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Contextual effects in the stimulus suffix paradigm

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Morton & Chambers (1976) showed that the suffix effect – a selective impairment in serial recall on the final serial position of an acoustically presented list – was crucially affected by whether the suffix was a speech sound or a non-speech sound. They also claimed that the classification of a sound as speech-like was determined simply by the acoustic properties of the sound and not at all by the context. The crucial sound in their experiments was a steady state, naturally produced vowel sound which failed to give a suffix effect. We report here that when the sound was the only suffix used, it did produce a suffix effect. We conclude that, contrary to Morton & Chambers' conclusion, context effects are indeed operative in determining whether a sound produces a suffix effect.

In a series of experiments using the stimulus suffix paradigm, Morton & Chambers (1976) claimed to demonstrate that 'speech-like' was an acoustic feature which could influence the route by which a sound was processed. In the stimulus suffix paradigm a list of digits is presented acoustically for serial recall. Normally, with a list which is just supra-span in length, recall of the final item is nearly perfect. If the list is followed by a further, extraneous, spoken sound, the stimulus suffix, recall is affected. In particular, recall of the final item is greatly reduced.

Morton & Chambers (1976) showed that the phonological complexity of the suffix sound played no role in the degree of interference with recall. On the other hand there was no effect on recall when a non-speech sound was played in the suffix position. One unexpected finding in these experiments was the existence of a particular (spoken) vowel sound 'ah' which produced no suffix effect whatsoever. This sound, termed AH I, was a gated portion of an extended vowel which had been intoned for about 5 s. Close inspection of this sound suggested that it was more regular in its constitution than other, similar, sounds which did produce a suffix effect. That is, there was less than usual moment-to-moment variation in the position of the formants. There were other features of the suffix which appeared unnatural – for example the onset and cut-offs of the sound were abrupt – but these proved to be insufficient to remove a suffix effect with other examples of vowel sounds.

The experiment which showed this absence of effects (Expt I) involved six suffix conditions. The other five conditions all employed non-speech sounds. Morton & Chambers suspected that there might be an artifact due to context effects. Accordingly they ran another experiment (Expt III) in which one of the non-speech conditions was replaced by a normally spoken vowel sound called AH II. This produced a suffix effect but the other natural sound still gave no effect. Morton & Chambers then concluded that the context of the sounds had not had an influence and that they did have a natural sound which was being classified as non-speech by the perceptual system simply as a result of its acoustic properties.

Experimental method

The experiments we report here involve the serial recall of lists of eight digits which were presented at the rate of one per 500 ms. The stimuli were drawn from the digits 1 to 9. In each experiment there were six suffix conditions. In each condition there were nine lists; lists for the six conditions were presented in a random order with the restriction that no two lists in the same condition were consecutive. The make-up of the lists was such that for each condition each of the digits occurred

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once in each serial position. The lists were organized so that no digit ever occurred on two successive lists in the same serial position. Each experiment was preceded by a block of 24 practice lists in which all the experimental suffixes occurred. The experimental lists were split into two blocks of 27 lists, each of which was preceded by two practice lists.

The subjects wrote their responses in boxes on prepared response sheets. They were allowed 15 s for this. They were instructed to wait until the end of the lists, including any suffixes, before starting to respond, and to write down the responses from left to right. They were told not to leave blanks but to guess if they were unsure. They were also told that the responses would only be scored correct if they were in the correct position. In this way we intended to make sure that they put what they thought to be the last item in the last box on the response sheet. They were instructed to ignore the suffixes, which were always demonstrated to them, and were told that these sounds were used as cues during the recording.

Subjects were monitored closely during the practice to ensure that they followed instructions. They were also watched during the test session. This was very necessary since the occasional subject found the strategy of reporting the last items first irresistible.

Subjects were tested in groups ranging in size from 6 to 20. The paid subjects came primarily from the APU volunteer panel and were female subjects between the ages of 21 and 65.

Responses were only scored correct if they appeared in the correct serial position. Practice lists were not processed for errors. As we wished to avoid floor and ceiling effects we chose to exclude subjects whose memories were either too good or too poor. The criteria we used were if the subject had no errors at all in any of the six conditions or if the subject had five or more errors on the final serial position of the no suffix condition then they were excluded from further analysis. The response sheets were copied into a computer, and all scoring and tests were done by program.

