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Auditory Memory

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Synonyms

Acoustic memory; Echoic memory

Definition

Auditory memory is the storage of information about sounds, including both acoustic features (sensory memory) and categorical information about sound categories and multi-sound structure.

Detailed Description

Auditory memory plays a critical role in various aspects of human activities, such as music, verbal learning, and communication. For example, when a person says, "I said 'rice,' not 'lice,'" the listener must keep the word "rice" in auditory memory to compare it with the word "lice" afterwards.

It is widely accepted that auditory memory can be partitioned into three components: echoic memory, short-term auditory memory, and generated abstract memory (Cowan 1984; Crowder 1976; Massaro 1975; Neisser 1967). Figure 1 illustrates these components and their relationships.

Preperceptual Auditory Storage

Preperceptual auditory storage retains the uncategorized representations of auditory inputs that have not yet been fully processed (Massaro 1975) and is also referred to as short auditory storage (Cowan 1984). It is the auditory counterpart of what is thought of as iconic memory in the visual domain. Preperceptual auditory storage is the first step in auditory processing and starts right after an auditory stimulus enters perception. The duration of preperceptual auditory storage is very short. Most researchers agree that it lasts less than 300 ms. One compelling source of evidence for the duration of preperceptual auditory storage comes from the finding that when a sound is very short (e.g., less than 100 ms), it is still perceived as lasting for about a quarter of a second, which is considered to be the duration of preperceptual auditory storage (for a review see Cowan 1984).

Synthesized Auditory Memory

The auditory features stored in preperceptual auditory storage can be further analyzed to form integrated representations of sound. These integrated representations are considered to be stored in synthesized auditory memory (Massaro 1975). The term "synthesized" refers to the process in which auditory features such as pitch, loudness, and aspects of timbre are analyzed and combined into integrated auditory representations. The duration of the synthesized auditory memory appears to

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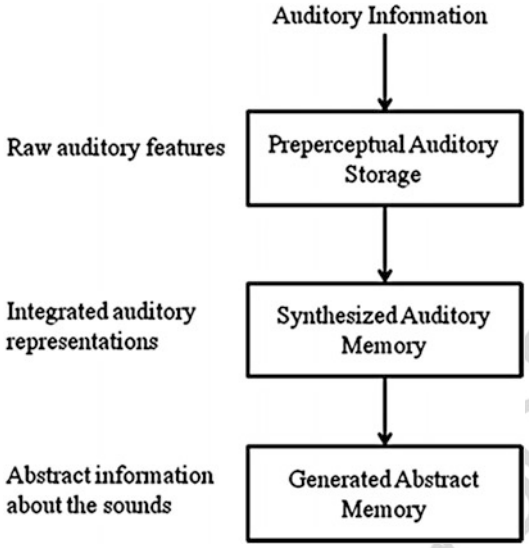

Fig. 1 Three phases of auditory memory according to Massaro (1975)

vary from less than 1 s up to 30 s, depending on how it is measured, but it is most often found to be several seconds (Cowan 1984).

The distinction between preperceptual auditory storage and synthesized auditory memory is supported by several lines of research, including backward masking, dichotic listening, and the suffix effect. One of the most convincing sources of evidence comes from a backward masking study by Kallman and Massaro (1979). Backward masking refers to the phenomenon that when two sounds are presented sequentially with a very short interval between them, the processing of the first sound (*target*) sustains interference from the second one (*mask*). Kallman and Massaro (1979) used two types of sound sequence: (1) standard tone, target tone, and mask (referred to as mask third or "M3") and (2) standard tone, mask, and target tone (referred to as mask second or "M2"). The participants needed to judge whether the target tone had a higher or lower frequency than the standard tone. In each type of sequence, the interval between the mask and its preceding tone (stimulus onset asynchrony or SOA) was varied, and the mask was either similar to the preceding tone or quite different from it (it was then a white noise). A prediction can be made on the basis of two forms of memory, preperceptual auditory storage and synthesized auditory memory. These two forms can be separately interfered with. In both types of trials, the comparison between the target and standard tones should be impaired by target-mask similarity at a very short SOA because at short SOAs, the similar mask interferes with preperceptual auditory storage of the preceding target tone. Additionally, in the *M2* trials only, it is expected that the comparison is always impaired by a similar mask, regardless of the SOA. The reason is that the mask in this procedure comes between the standard and target tones and therefore can interfere with synthesized auditory memory of the standard tone. These expectations exactly match what was found; the target-mask similarity mattered only at short SOAs in the *M3* condition, but it mattered at all SOAs in the *M2* condition. This finding supports the distinction between preperceptual auditory storage and synthesized auditory memory.

Generated Abstract Memory

The integrated representations in synthesized auditory memory can be further processed to form abstract representations in generated abstract memory (Massaro 1975). The abstract representations are considered to be domain general, meaning that they do not carry information about specific

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sensory details. Thus, abstract representations generated from each sensory domain (hearing, vision, touch, and so on) are all stored together in the generated abstract memory.

In more recent literature, generated abstract memory is often referred to as "the focus of attention" and is reported to have a core capacity of three to five items when various memory strategies are controlled (Cowan 2001). It is thought that information must be saved in generated abstract memory before high-level thinking about it can occur.

How Auditory Memory Is Used

Although auditory memory is usually partitioned into three phases, all three phases can be used in parallel to process auditory information. Suppose that you are sitting in a noisy airport reading and a stranger asks you what time it is. Even though you did not catch the words immediately, you can still extract the raw auditory information from the preperceptual auditory storage, except for the very last sounds that were masked by someone else nearby talking immediately afterwards. The extracted information is then integrated into synthesized auditory memory, which can save the auditory information long enough for you to turn your attention away from the reading and toward the sounds. When your attention is focused on the sounds, you can analyze the sounds based on their memory, using your existing language knowledge. You form a generated abstract memory of what the stranger meant, and you can then respond with the correct time if you have it. This is a typical scenario in which all three phases of auditory memory work together to serve the auditory processing involved in social interactions.

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