

This Week's Citation Classic

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Crowder R G & Morton J. Precategorical acoustic storage (PAS). *Percept. Psychophys.* 5:365-73, 1969. [Dept. Psychology, Yale University, New Haven, CT]

This paper describes a system of sensory memory for the auditory modality. It occurred at a time when the visual sensory memory system was well established but no corresponding auditory store had yet been proposed formally. The main applications of the precategorical acoustic storage hypothesis (PAS) are to experiments on presentation modality in immediate memory and to experiments showing interference with immediate memory by a redundant stimulus suffix. [The *Science Citation Index*® (SCI®) and the *Social Sciences Citation Index*™ (SSCI™) indicate that this paper has been cited over 175 times since 1969.]

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"The preparation of this paper owes entirely to the fact that John Morton spent 1967-1968 visiting at Yale. But it was the English psychologist R. Conrad who was responsible in a more basic way. Independently of Morton, I had been interested for several years in a discovery by Conrad in the late 1950s—that producing a redundant prefix immediately before recall of an immediate memory list hurts recall for that list. (Perhaps the British postal and telecommunications system should be thanked, for they supported Conrad's work.) When I met Morton in 1967, I had just published a paper showing that if the redundant item is presented at the end of the memory list, spoken by the tester rather than by the person being tested, the effect is quite different.¹ In this case, with a suffix presented at the end of the list, performance is again damaged, but only for the last item or two in the list.

"Meanwhile, at the Medical Research Council's Applied Psychology Research Unit in Cambridge, Morton had become aware through contact with Conrad that visual and auditory presentation of memory lists do not yield the same result; rather, the auditory mode gives better performance on the last few items in the list. This observation fit with expectations of a large theoretical model² Morton had been working on for explaining certain relationships between memory, perception, and language (the logogen

model). He, too, had just finished a study showing a selective interference effect on the last portion of memory lists.³

"When we saw how neatly Morton's model seemed to handle the results of both of our experiments, we spent several months testing further implications of the PAS notion. The most important of these was that a spoken suffix following visual presentation of the list should not affect performance. The paper was drafted while Morton was still in New Haven and then revised later by correspondence. We were pleased that it gave us the opportunity to tie together a large number of experimental findings in the literature about short-term memory as well as to lay down Morton's views on the roles of audition and articulation in memory.

"A particular emphasis that I pushed was the intimate relation between perception and memory coding. This emphasis on coding analysis seems to have anticipated the more recent interest in 'levels of processing' that has developed with a disillusionment about distinguishing short and long-term memory stores. We said, for example, '...linguistic materials go through a somewhat stereotyped progression of perceptual stages...' "What is learned" by the S in an experiment may then be said to depend on how far into such perceptual processing the materials have passed at the termination of stimulus presentation.'

"I wish these more systematic aspects of the paper had had more impact and that our estimate that PAS could last about two seconds had had less impact. The time estimate was pure conjecture, and there was then no evidence (nor is there now) to prefer it over some other figure of the same order of magnitude. Yet, the two-second conjecture seems to be our most frequently cited statement.

"The PAS hypotheses have survived almost a decade of experimental tests reasonably well. The revisions that have been suggested by subsequent work largely have been to elaborate the original assumptions rather than to change them fundamentally. For me, the most important of these elaborations have been, first, to show the relation of PAS to different classes of speech sounds, and, second, to discover the type of backward masking that is responsible for the suffix effect."

1. Crowder R G. Prefix effects in immediate memory. *Can. J. Psychol.* 21:450-61, 1967.
2. Morton J. Selective interference in immediate recall. *Psychonom. Sci.* 12:75-6, 1968.
3. Morton J. The interaction of information in word recognition. *Psychol. Rev.* 76:165-78, 1969.