Review Article

BIOMEDICAL Journal of Scientific & Technical Research

ISSN: 2574 -1241

DOI: 10.26717/BJSTR.2023.49.007836

Attention as a Cognitive Function

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ARTICLE INFO

Received: March 24, 2023

Published: April 11, 2023

Citation: Theofilidis Antonis, Savvidis George and Sofologi Maria. Attention as a Cognitive Function. Biomed J Sci & Tech Res 49(4)-2023. BJSTR. MS.ID.007836.

ABSTRACT

The concept of attention held a special place during the historical development of psychology (Cohen, Sparkling –Cohen & O' Donell, 1993). Although hundreds of articles dealing with the concept of attention are published each year (Whyte, 1992a), due to the lack of coherence at a conceptual, methodological and theoretical level, there continues to be disagreement among scientists (Anderson, Craik & Naveh-Benjamin, 1998. Van Zomeran & Brower, 1994) on the nature of attention.

Aim: The main purpose of the article is the definition of attention.

Method: a review of the literature was made and the most representative articles on the concept of attention were selected.

Conclusions: Attention is a multifaceted concept. Its special nature leads to the non-existence of a unified psychological theory that will explain and include all its dimensions.

Keywords: Cognitive Functions; Attention

Introduction

The concept of attention held a special place during the historical development of psychology (Cohen, Sparkling –Cohen & O'Donell, 1993). Although hundreds of articles dealing with the concept of attention are published each year (Whyte, 1992a), due to the lack of coherence at a conceptual, methodological and theoretical level, there continues to be disagreement among scientists (Anderson, Craik & Naveh-Benjamin, 1998. Van Zomeran &Brower, 1994) on the nature of attention. The meaning and nature of attention has not been defined even today. This signals the problems faced by clinicians due to attention deficits, which are secondary to brain damage and can have negative effects on patients (Cohen, Malloy, Jenkins 1998) (Van Zomerem, et al. [1]). Attention is usually described as a wide variety of abilities, processes and cognitive states, which concern how an organism takes in stimuli but also how the processing of the stimulus (either internal or external) can begin (Parasuraman [2]). Attention incorporates a new range of cognitive functions, such as focused attention, sustained attention, divided attention, and vigilance, yet the terminology for its classification varies. In brain-injured patients, reduced reaction time and reduced speed of information processing are notable examples of attentional deficits (Gronwall, et al. [3-7]). Concentration problems, increased rate of distraction, inability to recall, and inability to perform more than two tasks simultaneously are also seen in people with acquired brain damage (Hinkeldey, et al. [8]), (Mateer, Sohlberg & Crinean, 1987).

Neuroanatomical Background of Attention Functions

Three separate but interconnected brain circuits control attentional functions (Posner, et al. [9]). These are:

A. The orientation of attention in space. This first circuit depends on the posterior attention system, which includes the posterior parietal lobe, the superior gyrus, and the lateral nucleus of the preoccipital thalamus. Spatial orienting of attention refers to orienting to simple stimuli. An important element of perception is the shifting of attention from one object to another. According to PET (positron emission tomography), when a person's attention shifts to a visual field, both the posterior (superior) parietal cortex and the frontal cortex are activated. This has to do with the different aspects of attention. For example, the parietal region is activated when attention is shifted based on sensory signals, independently of performing an overt movement. The frontal region is active only when selective stimuli lead to an overt response. Observation of patients with lesions in the parietal or frontal cortex reinforces this view. When patients with damage to the parietal lobe simultaneously receive stimuli in the left and right visual fields, they fail to locate the sensory stimulus on the opposite side of the lesion. This defect, known as attenuation, appears to reflect the inability to shift attention to the contralateral space, that is, the space opposite the lesion, when attention is focused elsewhere. Although the inability to focus spatial attention does not by itself explain the wide range of observed phenomena contributing to inattention, it appears to be an important contributor to the clinical syndrome. Like neglect, extinction is much more common for right-sided stimuli. Data from positron emission tomography show that the asymmetry is observed because the right hemisphere is able to direct attention to both the left and right visual fields, whereas the left hemisphere can only control attention to the right visual field. Attention to the left visual field leads to activity in the right superior parietal cortex. Attention to the right visual field elicits bilateral activation in one area in the left superior parietal cortex and in separate areas in the right superior parietal cortex. So there are two clear ones representations in the right superior parietal lobe for directing attention separately to the left or right visual field, while there is a single representation in the left superior parietal lobe for directing attention primarily to the right visual field.

B. Target selection and conflict resolution. This circuit is executed in the anterior brain regions, which include the anterior arcuate fasciculus and supplementary motor areas. The thalamus is a brain structure directly linked to the selection of requested information. Information is collected in the brainstem's nonsensical pathways. In this process, the nuclei of the brain play an important role, as well as the selection of information, which proceeds to higher-level processing, as well as the selection of information, which, coming down from the cortex, is integrated and sent for further analysis (Mateer, Ojemann 1983). The ability to shift and switch attention is related to the foregoing and is a function primarily associated with activation of the anterior arcuate fasciculus (Bakay Pragay, et al. [10]).

