The participants read the instructions, started the experiment and self-paced the task. For the recognition task the participants were told that they would see consonant lists of variable lengths, between six and ten items each. The end of each list was indicated by an asterisk in row 8 and column 40 for 500 ms. Immediately afterwards, the probe letter appeared at the same screen coordinates. The task was to say if the probe was or not among the last four letters of the presented list.

Participants pressed the "yes" key (the "+" sign on the numeric computer keyboard) or the "no" key (the "−" sign of the numeric keyboard) with the index finger of their right hand. When the response was correct the computer gave reaction time feedback. When the response was incorrect the word "error" was presented. Participants had to answer all the trials and to guess if they were unsure. Speed and accuracy were equally emphasised.

The exposure time for each consonant was 1 s for the first 10 practice trials, 500 ms for the next 10 practice trials, and 500 ms for the remaining 232 experimental trials. The *inter-stimulus-interval* ISI was 500 ms. Following trials 78 and 155 participants were allowed a short break in which they received on the screen a summary showing the number of correct responses and hit rate for each serial position.

Each list length condition consisted of 48 trials, with the exception of list length 9 which had 40 trials. The number of positive and negative trials in each list-length condition was the same. Half of the times, the negative probe was one of the pretarget list items (internal letter) and the other half of the times it was an extra-list item (external letter). Fig. 1 gives a graphic representation of the relationship between the letters presented in the list and the participants' responses. It shows that there were experimental trials for every one of the list-length conditions only for positions −1 and −2.

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