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Attention

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Attention is a construct for which everyone has an intuitive definition. While most of us believe we know what attention is, it is difficult to operationalize. Because it is a process that is so widely distributed throughout the brain, different networks have been proposed to explain the varying types of attention.

In some ways attention and perception are similar. You need to hear, see, or feel a stimulus to attend to it. But we can also pay attention to internal inputs such as thoughts and ideas. One can be distracted by thoughts that continue to intrude on your mind as well as memories that can be summoned by smells or songs on a radio. In this manner, perception and attention become separate but related constructs.

When a stimulus is perceived initially the perception is at the level of the senses. Additional information processing then occurs where a link for encoding is established in order for the information to be further processed. At this level, the processing is purely perceptual. Once analysis and encoding of the stimulus takes place, higher stages of information processing are used and attention comes into play. Generally stimuli that are salient and being attended to are processed and, subsequently, the person becomes aware of the stimulus.

Generally the most salient information of a stimulus is selectively attended to while irrelevant information is discarded. In this manner stimuli is selected to be attended to so that a person will not become overwhelmed by too much stimulation. At times, however, unattended information that was not completely deleted from conscious awareness is perceived by the person. If this information is important enough, it may become attended to and selected for further processing. This selection allows for previously irrelevant stimuli to become relevant when attention processes switch from attended input to unattended input (Broadbent, 1970; Treisman, 1969).

Woldorff and Hillyard (1991) studied the responses of attending to one ear while ignoring input to the other ear. Findings indicated that brain activity showed a larger response to the attended stimuli compared to the unattended one. Neuroimaging techniques can trace brain activity level to specific locations. The attention control systems have been found to affect how neurons interpret the features of the attended or unattended stimuli. In other words, attention directs which neurons fire in response to a perceptual input. For example, when a student attends to a teacher presenting in the classroom, neurons in the auditory comprehension and language areas of the brain become active while those in the motor or sensory areas of the brain are not activated. By having specific areas of the brain energized for selected types of tasks, the person is able to focus attention on those aspects and ignore extraneous noises and sensory input.

A Model of Attention

Posner and Raichle (1994) proposed a model of attention that involves three networks, with specific brain areas implicated for each network. The type of network activated depends upon how much conscious awareness is required for the particular attention task. The first network consists of the right frontal portion of the brain and a system that runs through the brainstem that permits the maintenance of alertness and vigilance. This system is the most basic network for attention and allows a person to attend to the environment. The second network includes the posterior portion of the brain and

structures in the center of the brain that are instrumental in the disengagement and orientation of attention to a new stimulus object or location. The third network, which is the most complex, consists of deep central structures and the front part of the brain, all of which have been implicated in the executive network of attention. This executive network plans and organizes the attended information after it has been brought into conscious awareness. According to Posner (1994), three stages are necessary for an individual to pay attention to a stimulus. First, the person must disengage attention from the current focus. Second, the person must shift or move attention to the new stimulus. Third, the person must engage attention onto the new stimulus. People who have attention difficulties (ADHD, particular brain lesions, etc.) may encounter problems at any of these three stages.

Types of Attention

The types of attention required for learning and memory are selective, sustained, divided, and alternated. Selective and sustained attention types are important for orienting and vigilance to the intended stimulus. Selective attention enables a person to overcome other inputs from the environment (e.g., noise) and concentrate on the signal of interest, with structures deep in the brain that help filter environmental distractions. If these structures are disabled, the person has difficulty filtering out irrelevant material and may become overwhelmed by too much input. Additionally, the frontal lobe is involved in the inhibition of unattended or extraneous environmental information and, therefore, plays a critical role in how information is selected.

Divided and alternating attention types are more complex, though it should be noted that selective and sustained attention types are still required for understanding the material. Divided attention occurs when an individual does two things simultaneously, such as taking notes and listening to the teacher. Alternating attention is when you need to shift your attention from one thing to another, such as when you are driving and you check your rear view mirror and then look at the road ahead. These types of attention require executive functioning of the frontal lobes and possibly the region of the brain that coordinates attention (anterior cingulate), which lies in the center of the brain and extends from the frontal lobes to the back of the brain.

