Chapter 4: The Varieties of Attention

Overview

"Attention" refers to a concentration of mental activity. If you think of perception as referring to how we process sensory input, then attention is what *selects* aspects of the environment to process. Attention is important for all areas of cognitive performance. Cognitive researchers tend to specialize in very specific areas of cognitive performance (for example, there are "memory researchers" and "reading researchers") but it should always be kept in mind that they interact a great deal. If you are, for example, testing memory performance, how well someone does on a test of memory will have a lot to do with the quality of the attention they paid to the items that are to be remembered.

The function of attention is not only to direct processing *toward* important stimuli and tasks that we are currently performing but also to *ignore* what's not important. **Selective attention** tasks require responding selectively to certain types of information while ignoring others. We are impressively capable of doing this even in challenging situations. For example, in a crowded room in which music is playing and conversations are going on all around you, it is usually not particularly difficult to selectively attend to the particular conversation in which you are involved.

The ability to selectively attend to specific information while ignoring distracting information also applies to objects in our environment. **Spatial attention** is often compared to a spotlight that focuses our attention on a specific location while keeping the surrounding area in attentional darkness. This spotlight can move in visual space either voluntarily (**endogenous shifts**) or involuntarily (**exogenous shifts**) when something in the environment captures our attention.

Of course, not everything in our environment captures our attention, and the ability to ignore objects in our environment is a key part of selective attention. One way of thinking of how we ignore distracting information is that it is *intentional* **inattentional blindness**—*trying* to ignore distractions. Inattentional blindness itself is, of course, unintentional. We sometimes fail to notice a new object that appears suddenly and unexpectedly when we are paying attention to other events in a scene. This unexpected object is more likely to be missed when it appears far away from the task-relevant action (i.e., farther from the focus of attention) but the "gorilla video" described in the text demonstrates that distance is not always a good predictor of our blindness to objectively noticeable objects. Participants were likely to miss the gorilla even though it was very much in the centre of where they were looking—it's almost as if participants look around the gorilla to count the passes!

One of the best-researched examples of selective attention is performance on the **Stroop task**. For literate adults, reading is so effortless and automatic that it is impossible to see words and *not* read them. Therefore, when asked to name the ink colour of an incongruent word, word-reading interferes with colour-naming. Something interesting to note about Stroop interference is that it is asymmetrical: incongruent words slow colour naming but incongruent ink colour does not slow word-reading. That is, if the task is to read the word "blue," it doesn't matter if the word is in blue or red. This shouldn't be too surprising—we read words all the time; we don't often name ink colours. Reading relies on automatic processing; colour-naming requires conscious processing.

Several theories have been proposed in an attempt to explain the nature of the limits to how much information a person can attend to at one time. Attention may be thought of as a finite resource that can be used up (the **capacity model**). It may be vulnerable to **structural limits**, where-

by similar tasks create interference. It is also sometimes conceived as a **bottleneck** with a fairly narrow passageway through which the information has to pass. Only so much can get in at once.

Dual task situations are likely to cause interference and, thus, compromise task performance. Even the seemingly benign act of **mind wandering** can contribute to such interference. As well, if attention is considered to be a stream of consciousness, a switch in task type may introduce a break in the stream. A cost in terms of speed and/or accuracy of task completion is likely following a task switch.

The **attentional blink** occurs when two stimuli are presented in very quick succession. The visual system seems to be overloaded in this case and the second stimulus is missed. This is *like* an eye blink in that the item was missed as it would have been if the eye had blinked at that particular time. Demonstrations of the attentional blink can be found online (see the link below) and it is useful to provide students with the experience. The attentional blink, like inattentional blindness, demonstrates that we can sometimes miss things because our attentional resources just can't keep up.

