4a | Introduction to Attention

The famous philosopher William James, in his textbook Principles of Psychology, remarked:

"Everyone knows what attention is. It is the taking possession by the mind, in clear and vivid form, of one out of what seem several simultaneously possible objects or trains of thought. Focalization, concentration of consciousness are of its essence. It implies withdrawal from some things in order to deal effectively with others, and is a condition which has a real opposite in the confused, dazed, scatterbrained state which in French is called *distraction* and *Zerstreutheit* in German." William James, from *Principles of Psychology*, pp. 381-382.

As we'll see in this module, James' comments were amazingly prescient. Not only is attention one of the most studied areas in cognitive psychology, but the issues that James focused on are still hot topics of debate today.

In this unit on attention we'll focus our attention on how theorists believe we perform selective attention- in other words how we decide what to pay attention to- how and why it is that some behaviours or actions seem not to require any attention at all, or are automatic, what can happen when there are problems with attention, some of the so-called disorders of attention, and attention in the real-world. The popular press is rife today with reports of cell phone use while driving a car. What does our knowledge of attention have to say about this?

4b | Selective Attention

We've all had moments like the little boy in the cartoon. We know we were present to receive some information, but just don't seem to have access to it. This is undoubtedly a failure of selective attention to help us process what we should be processing. Sometimes, despite our best intentions we find our mind wondering and we leave a situation without vital information that we should be able to remember.

We'll start our attention unit with a short demonstration. On the screen in front of you, you'll see a paragraph written in two fonts—a bold font and an italicized one. Take a moment to read only the message written in the bold font, beginning with the word **Among**. While you're doing this I'm going to ask you to perform a technique that was first used in psychology a long time ago. That's the technique of introspection and you probably remember learning about that in your introductory course. In introspection, what you are asked to do is think about what you're asked to do is to think about your experience as you're performing some task. So as you are reading this paragraph I want you to think about what makes it hard to do, what makes it easy to do? What kinds of things are affecting you while you read this paragraph?

Now that you have finished reading, what was it that you read? Were you able to understand the bold message? Did you happen to notice any of the italicized text? If you are like most observers, you were able to get the gist of the text in bold, but you also had intrusions from things you were not supposed to pay attention to. Certainly the content or the story line of the text and its syntax or the rules for putting sentences together helped keep you on track, it helped keep you able to read the message in bold. As for what made the task more difficult, people generally mention that novelty, like the presence of numbers, emotional words, and names were likely to be distracting. Those were the types of things that they ended up noticing.

We'll begin now with our discussion of the theoretical views of selective attention. The key elements in these theoretical approaches concern when selection takes place, that is, how much processing do we do on information before we say that attention actually selects that information. The other main issue that we're interested in is not only the fate of information that we do select to process, but what actually happens to that information that we don't select for processing? Does any of that get in and can any of that information ultimately affect our behavior.

Broadbent

One of the first theoretical views of attentional selection was Donald Broadbent's Filter Theory. His model is referred to as an "Early Selection" model because it posits that attentional selection operates very early in the stream of processing, before the observer actually knows what the information is and that this selection is based only on physical characteristics like where the information is coming from, its pitch, volume, colour, brightness, and so on. Critically then, selection occurs early, before any meaning information, also known as semantics is processed from the item.

The figure in front of you depicts the dichotic listening task. This was one of the most popular methods of studying selective attention. In this task, an observer is played two distinct messages, one in each ear. The observer is then asked to shadow one of those messages. Shadowing is essentially repeating everything that is spoken to you, as quickly and as accurately as possible. Anyone who has a brother or sister has likely experienced shadowing as

an attempt at sibling irritation. Shadowing in an experimental setting is actually very difficult however, because the second message is played at the same time. What Broadbent found was when observers in his experiments were doing a good job of shadowing the message they were supposed to paying attention to, let's say it was the left ear, they noticed virtually nothing at all about the message being played in the right ear. They might notice the volume of the message or the pitch of that message, but they could not accurately say what was being spoken. That was true even if the same word was repeated again, and again, and again in that other ear. They also were unable to notice if the language spoken in that second ear was different from the language in the ear they were shadowing.

Broadbent argued then, that attentional selection was selecting material from the appropriate channel, allowing it to be processed to the point where one can understand that information. Moreover, he said that information in the unselected, unattended channel was not being processed beyond its basic physical features, and certainly not enough to allow the observer to know what that information was or even what language that information was being conveyed in.

