The Distinction Between Conscious versus Unconscious Cognitive Processing: Implications for Acquired Brain Injuries

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The goal of my talk is to highlight the interplay between conscious and unconsciously influences on performance, and to highlight their differential sensitivity to brain injury. The first part of the talk defines how cognitive psychologists think of conscious and unconscious influences, both defining the terms and making the distinction clear by highlighting the interplay of these influences in experimental and real world contexts. The second part will then consider how brain injury relates to this distinction, highlighting the fact that conscious influences are often, although not always, more strongly affected by brain injury.

The terms "conscious" and "unconscious" are both used in a variety of contexts, often with very different connotations. For example, within a medical context, patients who are asleep or in a coma are considered unconscious; those who are not are considered conscious. Thus, the distinction is related to whether the patient in essentially interacting in an alert manner. Within psychology this distinction is more nuanced, where the notion is that even though a human is awake and alert, their behaviour might be influences by cognitive processes of which they are aware of unaware; processes thus labeled as conscious or unconscious.

Even within psychology the specific nature of conscious, and especially unconscious, processes depends partly on one's orientation within the field. Following the tradition of Sigmund Freud, clinical psychologists working within a psychoanalytic framework see unconscious influences as reflecting deep motivations, often of a sexual or aggressive nature, that are attempting to fulfill certain needs or desires in a manner that does not conflict with an individual's desire to be seen as a good person. Thus the unconscious is sometimes portrayed as a semi-intelligent entity attempting to satisfy goals of which the person is unaware.

I am a cognitive psychologist, a psychologist who is primarily interested in the mental processes that underlie behaviour. From the perspective of a cognitive psychologist the distinction between conscious and unconscious processes is best translated as a distinction between goal-directed versus habitual behaviour. This distinction is best explained via example.

When we first learn to drive a car, we need to learn how to map behaviours of our body onto desired behaviours of our car. If the car has a standard transmission this can be quite a complex mapping that involves us learning how to depress the clutch with one foot and we release the gas with another, then shifting a gear shift at the appropriate time as we also release the clutch and apply the gas. Even when the transmission is automatic we still need to learn how and when to appropriately apply gas, brakes, and how to map movements of the steering wheel with changes in

the direction of the car. What's more, we have to do all this while constantly monitoring conditions on the road.

When we first begin performing these behaviours we do so using with a heavy, if not exclusive, reliance on conscious processes. That is, someone explains to us the things we have to do and watch out for. We keep these things constantly "in mind" as we attempt them, which often results in very crude and non-graceful performance. Do you remember the first time you tried backing into a long drive-way or performing a parallel park? If you are at all like me you were constantly over-steering, going too far one way, then overcorrecting too much the other way. If one were watching you from above they would see a car snaking its way down the drive or into the available spot.

However, as we kept driving, and kept practicing, slowly our driving behaviour became more graceful. Oddly, as it did so, the extent to which we thought about what we were doing actually became reduced. This is a process that psychologist call automatization. With repeated practice any behaviour becomes both more elegant and less conscious. This is a gradual process, but for most of you this process has proceeded to the point where you can drive to work in the morning with barely a conscious thought about driving. You may be worried about your work day, or your family, or various chores you need to perform, but you're not worried about your driving. The driving just happens smoothly because you have formed effective habits; habits like stepping on the brake when brakes alight on cars in front of you, stepping on the gas when lights turn green, or backing into long driveways without over-steering. Thus, habits allow us to perform even very complex behaviours, like driving a car with a standard transmission, almost completely without conscious thought, allowing us to use our conscious thought for other purposes.

At this point in the learning process, a cognitive psychologist would say that your driving behaviour is being controlled by unconscious processes; processes that monitor the environment and emit appropriate behaviours without bothering to alert your conscious mind. Critically, they are not doing so because they want to, or for any other motivation associated with any sort of "intelligent" behaviour. Rather, they are essentially mimicking the stimulus-response mappings originally performed, in an albeit non-graceful manner, when the behaviour was consciously controlled. It is almost as if unconscious processes see what the conscious processes do in certain contexts and, over time, take over in a more fluid manner.

One thing to take from all this is that, in the vast majority of situations, unconscious processes are extremely useful. When some behaviour involves a very consistent mapping between environmental situations and appropriate behaviours, unconscious processes learn these associations and take them over, freeing up conscious thought for other tasks. Given we can only consciously think about one thing at a time, this is a luxury, almost akin to having a maid, cook or gardener deal with the mundane aspects of life so that we can focus on the sorts of activities we would rather be doing.

Another important thing to note, and one of the main messages of this talk, is that in most cases conscious influences are far more fragile than are unconscious influences. Unconscious influences reflect habits formed of many repetitions. In computational models of the brain, these influences are often seen as reflecting a so-called "slow learning" mechanism often assumed to be associated with association cortices. Association cortex is spread throughout the brain, essentially connecting those parts of the brain that orchestrate to give rise to the habitual behaviour in question. Thus, driving requires the integration of vision, sound, tactile and motor behaviours to operate properly and, through repetition, association cortex slowly links these areas in ways that allow a proper behaviour (e.g., depressing the brake with your foot) to occur when certain stimuli (e.g., red tail lights, or a red stop light) are present in the environment. Because these associations are extremely broad and distributed, they are relatively insensitive to damage or interference. As they say, you never forget how to ride a bike.

Conscious, or goal-directed, behaviours are much more fragile. They typically rely on direct involvement from the frontal lobes, sometimes to overcome the influences of habit. The frontal lobes can be very busy, and can typically only focus on a single goal at a time. So let's say that you drive to work 5 days a week, and your typical drive is about 15 kilometers and involves about 10 different points where you have to change your direction of movement (i.e., turns). Today, however, is Saturday, and you intent to go to the mall, not to work. As it turns out, this requires you take a roughly similar route but, after about 12 kilometers, your turn left instead of right and, of course, proceed differently from there. Off you go to the mall. A while later, to your complete surprise, you find yourself turning into an empty work parking lot. What happened?

