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Divided Attention

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Synonyms

Simultaneous attention

Definition

Attention is a fundamental cognitive process by which some inputs are selected for preferential processing. Divided attention specifically refers to situations in which two or more channels are attended simultaneously. The attended channels may be within the same or different sensory modalities. For example, a foraging bird might attend to a pile of seeds while simultaneously listening for the sound of approaching predators. While divided attention can be useful and can support a range of complex behaviors, it is often accompanied by a decrement in performance relative to selective attention, or focus on a single input.

Introduction

Divided and selective attentions have been extensively studied by cognitive psychologists. For example, in dichotic listening tasks (e.g., Cherry 1953), participants are simultaneously played two auditory messages and asked to monitor one or both. Participants can usually report the contents of one message, though accuracy is often impaired relative to when a single message is presented in isolation. More importantly, the contents of the other channel are significantly but not completely attenuated, with only major physical changes (such as changes in pitch or voice) and subjectively important messages (such as the listener's name or taboo words) being recognized. This has been dubbed the "cocktail party effect," in reference to the challenge faced by a conversant in a crowded ballroom.

While dichotic listening tasks are among the most widely utilized, similar results have been obtained from parallel visual procedures (Neisser and Becklen 1975), indicating that divided attention is not a purely auditory phenomenon. The results of such experiments have had profound theoretical implications and led to popular characterizations of attention as a bottleneck or selective filter (Broadbent 1958) that reduces inputs to an amount that can be managed by a limited capacity working memory. Though there is still debate about the nature of this filter and whether it applies relatively early or late in processing, most theories agree that attention to multiple inputs results in relatively poorer performance.

The complexity of the natural world and the corresponding diversity and sensitivity of many animals' sensory systems would suggest

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that a similar attentional filter would be quite useful for many nonhuman animals. Consequently, there have been efforts to apply similar logic and methods to study divided attention in nonhuman animals.

Methods of Studying Divided Attention in Nonhuman Animals

One of the most useful and direct procedures for studying divided attention uses a variation on the classic matching to sample task (e.g., Maki and Leith 1973). An animal is presented with a sample stimulus on a center response key, followed by two comparison stimuli on adjacent side keys. On single-element trials, the sample and comparison stimuli are all of the same type (e.g., all colors or all line orientations), and a response to the comparison stimulus that matches the sample is reinforced. On compound trials, the sample features two element types (e.g., a color and a line orientation), while the comparison stimuli still consist of single elements. A response to the comparison stimulus that matches either of the elements present in the sample is reinforced. Because the matching comparison stimulus could feature either of the elements present in the sample, an animal must divide attention between both sample elements in order to support accurate responding. Typical results indicate that there is an accuracy cost to divided attention: matching to sample performance is worse on trials with compound samples than on trials with single element samples. This result is consistent with bottleneck theories of attention: dividing attention between elements results in fewer resources allocated to each and thus poorer performance.

Divided attention also factors into other cognitive processes of interest to comparative psychologists. Categorization, for example, allows an animal to respond to a range of category exemplars with the same appropriate response, as when a pigeon recognizes a never-before-seen hawk as a dangerous predator and executes the appropriate evasive action. Given that the members of many natural categories vary immensely, and multiple perceptual dimensions may be simultaneously and jointly diagnostic of category membership, successful categorization frequently requires divided attention. While the numerous mechanisms underlying categorization are still being clarified, researchers have specifically investigated the role of divided attention in categorization. Herbranson et al. (1999) created artificial categories that varied continuously on two dimensions. Individual exemplars were rectangles that varied in height and width, and the relevance of each dimension to category membership was varied across conditions. In some conditions, only one dimension (either height or width) was diagnostic of category membership, whereas the other varied randomly and was unrelated to category membership. In other conditions, both dimensions were jointly diagnostic of category membership, and thus accurate categorization required attention to both dimensions. Pigeons' responses were mathematically analyzed to assess attention to the two stimulus dimensions. Results indicated that pigeons were capable of selectively attending to a single dimension or dividing attention between two dimensions, as demanded by the category structures in effect.

Another example of a cognitive process influenced by divided attention is visual search. Many animals can effectively scan their environment to identify specific targets based on visual features. Foragers, for example, use a specific searching image to spot prey at a rate greater than would be expected by their distribution alone (Tinbergen 1960). Cryptic prey in turn protect themselves by using natural camouflage that forces predators to search for a conjunction of features, rather than a single visual feature (e.g., a combination of shape and color, rather than shape or color by itself). Conjunction searches require that attention be divided between multiple visual features and consequently are more difficult than single-feature searches (Treisman 1986). Cook (1992) investigated this in the lab by presenting pigeons with texture displays on a video screen. Pigeons were trained to peck a small odd region of an otherwise uniform array of elements. On feature search trials, the odd region was differentiated by a single feature such as color (e.g., a small blue region among green elements) or shape (e.g., a small region of circles among squares). On conjunction search trials, the odd region was differentiated by a conjunction of color and shape (e.g., a small region of blue squares and green circles among green squares and blue circles). Conjunction searches required divided attention and resulted in lower accuracy than feature searches, though both were above chance. These visual search results further elaborate on the nature of divided attention by indicating that attention is not distributed exclusively across spatial locations. It can be divided among features within the same sensory modality and even in the same spatial location and yield the same pattern of results.

Conclusion

Animals have a limited processing capacity, yet live in a world where many aspects of the environment may be simultaneously relevant. In such cases, the ability to divide attention across multiple channels can be useful. Nevertheless, divided attention usually comes at a cost and results in poorer performance relative to situations that utilize selective attention. This ability to divide attention supports many critical cognitive abilities, including but not limited to categorization and visual search.

Cross-References

- ► Attention
- ► Camouflage
- ► Categorization
- ► Cognition
- ► Concept Formation
- ► Foraging
- ► Matching to Sample
- ► Perception
- ► Search Image
- ► Visual Search
- ► Working Memory

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