As is often the case in science however, things can turn out to be much more complicated than they initially seem, and problems with Broadbent's Filter Theory began to appear.

You've probably experienced one of these problems first hand. Have you ever been in a crowded, loud party and been struggling to carry on a conversation with a friend? You find yourself concentrating on his or her words so that you can hear them over the background noise. All of a sudden, you hear someone mention your name- not calling out to you- just in regular conversation. According to Broadbent, that should not occur, because you had not selected that information. Instead, you were intently processing your own conversation and therefore you should not have "known" that it was your name that was being spoken.

This phenomenon is known as the cocktail party effect and was described by Moray in 1959. Using a dichotic listening task, Moray showed that people often did notice their own names when their own names were played in the unattended channel, even though they were keeping up with the difficult task of shadowing information in the attended channel. Again, according to Broadbent, that should not have occurred.

Treisman

Work by Anne Treisman further underscored this problem with Broadbent's model by showing that when shadowing we sometimes do pick up information from the unattended channel, but only when that information is important to us. So for instance, it could be our name, or a warning word like fire, or some other information that's relevant to the context of the information we're currently trying to process.

This led Treisman to propose our second model of attentional selection, the Attenuation Theory, or Leaky Filter model. Hers, like Broadbent's, is an early selection model and states that there is almost no processing of information from the unattended channel. The only information from the unattended channel that will be become processed is information that ultimately leaks through the filter and that's because that information has some kind of special value to us.

Corteen and Wood

Perhaps the most clever challenge to the class of early selection models was an experiment done by Corteen and Wood at the University of British Columbia. If you remember back to your days of studying introductory psychology, you'll know that it is possible to elicit a fear response to a non-fearful stimulus by simply pairing it with an aversive event, such as an electric shock.

Corteen and Wood paired select Canadian city names, such as Vancouver, Montreal, Regina and Winnipeg, with electric shocks until the mere mention of these city names produced a fear response that could be measured in the observers' galvanic skin response or GSR. A GSR measures changes in respiration, perspiration, and so forth that can be picked up on the skin.

Corteen and Wood then had their observers participate in a dichotic listening task and asked them to shadow a message. Unbeknownst to the observers, Corteen and Wood played the names of the Canadian cities in the unattended channel. Despite the fact that the observers did not report hearing the city names, they produced a GSR when the names were played, indicating that they had indeed processed this "unattended" information.

Even more amazingly, Corteen and Wood had also embedded names of other Canadian cities in the unattended message. These city names, such as Toronto, Saskatoon and Halifax, had never been paired with shock before. Fascinatingly, the observers also produced GSRs when these new city names were presented, despite the fact that they were not aware of having heard them.

This clearly indicates that these items were processed to the level of semantics, as only then can one know that Toronto is indeed a Canadian city. This result provided a major challenge to early selection theories, as it would suggest that perhaps all information in the unattended channel is processed all the way to the level of meaning or semantics, even if the observer never becomes aware of that.

Deutsch

Results like those of Corteen and Woods led to the development of a late selection model of attention, also known as the Deutsch-Norman model.

This model posits that all information—whether we are trying to attend to it or not- is processed until the point at which we can access its meaning in long term memory. Selective attention then operates at this late stage in order to direct our awareness or to guide our response to that information.

So, even if we aren't aware of information, it is possible that we have processed it and have actually activated its representation in memory and that it can, in fact, influence our behavior.

4c | Automaticity and Practice

In the first part of our unit on attention, we talked about attention as our ability to process or respond to some things, but not others—so-called selective attention.

In this section, we will view attention according to a resource metaphor—much like having the fuel that is necessary to accomplish some task. For instance, we all have the intuitive sense that it takes many more resources, or much more attention, to read our cognition text the night before the big exam than it does to read our favourite novelist in bed on a rainy day. Likewise, those first few times we drove a car, operating that vehicle required so many attentional resources that we couldn't listen to music or carry on a conversation without sometimes feeling overwhelmed. Now, however, it seems hard to imagine driving without music and we are sometimes even tempted to carry on a cell phone conversation while we're driving— but we'll talk about that specifically later.