An examination of Natural AH I suffix

We had set ourselves the task of determining those acoustic features which influence the way in which a sound is classified. This work, reported in Morton *et al.* (in press), revealed that both the regularity of the suffix sound and its spectral characteristics had an effect on its potency as a suffix. In the course of this inquiry we had decided to examine in more detail the sounds used in Morton & Chambers (1976) – henceforth *M & C*. The naturally produced sound from *M & C* which did not produce a suffix effect was called Natural AH I. It had been recorded as a steady-state vowel which lasted about 5 s. The central 3 s or so had been formed into a tape loop and the suffixes for Expts I and III in *M & C* had been recorded by electronically gating out 300 ms of this loop at the appropriate moment. Unfortunately the loop itself had been cut up for a demonstration tape soon after the equipment had been run, but the experimental tapes were available. Before continuing we wished to get all the relevant sounds on to the computer so that any subsequent manipulations would be standardized and simplified. Accordingly we recorded good examples of the digit set on the computer and also registered five of the AH I suffixes from Expts I and III in *M & C*. These were different 300 ms of the original 5 s tape loop. With this material we made up a standard stimulus tape together with samples of the AH I suffix loop and a 'no suffix' control condition.

Experiment 1 ($n = 9$)

All the suffixes gave an effect. It should be remembered by the reader that these were the sounds which had *not* produced a suffix effect in the *M & C* series. The serial position curves from this experiment are shown in Fig. 1.

This result astonished us as we were operating on the premise that the majority of the examples would produce no effect. We ran three other experiments with minor variations in procedure and conditions of presentation and in all cases the sounds produce a clear suffix effect.

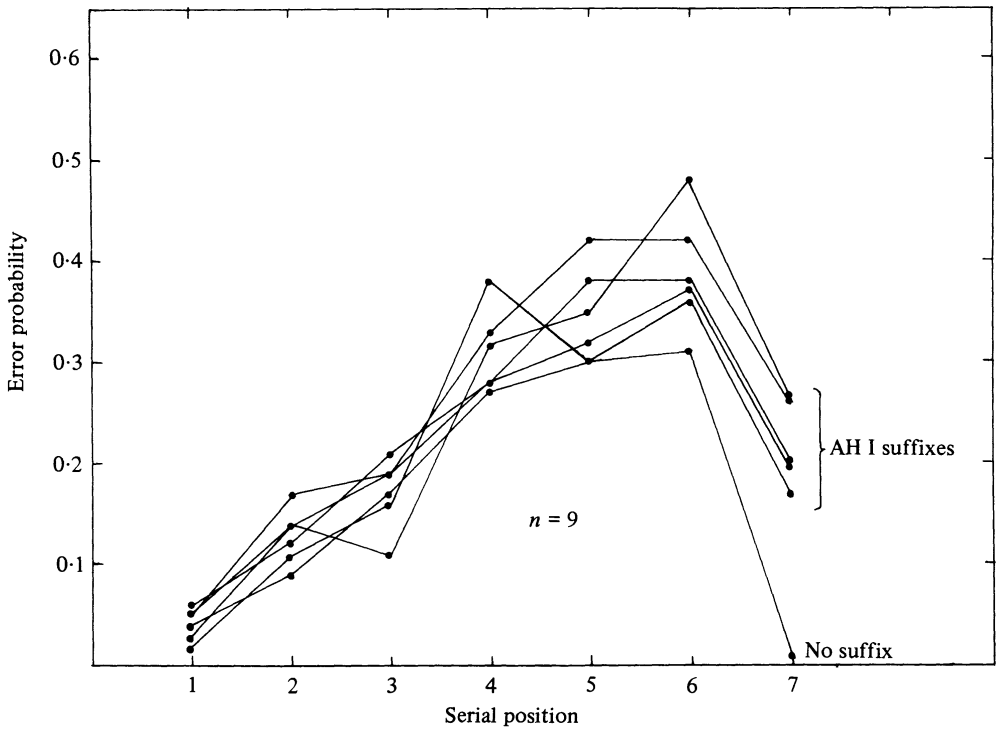

Figure 1. Error probabilities for lists with suffixes which previously produced no suffix effects.

