The Quarterly Journal of Experimental Psychology
Publication details, including instructions for authors and subscription information:
http://www.informaworld.com/smpp/title~content=t716100704

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To cite this Article Morton, John and Chambers, Susan M.(1975) 'Channel selection and the suffix effect', The Quarterly Journal of Experimental Psychology, 27: 3, 357 — 362
To link to this Article: DOI: 10.1080/14640747508400495
URL: http://dx.doi.org/10.1080/14640747508400495

Quarterly Journal of Experimental Psychology (1975) **27**, 357–362

CHANNEL SELECTION AND THE SUFFIX EFFECT

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Subjects were presented with a list of digits to alternate ears for serial recall. The list was followed by a suffix, a redundant acoustic event which did not have to be recalled. The suffix was presented either to one of the ears or binaurally. In all cases the suffix gave rise to a selective impairment of recall of the final items in the list. The results are interpreted as showing first that stimuli of the kind used are processed by simultaneously selecting both ears rather than by switching attention, and second that the site of the suffix effect is after the selection mechanism.

Introduction

Crowder and Morton (1969) have proposed that information concerning the last item or two in acoustically presented lists is held for a time in a Precategorical Acoustic Store (PAS). The most obvious effect produced by such a store is in serial recall tasks where performance is better with acoustic rather than visual presentation, and the advantage is limited to the final serial positions. This

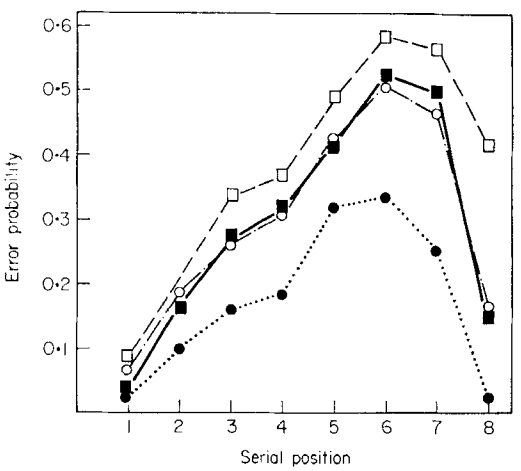

FIG. 1. The error probability following serial recall of monaurally presented digit lists as a function of serial position with the mode of presentation of the suffix as a parameter. There was no suffix in the control situation. (From Morton, Crowder and Prussin, 1971.) Ipsilateral suffix (□ – – – □). Contralateral suffix (■—■). Binaural suffix (○ — . — ○). Control (●. . . .●).

performance difference can be abolished by the use of a "stimulus suffix" (hereafter simply "suffix"), a redundant or irrelevant spoken item presented immediately after the stimulus list (Crowder, 1967; Morton, 1968). The obvious inference is that in such conditions PAS is left filled with irrelevant information. Morton, Crowder and Prussin (1971, Experiments VII, VIII and XI) have shown that the effect of the suffix is reduced when it is presented on a "channel" different from that used to present the stimuli. Thus, if the stimulus list is presented to one ear, the effects of a suffix on recall of the final items is smaller when the suffix is presented either to the opposite ear or binaurally than when the suffix is presented only to the same ear as the stimulus list. The relevant data are shown in Figure 1.

The lack of difference between the effects of the binaural and contralateral suffixes establishes that the channel rather than the ear of presentation is critical. Accordingly, Morton *et al.* (1971) interpreted their data in terms of a model, shown in Figure 2, based on Broadbent's (1958) filter model. In the model, acoustic stimuli are automatically separated in the buffer store on criteria such as localization. The selection mechanism allows information on a particular channel to pass through for further analysis and storage.

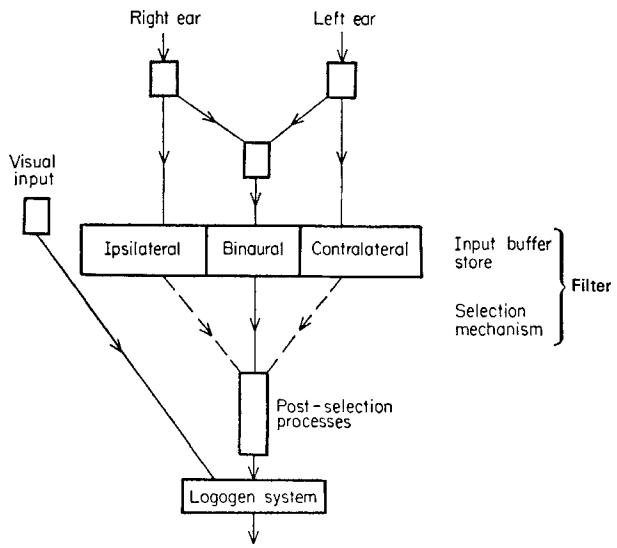

FIG. 2. An information-flow model which accounts for a variety of results involving various suffixes (adopted from Morton *et al.*, 1971). Responses to either visual or auditory presentation are produced by the Logogen system. It is deduced that PAS lies in the post-selection processes.

