Attention : a vital cognitive process

Sachin K Salim (14575)

1 Introduction

Cognitive psychology[1] is the branch of psychology that is concerned with scientific study of mind. The term 'cognitive psychology' was coined by Ulrich Neisser in 1967 in his book with the same title. Cognitive psychology consists of many different processes that are linked to each other by the nervous system that control them. These processes are usually referred to as the cognitive processes and include perception, attention, thinking and decision-making. They are created by the specialized regions of brain which work together to form a unified experience.

One of the most important of these processes is attention. Attention determines our experiences by directing our focus towards a particular point of interest. But unfortunately, we do not have complete control over attention. Most of us have experienced difficulty in focusing on a task and get distracted by some unexpected events. Attention has to do mostly with current awareness. It might be expected that current awareness is the awareness of all the events taking place in the given moment, but it is more like a fragment of all the current events since one cannot attend to all the events taking place at a time because of the limited capacity of the brain.

So now the question arises on which parts of our experiences do one attend to, or more precisely how does the brain determine which stimuli should it neglect and which ones should it let through. This question is what psychologists have been trying to answer for decades. Through this paper, I try to answer why it is important to learn about how attention works.

2 Previous Work and Research

One of the first theory on attention was Broadbent's filter model[2] in 1958. The main idea of this model is that information is processed early in perceptual process and unwanted/unattended information is filtered out. The stimuli is processed based on physical properties like color, intensity, amplitude, etc.

Then came the Treisman's Attenuation Theory[3] in 1964. She replaced the filter in the Broadbent's model by an attenuator that weakens the unattended stimuli instead of completely rejecting it. Another main difference of this theory from that of Broadbent's is that Treisman argues that information is selected after the meaning is processed, and not during early stages of processing. Treisman showed through her experiments that the subjects were able to process the meanings of both the attended and unattended messages if the unattended message surpasses a threshold, mostly determined by its meaning. A familiar

word such as one's name has a low threshold while an uncommon word has a higher threshold to prevent inappropriate intrusion to awareness.

Treisman later came up with the Feature Integration Theory[4] which states that different visual stimuli such as colour and orientation are extracted preattentively while the complete objects are recognised at a later stage. This theory proposes that simple physical features like colour are learned in parallel while more complex features such as a mix of multiple simple features require a linear search.

Some researchers believed that attention was not just based on the physical properties of the stimuli. This idea, known as the Memory Selection Theory of Attention[5], claims that all the incoming messages pass through the initial filter and then later processed and separated based on its meaning. The attended messages are then passed onto the short-term memory.

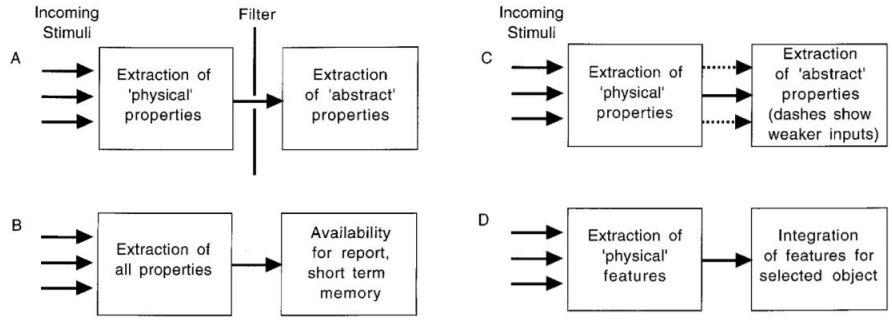

Figure 1: Schematic depiction of four influential accounts of selective attention[6]:
A - early-selection filter theory
B - a rival late-selection account
C - Treisman's (1960) 'attenuation' version of Broadbent's theory
D - Treisman and Gelade's (1980) feature integration theory

3 Attention

Attention is the ability to concentrate on a particular stimuli from our surrounding, and is mostly accompanied with partial or complete ignorance of other stimuli. The 19th century psychologist and philosopher William James describes attention as "the taking possession of the mind, in clear and vivid form, of one out of what may seem several simultaneously possible objects or trains of thoughts... It implies withdrawal from some things in order to deal effectively with others".

3.1 Types of Attention

Attention is divided into four categories[7].

1. Selective attention: It occurs when certain features are blocked out to focus on a particular feature of interest.

Eg: When we are reading a book in a cafe and not pay attention to other conversations.

2. Divided attention: It is used when we attend to two things at once.
   Eg: Talking to co-passenger while driving.

3. Sustained attention: It occurs when we concentrate on a particular task for a long duration of a time.
   Eg: Working on a painting for hours.