What happened? You were likely thinking about something else at the time when you had to turn left instead of right. Maybe you were singing along with the radio, or planning some future activity or worrying about something stressing you at work. Whatever it was, if your mind was on it then it likely was not thinking about the change of route. Habit took over, and just brought you alone the path of strongest history. It's what psychologist term a "Capture Error", when behaviour is captured by habit even when it opposes our current goals.

These kinds of situations can also be reproduced in a psychology lab. One example uses a recognition test to assess memory. The recognition test works like this. A list of study items are presented, usually one at a time. Participants are asked to "study" each item for a later test of memory. The test consists of presenting a single item at a time. On half of the trials the item was presented in the earlier study list, and these items are called OLD items. On the remaining trials the items are were not presented at study; so-called NEW items. Participants are asked to look at each item and to decide whether they think it is old or new.

In one variant of this task, half of the items in the study list are uncommon items, and half are common items. Similarly, half of the new items are uncommon and half are common. When one examines memory in this situation the results show that

common items that were actually NEW are more often mis-categorized as "old" when they are common that when they are uncommon. This is assumed to reflect the fact that common items generally feel familiar, and this higher familiarity makes them feel like they might have been presented earlier. Familiarity is seen as an unconscious memory influence and this unconscious influence is assumed to be stronger for common items. However, in seeming opposition to this view, when items were actually OLD they were correctly categorized as "old" more often when they were uncommon than when they were common. Shouldn't the less common items be less familiar? Why are participants saying "old" more to the less familiar items?

One current theoretical argument, one that I and others favour, is that while common items are always more familiar than uncommon items, uncommon items may be easier to consciously recollect in the context of a recognition test. That is, because uncommon items have been associated with fewer contexts prior to the experiment, the presentation of an item within the study phase may "stand out" more for uncommon items. The study list presentation may be more distinct for uncommon items, and this may make them easier to recollect and, hence, call old.

The recollection advantage described above can only happen for OLD items because it requires presentation in the study list. So the theoretical story becomes this. For NEW items, participants say old more to common items because they are more familiar. The same is true for OLD items, but the tendency to say "old" more to common items is opposed and dominated by an enhanced ability to consciously recollect uncommon items. Thus OLD items give rise to both unconscious and conscious memory influences with the conscious influences dominating.

According to this theoretical story, and if conscious influences are indeed more fragile that unconscious influences, then if we could find manipulations that reduce the ability of conscious processes to influence behaviour, predictable things should happen. Specifically, as conscious influences are weakened, then tendency to say "old" more to uncommon items should become reduced to zero, or even reversed completely. Reversal would occur when conscious influences were reduced to such a point that unconscious influences – familiarity in this case – would begin to dominate.

In the lab, this prediction has been shown to be true across a range of experimental manipulations. If attention is divided, then the data change as they should if conscious influences were weakened. The same is true if study duration is reduced (i.e., less time to encode an item strongly enough to support recollection) or if retention interval (i.e., the time between study and test) is increased.

Perhaps more relevant to the current talk, according to studies such as those described above, drugs that affect memory (e.g., Midazolam) also seem to primarily interfere with conscious memory (i.e., recollection) leaving the influences of familiarity largely intact. The same seems to be true for normal aging and even mild cognitive impairment. As memory degrades, it is typically conscious memory that

degrades most. In fact, in several cases of amnesia, patients continue to show a healthy procedural memory on spite of profound deficits to their conscious memory systems.

One such patient is Clive Wearing. Clive was a relatively famous pianist, composer and singer prior to experiencing a viral infection that completely damaged his hippocampus, and also damaged his frontal lobes. Clive can no longer remember anything. He cannot remember his past, and each new experience disappears before it can be stored in his memory. He lives in the eternal present. Yet despite his complete inability to consciously remember anything he still plays piano, and sings, and conducts, and he does so fluently. Those habits, those unconscious memories, are working just fine.

This pattern is relatively normal with acquired brain injuries. Patients with damage to their fusiform gyrus, for example, might not consciously recognize the faces of family members, but they will sense their familiarity by saying things like "well, this might be my brother, or maybe he is a movie star!" They say similar things when seeing the pictures of movie stars. Familiarity remains intact, even when conscious memory is lost.

Other patients suffer from blindsight, a condition caused by damage to primary visual cortex. Such patients claim they cannot see the orientation of items presented with visual blindspots caused by the damage. However, if they are asked to guess, they can guess the orientation correctly at higher than chance levels. At some deeper level, visual information is being processed and affects guesses, but conscious information is lost.

Generally speaking, any form of insult to the brain is most likely to affect conscious processing. I don't wish to imply that all forms of brain damage affect conscious influences first, there are some cases in which unconscious forms of memory or perception seem most effected. But those cases are rare, and the typical pattern is for conscious influences to be more prone to damage and degradation.

Overall then, in many cases, insult to the brain can leave it in a state not altogether different from the state we are in when we are driving distractor. Our basic habits are intact and they can steer our behaviour so far. But anything requiring conscious thought; learning new tasks, responding to complex situations, retrieving things from memory, those things are likely to not work as well as we might like.

Right now I'm honestly not sure if all of this has helped you to think more about whatever perspective you have on brain injury. I'm not sure you've thought about the distinction between conscious and unconscious influences before and, if so, if the way I have presented them is in line with your way of thinking about them. But I do hope this framework has been useful. It is one supported by a great deal of research and I would be honestly surprised if it didn't fit with a lot of your

experiences with brain injury. I look forward now to learning a whole lot more from all of you.