There are times, however, when it is crucial for us to pay attention to a task over a prolonged period of time. Research on **sustained attention** and **vigilance** (our ability to sustain our attention) suggests a negative correlation between time on a task and performance on the task. Specifically, the longer we are required to dedicate attention to a task, the worse our performance on that task becomes. This **vigilance decrement** has been explained through two dominant views, each one focusing on the demands of the task. The overload view suggests that attentional resources become depleted on high-demand tasks leading to the decrease in performance. The underload view, on the other hand, suggests that the vigilance decrement occurs on low-demand tasks because the tasks do not offer sufficient stimulation to hold our attention.

To provide background for an examination of **overt attention**, the textbook provides a description of types of eye movements. This provides an opportunity to discuss the various realms in which eye movements have been used as measures of attention. Market researchers may use eye trackers to ensure that attention is focused on the target aspects of advertisements. Eye tracking can be used as a measure of what effective inspectors should look at when judging quality in assembly lines. An inspector who has been doing a specific type of quality control for a long time learns what to look for (just as a doctor knows what to look for on an x-ray) but they may not know how to *describe* what they're looking for since it has become so automatic. By measuring eye movements, it's possible to measure what exactly they are fixated on and this can be used to help teach novices what to look for.

Learning Objectives

In this chapter students will:

- Distinguish between theories of early and late attentional selection and review experimental evidence for each.
- Discuss endogenous and exogenous shifts of spatial attention and how attentional capture and inattentional blindness are complementary aspects of cognition.
- Review experimental studies investigating divided attention.
- Explain why mind wandering reduces attention to a primary task.

- Discuss the vigilance decrement and explain why performance on some tasks declines over time.
- Distinguish between covert and overt visual attention.

Key Concepts with Illustrative Examples

attentional blink (see page 104)

The attentional blink refers to a half-second gap in attention that occurs when you shift your attention from one object to another. This gap results in a failure to notice the second of the two stimuli presented within 550 milliseconds of each other. We frequently experience attentional blink in our everyday lives. For example, imagine you are driving down the road when the car ahead of you begins to drift into the other lane. Watching the actions of that car limits your ability to focus on anything else that might happen in front of you for the next half second. Although a half second does not sound like a lot of time, when you are behind the wheel of a moving vehicle it can mean the difference between being able to stop for a person on a crosswalk and possibly having an accident.

controlled vs. automatic processing (see page 91)

Automatic processing proceeds without conscious thought or planning. Tasks that are either very easy or very familiar/practised tend to be processed automatically. Controlled processing involves intentional effort and occurs with tasks that are more difficult and/or unfamiliar. Tasks that first require controlled processing can become automatic. Learning to read, for example, may require a great deal of conscious effort whereas recognizing familiar words after years of reading experience is quite automatic.

covert vs. overt attention (see page 111)

Covert attention and overt attention differ with regard to eye movement. Overt attention can be quite easily behaviourally measured by tracking eye movements; covert attention is not directly observable. Imagine assessing attention paid to commercial advertisements. Market researchers sometimes use eye trackers as a measure of what catches peoples' overt attention (what they're likely to notice, what they spend the most time looking at). Covert attention is likely just as important but is more difficult to assess.

divided attention (see page 100)

Although, obviously, we can't pay attention to everything at once, it is possible to divide attention between more than one stimulus. Driving is a good example of a divided attention task; a driver must simultaneously control the steering and the brake while watching for changes in the environment. On top of that, drivers may be conversing with someone in the passenger seat, fiddling with the radio, or eating lunch. Although we may be able to split attention among variance tasks, performance on each individual task is likely to suffer.

endogenous vs exogenous shifts (see page 93)

Endogenous shifts of attention are voluntary shifts that occur as we move our attention from one object to another. Exogenous shifts, on the other hand, are an involuntary response to external stimuli that captures our attention regardless of our intent. For example, if you are reading a book and you decide to check the time, you would be making an endogenous shift of attention. If, however, you were reading your book and your dog suddenly barks, your attention would likely involuntarily shift to the dog. In other words, you would exhibit an exogenous shift.

inattentional blindness (see page 96)