We say a process or a behaviour becomes more automatic as it requires fewer attentional resources to perform. This typically occurs with practice. For instance, in addition to driving and listening to music, you probably find it much easier now to listen to a lecture and to take notes at the same time than when you began university and it may have felt like a struggle to keep up with the pace that your instructor was setting.

In addition to practice leading to greater automaticity and the need for fewer resources to complete a task, it can sometimes have an unwanted side effect. That is, sometimes the more automatic behaviour becomes so automatic that we simply cannot prevent it from happening, even when we don't want to do it, and when doing it actually impairs our ability to do the thing that we're trying to do.

Stroop

The Stroop effect, named after John Ridley Stroop, is probably the best known example of the interfering effects of a relatively automatized process. In addition, the Stroop effect is one of the most popular and well studied phenomena in psychology. There have been hundreds of papers published on the Stroop effect since John Ridley Stroop published his first paper on it in 1935.

We'll introduce the idea of an automatized process actually interfering with behaviour by way of an experiment. While performing the following little experiment, I'd like you once again to practice introspection. That is, as you're performing this exercise, think about what you're experiencing.

Your task is a simple one—one you've likely been able to do since you were a toddler. The next slide you're are going to see a column of ink colours and what I'd like you to do beginning at the top of the screen and working your way down, is as quickly as you possibly can, yet as accurately as you possibly can, name aloud the colour of the ink that you see. While you're doing this please remember to introspect and think about what the process is like for you. After you've completed the first slide, please do the same thing, name aloud the ink colours that you see for each of the following two slides.

What happened? You undoubtedly found slide 3 to be much more difficult than either of the other 2. Indeed, when we perform this experiment in a large classroom, the class inevitably

breaks into laughter because they find this process so frustrating. You obviously noticed that whereas the stimuli on slide 1 were colour bars, on slides 2 and 3 the ink colour was carried on a word spelling a colour name. On slide 2 the ink and word indicated the same colour name, whereas on slide 3 they indicated different colours. It is hypothesized that reading is such an automatic process in expert readers that one cannot prevent it, even when its effects are deleterious on what we intend to do. This in fact is what produces Stroop interference which you likely just experienced.

Those of you with little brothers or sisters, say in kindergarten, will find that they are not at all troubled by Stroop interference, or at least not like you are. They simply are not yet expert readers performing an automatic behaviour. For them, reading is a controlled behaviour. If you have a friend who is just learning a new language, you might also find that in the new language, these individuals do not yet produce Stroop interference, although they would produce Stroop interference in their native language. Beginning readers and readers learning a brand new language are not yet expert readers performing an automatic behaviour. For them, reading is still a controlled process.

Controlled Processes

What, then, are the theoretical characteristics of controlled vs. automatic behaviour? Controlled behaviours are said to be those that we undertake serially, or one at a time, and that require attention. Moreover, they are said to be capacity limited, meaning that if we attempt a second process that also requires attention while we're trying to perform the first, at some point we'll not have enough resources to perform both—we'll simply run out of fuel. Finally, controlled processes are under our conscious control.

Remember those early days of riding a bicycle or driving a car? Remember how aware you were of trying to stay balanced and when to brake when you're on your bike, or how to keep on the road or when to shift if you're learning to drive a car? As proficient bicyclists and drivers, we're simply not aware of those things anymore.

In contrast to controlled processing, automatic processing occurs without our intention, and we often are not aware of doing it. It does not require attention, so it in itself does not interfere with other mental activities, although the result of such automatic processing might, as we just saw as in the case of reading in the Stroop task. When you read those words, it actually interfered with your ability to name the contrasting ink colours.

Finally, automatic processing can occur in parallel with, or along with, other processes and they do not constrain capacity limitations, because they require little or no attention at all.

To summarize, then, in this section we've discussed attention as a processing resource, and we've seen that humans can be quite flexible in allocating this resource, but that there are some limitations, and sometimes these limitations in themselves interfere with behaviour.

4d | Disorders

So far we've talked about selective attention and attention as a resource and we've done so discussing what we call normal or "intact" populations. These are most commonly psychology undergraduates that we study in the lab. It is also true, however, that we learn a great deal about attention by studying individuals who have undergone unfortunate brain traumas and those traumas have led to various disorders of attention.