Within this framework, Morton *et al.* (1971) concluded that PAS is located after the selection mechanism. Two experiments yielded data which suggested this conclusion. In one experiment the suffix was presented at random to one of three channels. Under these conditions the difference between the effects of the ipsilateral suffix and the other two was greatly reduced. These data are presented in Figure 3. Similar results were obtained when the subjects were

forced to pay attention to the suffix. This was done by presenting one of two alternative suffixes ("tick" or "cross") at random. Subjects had then to make the appropriate mark before recalling the digits. This procedure also led to a reduction in the difference between the effects of ipsilateral and contralateral suffixes. If the differences shown in Figure 1 were attributable to preattentional processes then the changes in procedure in the two experiments just described would have had no effect.

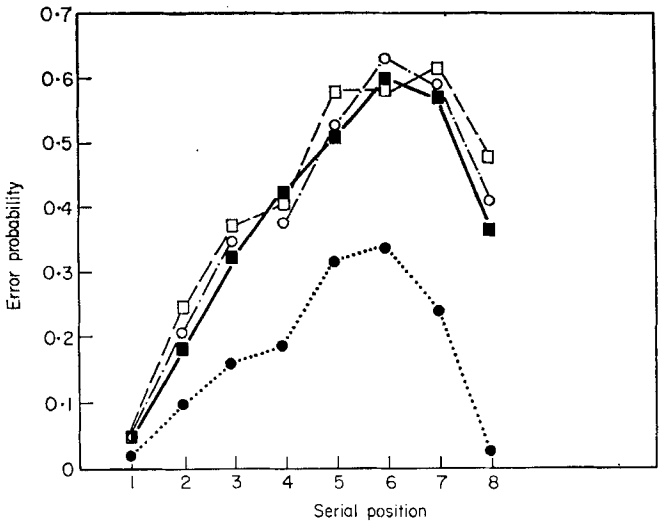

FIG. 3. The error probabilities following serial recall of monaurally presented digit lists as a function of the location of a suffix. In contrast with Fig. 1 the subjects did not know in advance on which channel the suffix would appear. (From Morton *et al.*, 1971.) Ipsilateral suffix (□ – – – □). Binaural suffix (○ — · — ○). Contralateral suffix (■——■). Control (●. . . . ●).

We thus have to take into account the following observations when considering the nature of the selection mechanism.

(1) The effect of a contralateral suffix is greatly reduced when the subjects know where it is coming from.

(2) Such knowledge is not sufficient to defend against an ipsilateral suffix.

Thus a suffix can only be defended against if its location is known in advance and if the attention mechanism is already linked to another channel. Such defence must be active rather than passive (e.g. inertia in the switching mechanism) for the differences between Figures 1 and 3 to be possible.

Consider now the situation in which digits are presented alternately to the two ears. This procedure was used by Moray (1960) who concluded that subjects were able to switch attention from ear to ear (i.e. channel to channel) in order to preserve presentation order in the response. This order was lost when pairs of items were presented simultaneously to the two ears, at the same overall rate. Broadbent and Gregory (1961) argued that Moray's results showed simultaneous selection of both ears.

Suppose, now, that following the presentation of a string of digits to alternate

ears a suffix is presented to one of the ears, the subjects knowing in advance which ear would be used. If PAS were prior to selection then the suffix should interfere with the last stimulus presented to that ear. Thus, if the suffix is on the opposite ear to the final digit it should have little effect on the recall of that digit but could impair recall of the penultimate digit, whose ear it shares. If Morton *et al.* (1971) are correct and PAS follows selection, then there are two possible outcomes depending on which selection method is operating. If attention can be switched from ear to ear then we would suppose the subject could adopt a suitable strategy to defend against the suffix. In the case that the suffix is expected on the same channel as the final digit, such defence would take the form of switching the selection mechanism to the other channel. When the suffix comes on the opposite channel then the defence could be to hold attention with the final digit. Performance on the final item should then be equivalent to that with the contralateral suffix in Figure 1, i.e. with about 20% errors. If, on the other hand, Broadbent and Gregory are correct and both ears are selected simultaneously, then there would be no defence against the suffix and we would expect all suffixes to have a full effect—i.e. giving about 40% errors on the final item.