Inattentional blindness occurs when we are so focused on one aspect of our environment that it leads to the failure to attend to events that we might expect to notice. For example, you are engrossed in watching a movie and do not notice your roommate come home.

inhibition of return vs the cueing effect (see page 95)

The inhibition of return (IOR) is the reverse of the cueing effect. In the cueing paradigm, participants are presented with a location cue followed by a target stimulus that appears either in the cued location or the uncued position. In the cueing effect, participants respond faster to targets that appear in the cued trials than in uncued trials. In the inhibition of return, also known as the reverse cueing effect, participants respond faster to uncued trials than cued trials.

mind wandering (see page 103)

We have all engaged in mind wandering at some point. Mind wandering describes a shift of mental resources away from the task at hand and towards internal thoughts. For example, you might have found that sometimes after getting home from work or school, you realize you were so lost in thought you do not remember much of the drive home.

selective attention (see page 90)

Selective attention refers to the ability to attend to relevant information (that which is important to the task at hand) and ignore irrelevant, unimportant information. Imagine reading a book in a crowded coffee shop: your reading comprehension will require blocking out extraneous goings-on.

switch cost (see page 108)

Task-switching involves shifting attention from one task to another. There is likely to be a switch cost in that responses are slower and include more errors after a switch in focus. This is very relevant to the level of multitasking that is common among students. If a student is sitting in class attending to the lecture and switches her attention to Facebook or a text message or a whispered conversation with a classmate, there will be a cost to re-attending to the lecture material. Comprehension of the material will be compromised.

Discussion and Debate Ideas

1. Ask students to consider the connection between inattentional blindness and eyewitness testimony. Roughly half of naïve participants fail to notice the gorilla amongst the basketball throwers. What if they had been asked to give eyewitness testimony for that episode? When asked, "Did you see a gorilla?" they would have emphatically answered "no." Explore the real-world consequences of the limitations of "meta-attention"—what we know (or don't know) about our attentional processing abilities.

2. Ask students to come up with some examples of tasks that have become so practised that they don't require conscious processing. Ask them to consider what happens when conscious processing is applied to tasks that don't require it. For example, what if you really think about how you're tying your shoe? Performance in such a situation may actually be hampered by conscious thought. Furthermore, there may be a negative relationship between the level of automatic skill and the ability to describe task performance. Who would be a better shoe-tying teacher: a 6-year-old novice or a 16-year-old expert?

3. Don't think of a pink elephant. Discuss the "ironic effects" of mental control. Sometimes trying *not* to pay attention to something makes it especially likely to come to mind.

4. Have the class consider the scan path and fixation differences between good and poor golf putters. Ask them which they believe comes first: the "good" scans or the good putting? Discuss implications for *teaching* good putting.

5. Attention is important to our survival. Have students discuss the adaptive purpose of different aspects of attention such as inattentional blindness, exogenous shifts of attention, and attentional capture.

6. Have students share their own action slips and have them explain them in terms of parallel mental activity.

7. Many people think they can successfully multi-task even though research on divided attention suggests otherwise. Have students discuss their experiences of multi-tasking. Examine cases where the student felt it was either successful or unsuccessful, asking them to outline possible reasons within the context of the text book (e.g., automatic vs. controlled processing for the two tasks, mind wandering, structural limits, or the capacity model).

8. Given the demands of our environment today, is it more beneficial to be able to attend to a wide range of objects simultaneously or to focus our attentional resources on a specific object (spotlight metaphor)? Have students discuss the advantages and disadvantages of each option.

9. Popular media and some clinicians often portray Attention Deficit Hyperactivity Disorder as being over-diagnosed. Discuss the reasons why the diagnosis of this disorder may have increased since the 1990's. Topics that could be discussed are a better understanding of the disorder, better testing methods, and social acceptability leading to a willingness to be tested.