4. Executive attention: When we block out unimportant features to focus on what actually matters, we use executive attention.
   Eg: When we are working on a research paper by making a detailed plan and keeping track of the progression.

3.2 Importance of Attention

Most of our day-to-day activities require attention for its successful performance. One way to realise the importance of attention is by learning about what happens in the lack of proper attention and why it occurs.[8] Internal preoccupations or internal stimuli such as pain or hunger often become the object of current attention at the expense of intended external sensory information. Irrelevant external sensory information might also distract an individual from what they are focussing to. This distracting stimulus is most likely a high priority signal like the chime of the notification from your mobile phone or someone calling out your name. One might also get distracted easily if the task she is engaged in is simply not interesting.

Attention improves our efficiency in performing a sudden physical task by preparing the motor part of our body to respond very quickly to the expected cue.[9] For instance, when an athlete is waiting on the starting line and hears the call of 'Ready', she prepares herself by attending completely to the next call of 'Go' to start running. Attention also improves sensory discrimination by giving more prominence to the objects of interest which then enters into our focus of consciousness. Attention can be used for acquisition of skill. Most skills require a careful attention to the hands and movements at beginning. But soon, they become automated and such attention may no longer be required. Attention also aids in learning and remembering as we tend to retain the details of specific areas accurately where we are paying attention to and forgets the unattended parts soon.

3.3 Understanding Attention

We tend to ignore some sensation in order to focus on a particular information. You might have experienced situations like failing to notice someone talking to you or walking past you because you were deeply involved in a task like drawing or watching a movie. This ignorance happens because our attention is limited. Researches have been going on for quite long to find out exactly how many things can a human brain focus on at a time. Studies have also shown that this limitation is not just on the capacity, but also on the duration to which we can pay attention to a task. These abilities are mostly influenced by our interest

on the task being performed and the amount and strength of the distractors experienced.

By studying neural activities that takes place in human brain by ERPs recorded as voltage fluctuations in the scalp or by functional imaging, it can be learned to a great extent on how attention actually works.[6] Even though pioneers such as Steven Hillyard and colleagues had conducted revealing attentional experiments using ERP several decades ago, it has reached the wider audience it deserves just recently. In one of these experiments, a particular visual stimulus shows a larger amplitude ERP when attended than when unattended verifying the attenuation theory of Treisman. Similar results can also be obtained by functional imaging methods like fMRI which provides a better localization information.

To further affirm why attention is essential, let's see the case where people fail to recognize a stimulus that is in plain sight, labelled as inattentional blindness (IB)[10]. In an experiment conducted on IB, 25% of the observers failed to detect a stimulus present in plain sight within 2 degrees of fixation for 200 ms as they were attending to another object. Further research on this then newly found topic of IB led to the hypothesis that conscious perception is not possible without attention. The increasing significance of IB shifted the focus of research from exploring the properties of objects perceived without attention to what properties a stimulus should possess to attract attention.

Two famous models were developed in 1980s to understand about how visual attention works. The first of these is referred to as 'spotlight' model[11] since this model compares the way attention works to that of a spotlight. The geometric center of visual attention from which information is extracted in high-resolution is termed as the focus. Information is extracted in a much more vague way from the area around the focus, termed as fringe which extends up to a cut-off called margin. The other model called zoom-lens model[12] has all the properties of spotlight model. In addition to that, it has the property of changing the size of focus but in the cost of processing efficiency.

4 Real-life Applications

Even though we take the ability of attention for granted, we knowingly or unknowingly process megabytes of information per second and filter out most of them because of the capacity constraint we already discussed. For instance, when we listen to a person speaking, we not only pay attention to what she is speaking, but also to her expressions and body language even though we might not realise that. These additional information can help a lot in determining her emotions and feelings. Researching and conducting experiments on attention to learn how our brain does this filtering mechanism, i.e, on what basis does it classify the relevant and irrelevant information will hopefully make us capable to master the art of paying more attention to what matters and neglect the unwanted things.

4.1 In Advertising

Understanding of the science behind visual attention is a great tool for finding out how people look at an advertisement[13] and what qualities make a product

draw attention most quickly. An important aspect of attention regarding this is iconicity, i.e, the expectation of us for the pictures around us to verify the conception we have of the world. So if a picture in an advertising poster violates any physical law such as a tilted bottle of a soft drink ad defying gravity, it draws our attention so effectively. Besides this, marketers also use archetypes such as the depiction of a flawless woman that appeals to common notions of beauty in order to engage the audience.