Generally speaking, alternating attention is less difficult than divided attention. The key to alternating attention involves smoothly transitioning through Posner's three stages of attention as the person switches between two tasks. Attention problems at any of these three stages would make alternating attention most difficult. Additionally, the material currently not being actively attended to, analyzed, manipulated, and so forth, must be efficiently stored in working memory. Otherwise, the person would be starting anew on the task each time he or she redirected attention to the other task, as is required in alternating attention tasks. Divided attention is a much more difficult task because it entails attending to two different tasks simultaneously. This process can lead to a cognitive bottleneck in the brain of available resources given that selective and sustained attention as well as working memory (the central executive and executive attention) would be required to keep the two relevant *data sets* available for simultaneous use.

Inhibition and Filtering

The ability (or inability) for people to filter incoming information affects how they attend to information as well what information they attend to (relevant versus irrelevant stimuli).

When participants are asked to attend to only one ear and ignore input to the other in a listening experiment, healthy participants show more response on electroencephalogram (EEG) recordings to the attended ear. This difference is absent in people with brain injury in the frontal lobe (Knight & Grabowecky, 1995). Inhibition of the unattended stimuli must occur to avoid overwhelming an individual with too much information. When inhibition does not occur, difficulties are frequently present in memory because the information has flooded the resources of the brain.

For people unable to filter information, all information becomes important and the person can easily be overwhelmed. In the case of a loss of filtering (or inhibition), information pours into the frontal lobe and the person can be quite vulnerable to such an overload. For people with this difficulty, basic cognitive skills are generally found to be intact (normal IQ), but the person has a very difficult time navigating through life and maintaining focus on the task at hand.

Working Memory

Attention has a limited capacity. Therefore the flow of information needs to be modulated so that it becomes manageable. Here is where filtering and inhibition operate as particularly important constructs. Working memory has been conceptualized as a temporary and limited capacity network that sustains the current contents of information processing. In other words, it allows us to remember an item while we think of it. For example, when looking up a phone number we rehearse the number in working memory until we use the number. To keep the information in working memory long enough to hold it or manipulate it, one must selectively attend to the desired information while filtering out irrelevant input. If interrupted on our way to the telephone, we will lose the number.

Additionally, one must keep the attention sustained on the material to manipulate or process it; otherwise the shift in attention will cause new items to be placed in working memory that displace the earlier items in storage. Working memory can decay relatively rapidly. In order for the material to become transferred into the long-term memory systems, the person needs to spend additional time attending to the information, such as through active studying and rehearsal (which require selective and sustained attention).

Development of Attention

Attention is a process that improves with age. In infancy and young childhood there is rapid development in many areas, including attention. Infants and young children learn to remember information and will consciously try to attend to tasks, particularly if they are novel in nature. Wellman (1988) hypothesizes that preschool children remember information because they attend to a repeated stimulus over time, and strategies are developing during this time. Divided attention begins emerging at around 2 to 4 years of age and improves drastically by age 7 (Teeter, 1998). In kindergarten, children learn how to selectively attend and focus attention on relevant versus irrelevant material. Although strategies are not developed by this time, involuntary attention heuristics are being developed.

Children in middle childhood, ages 6 to 12 years, begin to learn that attention strategies are needed to study and learn a particular task or to solve a problem (Berk, 1989). Attention becomes more under the child's control and can be sustained as well as

planned. In addition, children learn how to adapt attentional processes to cope with environmental demands (Teeter, 1998).

Older children work at ignoring irrelevant details and distractions when learning. Thus they become more attentive and are more successful in focusing attention. The ability to use alternating attentional skills improves during early adolescence and depends on task demands—as tasks become more demanding, these skills are less effective (Teeter, 1998). During late elementary and early middle school years, attention becomes more deliberate, planned, and adaptive.