C. Alertness/Maintaining attention. The third circuit is used when attention needs to be maintained in the absence of new external stimuli. Right prefrontal regions and the norepinephrine system are involved in maintaining vigilance. Working memory also recognizes the contribution of multiple systems to the successful storage and retrieval of memory, as its processes help to temporarily hold information and activate brain networks that include areas of the dorsolateral prefrontal cortex, with differential localization for verbal and spatial material. and posterior regions (Awh, et al. [11,12]). It is considered to be a crucial concept for understanding the term attention. Working memory is that which allows the individual to temporarily actively store information until it is used or to maintain immediate access to already stored information. For example, working memory allows the individual to retain information for as long as it takes to record it and to direct the individual's attention temporarily to a task and then successfully return to the original activity. Sustaining attention, selecting requested information, capacity for information processing ability, and switching attention between two tasks rely on working memory but also on the processes of the central processor, which is the link between permanent storage and of working memory (Baddeley, et al. [13]). Working memory is understood to be linked to an active set of control processes, including rehearsal, encoding, decision, and retrieval strategies. These processes facilitate the encoding and retention of information in a temporary storage area. Working memory requires not only the storage and retrieval of information, but also the manipulation of that information for task purposes. The figure below shows working memory, which depends on retrieving and storing information.

Special Characteristics of Attention

There are several researchers (Leclercg, et al. [2,14,15]) who are satisfied with the characteristics of attention, attributed by James (1890). These characteristics concern two areas of attention, reflexive and voluntary. Reflexive signals the automatic processes, while voluntary signals the controlled processes of attention. Spikman, Kiers and their colleagues (2001), called them respectively «Stimulus-driven reaction» and «Memory-driven action», emphasizing in particular that control by the subject is a primary characteristic of the latter. Other characteristics of attention that have been recognized are its finite reserve and its finite ability both to change its focus and to respond to aesthetic or semantic features of the stimulus. Another type of differentiation between attentional activities has to do with whether it is sustained tonic attention as in vigilance, or switched accordingly as phasic attention, which orients the organism to changing stimuli. Most researchers, (Lavie, et al. [1,15,16]), understand the concept of attention as a system in which processing takes place sequentially through the stages in the various brain systems that belonged to attention (Butter, et al. [17,18]). This system appears to be organized in a hierarchical manner whereby early input is specialized according to the primary sense, while late processing, for example at the level of awareness, is suprasensory (Butter, et al. [9,17]). Attention disorder can result from damage involving different parts of this system (Robertson, et al. [19,20]). A notable feature of the attention system is its limited capacity (Lavie, et al. [1,15,16]). The limitation of the amount of processing that can take place at a given time is such that the system's engagement in processing a task that requires controlled attention may interfere with a second task that has similar processing demands. For example, someone may be unable to concentrate on a radio newscast while closely watching a sporting event on television yet can easily perform a task that requires automatic (in this case highly overlearned) attention such as driving on a familiar route while listening to the newscast. The ability to pay attention varies not only between different individuals but also within the individual at different times and under different situations. Depression or fatigue, for example, may temporarily shrink attentional capacity in a normal adult (Landro, Stiles, Sletvold 2001), (Zimmerman, et al. [14]), yet old age (Parasuraman, et al. [2]), (Vander Linden, Collete 2002), along with brain damage may limit the ability to pay attention more permanently (Robertson, et al. [1,19,20]).

The Nature and Classification of Attention

The terminologies regarding the functions of attention vary, as do the articles that have been published (Bracy, 1994). Many researchers have given different terms to a function that serves the same purpose (Bracy, 1994). A typical example is the ability to switch one's attention to different tasks (e.g. driving and listening to a radio broadcast), referred to as "switching attention" by Sohlberg and Mateer (1987), as "strategic control" by Whyte (1992a), as "selective response and intention" by Cohen et al. (1998), as "selectivity" by (van Zomeren, et al. [1]), as "orientation to simple stimuli" by Bracy (1994) and as "vigilance function" by Posner and Rafal (1987). The table below presents the theoretical and clinical definitions of attention functions.

Models for Attention

There is considerable overlap between factorial models of attention, cognitive processing models of attention, and clinical models of attention. Most of the factor models include functions related to sustaining attention over time, capacity for information, shifting attention, as well as the detection and exclusion of off-target information. For example, in their factor model Mirsky, Anthoni, Duncan, Ahearn, and Kellam (1991), identify four factors for attention:

1) Focus-execution,

2) Maintenance,

3) Encoding, and

4) Shifting.

In a clinical model for attention, Mapou (1995) includes the following factors: attention activation, capacity, resistance to interference, and mental manipulation. Cognitive processing models incorporate the concepts of vigilance, selection, dual-task performance, and automaticity (Baddeley, 1986). According to the review of various models of attention, related to individuals with head injuries, attention maintenance, selection, capacity, and attention switching emerge as key theoretical concepts with a high degree of clinical relevance [21-23].

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ISSN: 2574-1241

DOI: 10.26717/BJSTR.2023.49.007836

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