Further Reading, Media Suggestions, and Teaching Aids

1. **Simons Lab Videos, University of Illinois: http://www.simonslab.com/videos.html**

   As referenced in the previous chapter's instructor's manual, the Visual Cognition Lab at the University of Illinois has a website with some fascination demonstrations of attentional limitations. The video used for the original gorilla experiment is available. Also posted is a variant of the gorilla video (The Monkey Business Illusion) that includes extra changes (one of the players leaves the game and the background curtain changes colour). As students may have seen or read about the original before, the variant may be an especially effective demonstration of missing *unexpected* changes.

2. **The "Attentional Blink" Test: http://www.youtube.com/watch?v=MH6ZSfhdIuM**

   This clip is a useful demonstration of the attentional blink.

3. **Conway, A.R.A, Cowan, N., and Bunting, M.F. 2001. The cocktail party phenomenon revisited: The importance of working memory capacity. *Psychonomic Bulletin & Review, 8,* 331–335.**

   Some individuals are more prone to the cocktail party effect than others. In this study, it was found that people with a low working memory capacity were much more likely to hear their name in a message that they were supposed to be ignoring.

4. **MacLeod, C. (2005) The Stroop task in cognitive research. In: Cognitive methods and their application to clinical research. *American Psychological Association*. 17 – 40**

   In this book chapter, the author reviews variations of the Stroop task that have been used across the years. Also discussed are the many factors that influence the results of this task and the issues that have arisen with its use for clinical research.

5. **Spering, M., & Carrasco, M. (2015) Acting without seeing: Eye movements reveal visual processing without awareness. *Trends in Neuroscience*, 38, 247 – 258.**

   Eye tracking research is often considered a strong indicator of overt attention. In this article the authors review recent research linking different types of eye movement dissociations to perception without awareness.

6. **Dukewich, K., & Klein, R. M. (2015). Inhibition of return: A phenomenon in search of a definition and theoretical framework. *Attention, perception, and psychophysics*, 77, 1647-1658.**

   Inhibition of return (IOR) refers to an effect whereby participants are slower to respond to a target stimulus presented at a location previously inspected than one presented at a new location. The authors review the variety of research conducted since the discovery of IOR as well as the many explanations offered on the effect. They further argue that the broad range of explanations is preventing a unified theory of IOR from being developed.

Homework or Study Questions

1. **Review the theories of attentional limits.**

   One explanation of limits in attention is the capacity model. By this view, attention can be thought of as the contents of a reservoir. Using up the supply drains capacity. Another hypothesis proposes that there are structural limits to attention. Interference occurs when two similar activities are engaged in at the same time. The greater the similarity, the greater the interference. Another set of theories uses the analogy of a bottleneck: a narrow path can only let through task-relevant information.

2. **How can the Stroop effect be explained with reference to controlled and automatic processing?**

   Literate adults have much more practice reading words than naming ink colours, so when we're presented with the word "blue" in red ink, the response we automatically tend to give is "blue." Reading is so automatic we find it difficult *not* to do it. The task we're *supposed* to be performing is naming the colour of ink, but that requires more conscious processing because it's something we are not nearly as used to.

3. **What are the differences among saccades, fixations, and nystagmus?**

   Our eyes are always moving. The movements, though, vary a great deal. Saccades are rapid and jerky. Fixations are pauses between saccades and typically last between 200 and 300 milliseconds. Although fixations keep the eye relatively still, there are continuous small movements called nystagmus.

4. **How does the sustained attention to response task (SART) demonstrate that mind wandering is associated with reduced attention to the primary task?**

   Christoff, Gordon, Smallwood, Smith & Schooler (2009) had participants perform a SART task that involved pressing the spacebar when a digit was presented on a computer screen but not pressing it when an infrequent "critical digit" was presented. Attentional effort is required to withhold responding to the critical digit. A commission error, then, demonstrates a lapse of attention. The task is relatively easy, but boring, and, predictably, participants' minds start to wander quite quickly. Researchers occasionally asked participants whether they were attending to the primary SART task or whether they were mind wandering. Brain activity was measured by having the participants complete the task in an fMRI scanner. Brain activity and SART behaviour were compared in the 10 seconds prior to mind wandering and the 10 seconds prior to on-task performance. Participants made more commission errors in the short time before mind wandering that on-task performance. Mind wandering was found to be associated with increased activity in a set of areas of the brain that are known to be active when people are simply thinking, not engaged in any directed activity. It seems that mind wandering compromises performance on the primary task, using up some of our limited attentional resources.