One class of brain trauma that often leads to a disorder in attention is stroke. As of the end of 2009, the Heart & Stroke Foundation of Canada reports that there are over 50,000 strokes in Canada each year. Of these 75% of individuals are left with at least a minor impairment or disability, and an impairment in attention is commonly seen.

The most common attentional disorder is known as visual neglect and is also sometimes called hemispatial neglect or unilateral neglect.

Visual neglect is associated with lesions in the parietal area of the right hemisphere. As a result, the patient tends to "neglect" the contralateral hemi-space. In other words, the patient suffering from a RH parietal lesion will neglect the left visual hemi-space. In some cases, the patient will even neglect the contralateral, or left side of his or her body, even sometimes denying that the left arm or the left leg belong to him or her!

It is important to note, however, that this is an attentional deficit, rather than a sensory one. It isn't that the patient cannot see the information in the left hemi-field, but rather that he or she cannot pay attention to it. Some patients even report the feeling that their attention is being held on the right side and that it cannot be moved to the left.

Some very simple tasks can be used to show the profound effect of unilateral neglect. One of the most readily used is the line bisection task. In this task, a person is presented with a horizontal line and simply asked to draw a vertical line to bisect the horizontal line, or cut it in half. As shown in the slide, whereas most people are pretty accurate at this task, a person suffering from neglect will bisect the line much too far to the right, indicating a failure to attend to the left part of the line when judging its length. Researchers often present individuals with not just a single line for bisection, but with many spread across a page. Whereas an intact individual will bisect them all, an individual with neglect generally fails to attempt any of the lines on the left side of the page.

Neglect can also be demonstrated by providing patients with simple drawings to copy. Their reproductions of the objects , although fairly accurate on the right showing that they can still see and draw, typically miss most, if not all of the information on the left, even resulting in incomplete objects that don't make sense. Again, it is not the case that the patient cannot see what is there, the processes that support vision are intact. They simply cannot pay attention to it. This doesn't occur just for tasks such as line bisection and copying. Sadly, unilateral neglect affects all aspects of the individual's life, even things as important as eating and grooming. Patients often fail to eat food on the left side of their plate and to groom half of their bodies.

One of the most profound demonstrations that visual unilateral neglect is an attentional disorder, and not a disorder of visual sensation was published by Italian researchers Bisiach and Luzzatti. They tested two individuals who suffered from unilateral neglect who had grown up in

very distinct, old, Italian villages. In these villages, important buildings such as churches, town halls and libraries were organized on a square plaza, centered around a fountain. Bisiach and Luzzatti asked the individuals to imagine that they were standing at one end of the plaza, say on the steps of City Hall, and to look out and describe the plaza. Their patients accurately described the "right hand side of the scene," but neglected all the buildings on the left. Next, Bisiach and Luzzatti asked them to imagine that they were at the other end of the plaza, standing on the steps to say, the Catholic Church, and to describe what they remembered seeing. Once again, they accurately described the right hand side of the plaza, but ignored all the buildings on the left. Incredibly, this means that they had just described buildings they had previously neglected to report, while neglecting to report buildings they had described only moments earlier. Clearly, all the information was present in memory and hadn't been simply forgotten. The patients' ability to attend to the left hand side of a visual memory was clearly affected.

So, as we see, brain injury can have a profound effect on our ability to attend to visual space. In term of our earlier metaphors, people suffering from neglect have difficulty in selecting information from visual and or mental space.

4f | Summary of Attention

To summarize our exploration of attention, it is important to keep in mind that we framed this concept in a few different ways. We spoke about attention as a selection device, which allowed information to be processed, and we found that selection is likely much more flexible than we initially believed, although there are probably also some serious limitations.

Selection appears to be early—or before meaning—sometimes, and late—or after meaning—at other times. This may even be in response to the environment, our internal state, and the number and type of other things that we're trying to do.

We've seen that automatic performance, or performance requiring little or no attention, can come from practice, as in riding a bicycle. This often brings benefits, as in allowing us to think of things other than just how to balance when we're biking, but it can also result in interference from the automated process. We experienced this first hand with the Stroop effect.

We discussed the fact that we can learn about attention by investigating cases in which it is impaired, as in unilateral visual neglect.

Finally, we broadened the scope of our treatment of attention beyond the lab, to consider its impact on life in the so-called real world. We talked about the impact of cell phone use on driving. As technology continues to advance, you can rest assured that attention researchers are going to stay very busy.