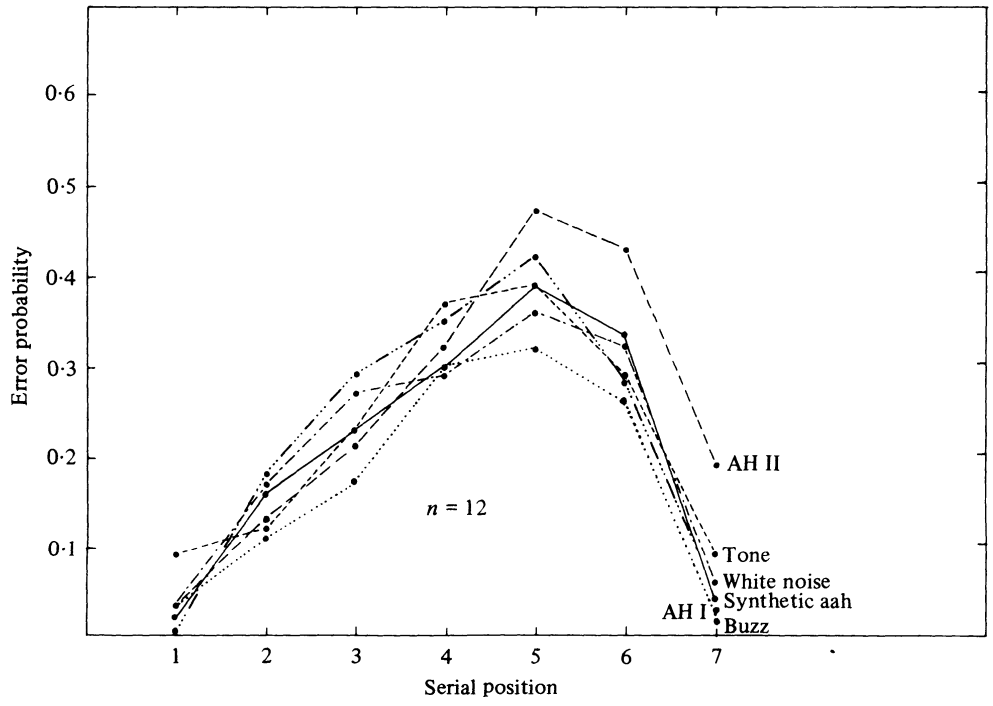

Figure 2. Replication of Morton & Chambers' (1976) experiment.

We then became worried that the original *M & C* experiment might have been carried out under significantly different conditions. Accordingly we replicated it.

Experiment 2 ($n = 12$)

We took the original tape from *M & C*, Expt III and re-ran it under conditions identical to those which were used in Expt I. The data are shown in Fig. 2. The results are almost exactly the same as the original *M & C* results. The AH I suffix gave no different effect from the non-speech sounds.

We also performed five other experiments in which we varied the acoustic properties of the digit list while keeping the suffix conditions identical, and in all cases AH II was significantly different from the non-speech suffixes and in no case was AH I different from the non-speech suffixes.

Discussion

Our data, then, appear to violate the principle so carefully established by *M & C* (1976). The effect of a suffix is in the limit affected by the nature of the other suffixes in the experiment. In Expt 1 the presence of five or six suffixes of the same type was enough to change the definition of 'speech-like' and thus allow suffix effects. The tests of contextual effects in *M & C* had been insufficiently stringent, and it is clear that the criterion for acceptability can be changed by other sounds in the experimental setting.

A recent experiment by Ayres *et al.* (1979) lends support to this conclusion. These authors showed that a *wa* sound, produced by a plunger-muted trumpet, could either be an effective suffix or not as a function of the nature of the other suffixes in the same experiment. If these were speech sounds then the *wa* gave a large suffix effect; if they were other musical sounds, such as a plucked violin note, then *wa* gave only a small effect. Ayres *et al.* suppose that these data cast doubt on the precategorical nature of the suffix effect. However, we find no difficulty in supposing that the precategorical mechanisms should be subject to general context effects. These would operate to change the criteria for acceptability as a speech sound. Other examples of this are demonstrated in Morton *et al.* (in press). In the case of Ayres *et al.* we wonder how their subjects might have performed had they *known* one sound was a trumpet.

Note that the discovery of a context effect does not change the status of the crucial sound in the *M & C* experiment. We still have to determine what it is that makes some sounds susceptible to this kind of influence. 'Speech-like' is the term we use to characterize the relevant dimension and we can see how the suffix effect can be used as a tool in helping us to establish the relevant parameters. This has been done in a series of experiments reported in Morton *et al.* (in press). In these experiments we showed that the acoustic properties of the digit list could influence whether a sound produced a suffix effect. In combination with the present findings, then, we have to conclude that Morton & Chambers (1976) were wrong and that the suffix effect is subject to the influence of context, both between suffixes and from the stimulus list.

References

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