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Baddeley A D. Short-term memory for word sequences as a function of acoustic, semantic and formal similarity. *Quart. J. Exp. Psychol.* 18:362-5, 1966.
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Subjects saw or heard sequences of five unrelated words and tried to recall by repeating them back in the appropriate order. Memory performance was grossly impaired when words were similar in sound (*MAN, CAD, MAT, CAP, CAN* versus *PEN, SUP, COW, DAY, HOT*). Similarity of meaning had little effect (*HUG, LONG, WIDE, TALL, LARGE* versus *THIN, WET, OLD, LATE, STRONG*). It was suggested that short-term memory relies on acoustic coding, in contrast to long-term memory, which a parallel study showed was influenced by similarity of meaning rather than similarity of sound. [The *SSCI*® indicates that this paper has been cited in over 180 publications, making it the most-cited paper from this journal.]

Acoustic Memory and Language

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I was working at the Medical Research Council Applied Psychology Unit on a grant provided by the British Telephone System. My task was to develop tests that would be sensitive to the quality of the telephone line, hence allowing different systems to be compared. I had previously worked on long-term learning but not short-term memory, which was the province of my supervisor, R. Conrad. He had demonstrated that it was harder to remember sequences of acoustically similar letters such as *B, C, D, G, T* than sequences of dissimilar such as *F, Y, W, R, J*, concluding that short-term memory was acoustic.

Conrad was on sabbatical in the US, and I decided to try out his new finding in connection with my telephone project, having listeners recall similar or dissimilar items heard in noise or quiet. The effects of the noise were minimal, but the acoustic similarity effect was huge, and I became intrigued. Like the sorcerer's apprentice, I got carried away with my boss's magic and spent most of the year investigating it, rather than pursuing the telephone project.

The paper above was concerned with the potential objection that Conrad had simply shown that short-term memory was sensitive to one kind of similarity. It was well known that many kinds of similarity effects could be found under appropriate circumstances, so I decided to contrast the effect of acoustic similarity with that of similarity of meaning. I chose meaning because it was an easy variable to manipulate, but it proved to be a lucky choice. I obtained a clear contrast, with sound affecting short-term memory and meaning affecting long-term learning. This led to the generalization that short-term memory relies on an acoustic and long-term memory on a semantic code. The paper was turned down by the *Journal of Experimental Psychology*, the principal North American journal in this area, with the suggestion that I should do "more parametric studies" but was accepted by the principal British experimental journal, and since that time it has been much cited.

My work continued to focus on short-term memory and subsequently showed that the concept of a unitary short-term memory system was inadequate to account for the data, proposing instead a concept known as Working Memory.[1] This was assumed to involve a number of subsystems, one of which, the Phonological Loop, is concerned with the short-term storage of speech-based material. Our model was able to account for our original findings and many more in this area, including the observation of short-term memory deficits in certain neuropsychological patients.[2]

Such patients typically have a very poor capacity to hear and repeat back sequences of unrelated material and typically do not show the acoustic similarity effect when the material is presented visually. They appear to have specific impairment of the short-term phonological store. Short-term memory patients do, however, present a problem since they seem to have remarkably few problems in coping with everyday life, raising the question of what function the short-term phonological store could serve, other than that of keeping psychologists busy.

We obtained a crucial clue when we tried to teach a patient with a very pure short-term memory deficit the vocabulary of a foreign language. Although she was normal at learning material that could be encoded in terms of its meaning, she was desperately impaired at learning new foreign words.[3]

This in turn suggested the hypothesis that the system might be crucial for the acquisition of language in children. We tested this by correlating performance on a task involving hearing and repeating back sounds with performance on a vocabulary test. We found that our immediate sound memory task was an excellent predictor of vocabulary, significantly better than general intelligence.[4] We also found that children who were poor at our repetition task were also impaired at learning novel names for toys. Finally, we found that children who are selected as having a specific disorder of language, with otherwise normal intelligence, proved to have a striking deficit in their capacity for immediate phonological memory, a deficit that was considerably more marked than the language deficit for which they had been selected.[5] The evidence appears to be accumulating, then, to indicate that the short-term acoustic memory system that I began to study in the 1960s is crucial for a child's development of its native language.

1. **Baddeley A D & Hitch G.** Working memory. (Bower G A, ed.) *Recent advances in learning and motivation.* New York: Academic Press, 1974. Vol. 8. p. 47-90. (Cited 55 times.)
2. **Baddeley A D.** *Working memory.* Oxford, England: Oxford University Press, 1986. 289 p. (Cited 20 times.)
3. **Baddeley A D, Papagno C & Vallar G.** When long-term learning depends on short-term storage. *J. Mem. Lang.* 27:586-95, 1988.
4. **Gathercole S & Baddeley A D.** Evaluation of the role of phonological STM in the development of vocabulary in children: a longitudinal study. *J. Mem. Lang.* 28:200-13, 1989.
5. ———. Phonological memory deficits in language-disordered children: is there a causal connection? *J. Mem. Lang.* (In press.)

1A - 24