Method

The stimuli were lists of seven digits presented through headphones at a rate of 2 s. The digits were presented to alternate ears, the first, third, fifth and last digits going to the right ear and the second, fourth and penultimate digits going to the left ear. There were four conditions which differed in the way in which a suffix, the word "nought", was presented; to the right ear (first ear), to the left ear (second ear), binaurally and a control condition in which there was no suffix. In the first ear condition the suffix was on the same ear as the final digit; in the second ear condition it was on the same ear as the penultimate digit. The rate of presentation was much slower than that used by Moray (4 items/s) and so should favour alternation of attention compared with the latter study.

The lists were drawn from the digits 1–9. There were 27 lists for each condition, each digit occurring equally often in all serial positions for all conditions and no digit occurring in the same serial position on successive lists. There were four groups of eight subjects who listened to the four conditions in an order determined by a 4×4 Latin square design. The test conditions were preceded by a block of 24 practice lists in which the four conditions were illustrated; in addition there were two practice trials at the beginning of each condition to allow the subjects to adopt an appropriate strategy if possible. This procedure is identical to that used by Morton *et al.* (1971) in the experiments described above.

The 32 subjects, drawn from the APU Subject Panel, were instructed to listen to the lists and not to start writing until the final item had been presented. They were told to write down the digits on prepared forms in the order they were presented and were encouraged to guess when uncertain rather than leaving blanks. Prior to each condition they were told on which ear the suffix would be presented. Responses were scored correct only if the digits were in the correct serial position. This design, procedure and subject population were identical to that used in the experiment for Figure 1, except that the lists were seven digits long compared with eight in the previous experiment.

Results

As there were no differences among the groups the data were pooled. The mean probabilities of error in the four conditions are shown in Figure 4. Wilcoxon tests were performed on the errors, comparing all conditions at all serial positions. The control condition gave rise to fewer errors than the other conditions at all

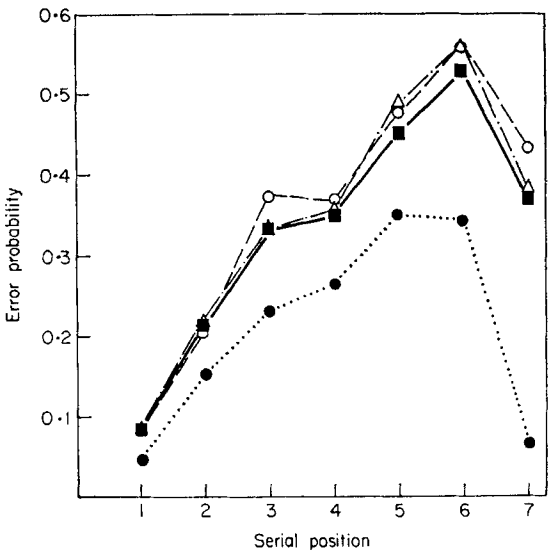

FIG. 4. Data from the present experiment giving error probability following serial recall. The stimuli were presented to alternate ears. The subjects had advance warning of the suffix location. The parameter is the kind of suffix. The suffix was presented on the same ear as the first, third, fifth and seventh items (○ – – – ○). Opposite ear (■——■). Binaural (△ – · – · △). Control (●. . . .●).

serial positions ($P < 0{\cdot}005$, one-tailed). The only difference among the suffix conditions occurred on the final serial position where the first ear condition was worse than the second ear condition ($P < 0{\cdot}02$, two-tailed). This numerically small difference matches the small differences between ipsilateral and contralateral suffixes in Figure 3.

It may be stated that the differences between the control condition and the suffix conditions throughout the list, also to be found in Figures 1 and 3 is to be attributed to a prefix-like action of the suffix which is relatively independent of the suffix effect and can be ignored for the purposes of the present experiment (see Crowder, 1967; Crowder and Morton, 1969; Morton *et al.*, 1971, Experiments III and IV).

Discussion

When the suffix is presented on the same ear as the last item it has a slightly greater effect than when the suffix is on the opposite ear or is binaural. The differences are, however, small compared with the usual effect of channel differences shown in Figure 1. The curves in the present experiment more nearly resemble the results found when the subject does not know what channel the suffix will arrive on (as in Fig. 3), with about 40% errors on the last item in all conditions.

However, in the present experiment the subjects were fully informed as to the location of the suffix. Thus we are forced to conclude that the subjects were incapable of filtering it out. The simplest account of this is that the subjects,

rather than selecting the ears alternately as the stimuli came in, were rather not selecting at all, but were accepting stimuli from both right and left ears as from a single channel. This result, and the absence of any major differences among the suffixes in their effect on the penultimate digit confirm the conclusion of Morton *et al.* (1971) that PAS information is located after channel selection. The numerically small difference between the first ear and second ear effects indicate that the above description is not completely adequate, but will require minor modification.

We are grateful to Donald Broadbent and Bruce Henning for commenting on a draft version of this paper, to Byron Morgan for providing a program for the Wilcoxon tests and to Keith Tayler for his kind assistance with the data processing.

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Received 29 *April* 1974