In adolescence, attention becomes more focused while at the same time diversifying into improvement in divided and alternating skills. Adolescents must learn how to take notes as well as to pay attention to classroom presentations. They also must improve their ability to focus on important aspects of life while attempting to control their attention to salient aspects of the environment (i.e., the opposite sex). Meanwhile, the ability to understand learning and analyzing their own performance is also important and develops rapidly during this phase of life and into adulthood. These skills are very important not only for cognitive development but also for success in interpersonal relationships. Some of the skills in attention and insight continue to improve through the third decade of life coinciding with increased differentiation of the frontal part of the brain.

In adulthood, attention continues to improve through the twenties. The ability to analyze one's behavior and change accordingly is an important related skill and crucial for coping with life. In people as they age, the ability to attend to more than one aspect of the environment at a time decreases; however, focused (sustained) or selective attention continues to be good as a person ages (until an elderly age, which varies with the individual).

Memory and Attention

Learning and memory are also related. Learning is how we acquire new information, while memory has to do with storage and the ability to retrieve this information (Squire, 1987). Distractibility and inattention can negatively impact our ability to remember things. For this reason, people with attentional difficulties are frequently also thought to have memory problems. For something to be remembered, it must be attended to first! Ultimately, the attention processes lead to the learning of the information that, in turn, leads to memory formation. Some types of memories require more overt attentional processes, such as knowledge of facts for both storage and retrieval processes. Other types of memories—such as procedural memories (tying a shoe)—may require selective and sustained attention for storage but do not require intentional attentional resources for retrieval.

Challenges in Attention

Children with attentional difficulties frequently experience problems in school and with peers. In school they may have difficulty completing assignments, following directions, and following through on requirements. They may be seen as flighty, disorganized, and irresponsible. Many times these same children are frustrated when they cannot complete assignments and are confused as to “why the teacher is mad at me.” Children with significant difficulties in this area may be diagnosed with attention deficit hyperactivity disorder (ADHD). This disorder is characterized by problems in attention,

impulse control, and sometimes with activity level.

Many people may have difficulty with attention but do not qualify for a diagnosis of ADHD. It is likely that attentional skills lie along a continuum. Because attentional abilities can differ among children, even those without ADHD, providing assistance for these attentional skills in the classroom is an important function of teachers. Providing frequent breaks, allowing the child to break tasks into smaller parts, teaching the child how to budget and manage time, and providing reminders and support are techniques that assist children with attentional difficulty. Visual cues are particularly helpful for children and people with attentional difficulty. Children with attentional difficulties who participate in classrooms that allow for cooperative learning and provide hands-on or visual support are often more successful.

Attentional difficulties, at times, result from medical problems. Severe traumatic brain injury frequently occurs with attentional problems, particularly when severe. Children with attention problems have also been found to have a higher incidence of head injury, possibly caused by poor impulse control. Treatments for leukemia and childhood cancer may also result in difficulty with attention. Individuals with emotional problems such as anxiety and/or depression also have concomitant attentional problems.

Attention is not an all-or-none skill, and it is affected by task demands. A person may do well on tasks that require sustained attention but have significant difficulty on tasks that require divided or alternating attention. Developing coping skills for these tasks is particularly helpful for children and adults. For example, audiotaping a lecture for a college student can help provide additional notes that may have been missed when first listening to the lecture. Providing a lecture outline also can help to focus attention on salient points. For adults, the use of an organizer or a personal digital assistant (PDA) device also provides assistance.

Thus, attention is a skill that develops over the life span and assists one in regulating behavior as well as adapting to changing environmental demands. Attention is intimately entwined with perception, memory, emotion, and learning.

- selective attention
- divided attention
- stimuli
- brain
- brain centers
- filtering
- memory

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See also

- [Attention Deficit Hyperactivity Disorder](#)
- [Time on Task](#)

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