4.2 Attention Disorders

A deep understanding of how attention works is essential to learn about different kinds of attention deficit disorders. A serious developmental disorder called Autism[1] occurs in people when the link between attention and social interaction is disturbed. These people tend to withdraw contact from other people and often fails to interpret other's emotions in social situations. Even though they face difficulty in actual social situations, studies suggest that they do not have problem in solving problems involving social situations.

Another common deficit following a brain damage is the unilateral neglect[14] - the inability to process and perceive stimuli on one side of the body or environment, where that inability is not due to a lack of sensation. When two events are presented simultaneously from two sides to an individual suffering from this disorder, they tend to miss out the event delivered on that side of the space where they have difficulty in attending to, and report only the event from the other side.

4.3 Attention Enhancing Drugs

Persistent researches on how attention works paved the way for the invention of cognitive enhancing nootropics[15] that are primarily used to treat attentional difficulties like ADHD. However healthy individuals, mostly students from competitive colleges, use these drugs to enhance their attention and productivity despite the side effects. It is still an ongoing debate among neuroscientists and psychiatrists about the use of these drugs without any medical indication.

5 Future Directions

We have learned a lot on the way from the models of Broadbent and Treisman on attention to the current cognitive approaches.[6] From a topic which was not payed much 'attention' in early 20th century, attention turned out to be one of the central topics in psychology and neuroscience later.

One of the topics of interest in the future research is determining the relations between different kinds of attention. For example, the way in which audiospatial attention determines visuospatial attention is yet to be learned in detail. Another development is on how the brain directs the motor processes to carry out a particular activity as the researchers have realised the pressure of selective processing to pick out a specific action since even an infinitely potential brain can direct one's eyes and arms to a single or very few tasks at a time. Another trend to be noticed is the unification of psychology and neuroscience

with the development of more and more sophisticated functional imaging methods. In particular, fMRI allows a detailed study of selective attention in brain by measuring the change in blood flow according to how our attention changes.

We've to make sure not to get lost in the potentially infinite number of questions and methods and lose focus on what the big picture is about. History suggest that for most of the discoveries, their real-life applications may not be very clear, but sooner or later they tend to rise in importance when more research is done on that topic.

References

1. Cognitive Psychology: Connecting Mind, Research and Everyday Experience, 3rd Edition, E. Bruce Goldstein.

2. Broadbent, D. (1958). Perception and Communication. London: Pergamon Press.

3. Treisman, A., 1964. Selective attention in man. British Medical Bulletin, 20, 12-16.

4. A Feature-Integration Theory of Attention, Treisman & Gelade, Cognitive Psychology, 12, 97-136 (1980).

5. Deutsch, J. A.; Deutsch, D. (1963). Attention: Some theoretical considerations. Psychological Review, 70, 80–90.

6. A selective review of selective attention research from the past century, Jon Driver, British Journal of Psychology (2001), 92, 53–78.

7. Attention as Part of Cognitive Development: Definition & Process, Jade Mazarin, 'http://study.com/academy/lesson/attention-as-part-of-cognitive-development-definition-process.html'

8. Inattention and distractibility, W. Cheyne McCallum, 'https://www.britannica.com/topic/attention/The-neurophysiology-of-attention#toc242025'

9. 'What is the importance of Attention in Learning?', Jay Prakash, 'http://www.preservearticles.com/201105206854/importance-of-attention-in-learning.html'

10. Inattentional Blindness - An Overview, Arien Mack & Irvin Rock, PSYCHE, 5(3), May, 1999

11. Eriksen, C; Hoffman, J (1972). "Temporal and spatial characteristics of selective encoding from visual displays". Perception & Psychophysics. 12 (2B): 201–4. doi:10.3758/BF03212870.

12. Eriksen, C; St James, J (1986). "Visual attention within and around the field of focal attention: A zoom lens model". Perception & Psychophysics. 40 (4): 225–40. doi:10.3758/BF03211502. PMID 3786090.

13. Attention in Advertising, Mike Vito and Louis Perrotta, BC: Art and Visual Perception, 2 May 2006.

14. Unsworth, C. A. (2007). Cognitive and Perceptual Dysfunction. In T. J. Schmitz & S. B. O'Sullivan (Eds.), Physical Rehabilitation (pp. 1149-1185). Philadelphia, F.A: Davis Company.

15. Lanni C, Lenzken SC, Pascale A, et al. (March 2008). "Cognition enhancers between treating and doping the mind". Pharmacol. Res. 57 (3): 196–213. doi:10.1016/j.phrs.2008.02.004. PMID 18353672.