5. **Explain the spotlight metaphor of spatial attention. Describe how this spotlight can be moved in space.**

   The spotlight metaphor is sometimes used to describe spatial attention. The spotlight acts similarly to attention in that it brings objects from a specific spatial location into conscious awareness with other objects in the environment. The spotlight of attention can be moved in two ways—through voluntary shifts of attention called endogenous shifts, and through involuntary exogenous shifts caused by something in the environment that captures our attention.

6. **Describe the connection between the cueing paradigms, stimulus onset asynchrony (SOA) and inhibition of return.**

   Although participants typically respond faster to target stimuli that appear in the cued position, as the interval between the cue and the presentation of the target (SOA) increases, participants become slower to respond to the cued location and faster to respond to targets in the uncued position.

7. **Explain how attentional capture and inattentional blindness might be considered complimentary processes.**

   If an object or event in our environment has captured our attention, it is unlikely that we will notice if something that is unexpected enters the environment. Therefore, inattentional blindness can be seen as a mechanism that allows us to focus on more salient objects or tasks.

8. **Define switch costs and explain why it might occur.**

   A switch cost is the finding that, when we switch our attention from one task to another, we often experience a decline in performance on the task to which we have just switched. This cost is likely due to the mental set that is established by the first task.

9. **Explain the vigilance decrement in the context of the overload and underload views**.

   According to the overload view, the vigilance decrement is likely to occur on more complex tasks because the attentional resources required by the task become depleted. The underload view, on the other hand, addresses the vigilance decrement on tasks that are less complex in that the decrease in performance occurs because the task itself is not sufficiently stimulating to sustain attention.

Suggestions for Research Paper Topics

1. How do good readers tend to differ from poor readers in terms of saccadic eye movements? What implications might there be for reading instruction?

2. Eye-tracking can be used as a measure of attention. What are some potential applications of this? For example, how could the business world use it to improve advertisements? How could factories use it for improving product inspections?

3. Box 4.1 explores the intriguing case of déjà vu. "Jamais vu" is sometimes described as the opposite phenomenon: a temporary lack of recognition for something that is familiar. Can you find a scientific explanation for jamais vu? Are déjà vu and jamais vu two sides of the same coin?

4. All 10 Canadian provinces and two of the territories have legislation in place that bans the use of hand-held cell phones while driving. Hands-free calls, though, are allowed. As a student of human attention, you know that hands-free is not good enough. Cell phone *conversations* impair driving. With reference to what you've learned in this chapter, write a letter to the provincial government arguing that they should ban all cell phones while driving. Back up your arguments with support from research on attention.

5. As more research is conducted on attentional blink the theoretical explanations for this phenomenon have changed substantially. Review the current literature and outline the development of the various explanations.

6. What can eye tracking tell us about cognitive processing in persons with autism? Review the literature connecting eye gaze and the social deficits commonly found in this disorder.

7. Research on inhibition of return suggests that there may be times when exogenous cues may be detrimental to performance. Based on this, examine the role of inhibition of return in some common types of traffic accidents.

8. According to the Canada Safety Council, one of the most common causes of workplace accidents is inattention. Research the factors that might play a role in workplace accidents. Some examples that could be explored are the vigilance decrement, mind wandering, or inattentional blindness.

9. Attention Deficit Hyperactivity Disorder (ADHD) is one of the most common childhood disorders. Review the core attentional symptoms of this disorder, and speculate how these symptoms may affect performance on some of the experimental tasks outlined in the chapter. Some examples would be the peripheral cueing task, Stroop task, and SART.