Memory and the Internet

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Human memory (and for that matter the memory of all organisms) is dynamic. It is active, ever changing and creative. As humans we are particularly inclined to not just construct and reconstruct our memories, but also assemble the reconstructed memories into a coherent narrative (even if one doesn't exist in the real world). We are story tellers and remarkably adroit liar. Only we, as super smart homo sapiens can weave a tale that is taller than any "tale" (actually camouflage) offered by a chameleon that is changing colors or a small insect pretending to be a twig.

There is much more to say here, for we humans, like the chameleon and twig-resembling insect are strongly influenced by our environment. Furthermore, like the chameleon we can engage in short-term adjustments to our environment, and like the insect can adjust in a more permanent way to the world in which we live.

Neurobiologically, this means that we can modify our brains, short term to environmental changes. Primarily this involves shifting patterns of neuronal firings and secretions of mood altering and behavior activating hormones. The longer-term modifications in brain functioning involve something that is quite controversial at the present time—this is our remarkable capacity to reallocate specific neural functions to different parts of our brain—a capacity called "neuro-plasticity."

Given that we are influenced by our environment and that this influence can lead to short-term and long-term alterations in brain and hormonal functioning, we should pay attention to what the environment is in which we now live and how changes in our environment are impacting on the structure and dynamics of our brain.

One of the obvious contemporary changes in our environment is the emergence (and current dominance) of the Internet. In this essay, we explore ways in which the Internet is changing our brains— and ways of brains are modifying the nature and use of the Internet. We specifically focus on human memory and explore how the Internet can be both a helpmate to human memory and a source of distraction and potential impairment of human memory.

The Building Blocks of Human Memory

We begin this exploration by introducing several conceptual building blocks regarding the nature and dynamics of human memory. These building blocks become the first characters to be introduced into our description of the dance that occurs between human memory and the Internet.

Assimilation and Accommodation

Many years ago, Jean Piaget described the process of memory (and learning) as a balancing act involving two modes. There is first of all**, Accommodation**. New information comes in that is different from what we already know and is important for us to acquire. We "accommodate" to this information by taking it in and changing what is already in our memory.

Secondly, the opposite is also taking place (at the same time). We don't just accommodate to new information, we also **Assimilate** this information—combining it (and transforming it) with what we already know and believe (our assumptions, recollections of past events, etc.) The new information gets "digested" (much as food gets digested in our stomach). What has come into our brain is no longer the same thing after it has been incorporated in our existing memory structures and patterns (our "schemas") (Bartlett, 1995).

Procedural and Declarative Memory

There is a second building block that we wish to introduce as we consider how the Internet influences and can both help and hinder memory. Once again, we introduce a duality. Our working memory is comprised of two independent (though complementary) systems. There is one memory system in our brain that deals with the thoughts, feelings and behaviors in which we engage that are repeated many times in our lives.

These serve as a foundation for the habits that we form. As noted in a previous essay, the neurons that fire together, wire together. This is certainly the case regarding a clustering of neurons that our frequently wiring in a specific sequence and at a particular time. For instance, when we are driving a car and, in particular, when we are driving to work or to our favorite restaurant or movie theater, then our thoughts, feelings and behaviors are likely to be the same (or very similar) each time we engage in this journey.

Our brain not only easily takes on the task of guiding this journey, it also does so without "bothering" us – we remain "unconscious" or at least rarely attend to the adjustments we are making regarding our adjustment of the steering wheel, accelerator or breaks. It is only when we are first learning to drive that we pay attention to these details – and we all know what an anxiety-filled experience this was the first time that we "took the wheel."

Fortunately, we don't have to attend to these details very often – and we are likely to remain an inexperienced and not very skillful driver if we continue to do this focusing. At best, we are attending to the other cars on the road, the speed limit and the weather – so that we can adjust our driving habits to accommodate (see here is this word being used) to the changing conditions associated with our journey.

The neural system involved in the engagement of these habitual processes is called **Procedural Memory**. It operates out of three areas of the brain: the cerebellum, parietal cortex and prefrontal cortex. All three of these areas are engaged early in learning motor skills. The cerebellum is especially important, as it is needed to coordinate the flow of movements required for skilled motion and timing of movements.

It is not easy to move and perform every-day tasks. Even though we may be only marginally conscious of our habitual behavior, many neural functions have to engaged and brought together for us to be skillful in the actions we take. The procedural memory plays a particularly important role as we grow older. While other areas of our brain may deteriorate as we age, the procedural memory system tends to remain intact. We might not be able to teach an old dog new tricks, but we can usually be assured that the old dog still can do the old tricks.

There is a second memory system that is engaged when we are trying to remember something, when we are sorting through existing information, when we are retrieving old memories to assist us with problem-solving or decision-making. This is called the **Declarative Memory** system. Much of what Piaget was describing in terms of the dynamic interplay between assimilation and accommodation relates directly to this second memory system. Procedural memory is almost purely assimilative—the habits pretty much run the show unless something important is happening in our environment and attention must be paid to the changes that are occurring (meaning that we are turning on our Declarative memory).

Our Declarative memory is one of the dynamic and creative elements of our brain—and it is fully interactive with the Internet (as well as other human-embedded technologies—to which we will turn in future essays). Declarative memory is primarily housed in the medial temporal lobe of the brain (the hippocampus, entorhinal cortex and perirhinal cortex). When this region is damaged then we are in deep trouble and can't easily navigate in the real world. We might still be able to play a mean game of tennis (as is the case with a colleague suffering from Alzheimer's) or even drive. However, we won't know what we are playing the tennis game or why we are driving to work or the restaurant.

The Loss of Memory

There is a third building block that we want to introduce. It has to do with the process of forgetting. What a horrible thing it is to forget something. We are embarrassed, often distracted and wondering if we are finally becoming a bit senile. Perhaps we discover some memory tool to reduce our rate of forgetting or we take one of the memory-enhancing pills that are marketed on TV and the Internet.

Before we bemoan our loss of memory, it is important to realize that it is actually a very good thing that we can forget. Otherwise, our brains would be cluttered and filled with a substantial amount of useless information—as well as memories that we would like to forget (as exemplified in "Eternal Sunshine of the Spotless Mind" and in a somewhat different way in "50 First Dates" (a movie starring Drew Barrymore and Adam Sandler about a young woman who starts each day without recent memory, requiring Adam to court Drew anew every day).

We have recently discovered that forgetting is not a passive process. We don't just lose the memory; rather, we actually wipe it out with specific neurotransmitters. Furthermore, we do a great deal of sorting and pruning during the night, dropping unessential material and keeping that with is important (and which can be assimilated with our existing memories – see that word "assimilation" again). There are people who do not have a sufficient amount of this neurotransmitter and do not sort out memories at night. These folks have been called "mnemonists" or more officially are labeled as HSAM.

One of the most famous 'mnemonists" was Teddy Nadler—a successful contestant on the quiz show called "The 64,000 Question' that led to the Van Doren scandal. Teddy was a world expert on the Opera and successfully answered all of the questions presented to him. The one problem is that Teddy was not an Opera expert. Rather, he was a "mnemonist." A few weeks prior to his appearing on The $64,000 Question, Teddy was given several books on Opera to memorize—which he did. Teddy wasn't interested

in Opera—rather the producers thought this would be a wonderful way in which to create a narrative about a poor cobbler listening to opera every week. Nadler had no idea about nor appreciation of the powerful role played by Opera in the lives of many people – but he did have the ability to retain facts.

Teddy Nadler was not alone. There is a famous (and fascinating) case study of a mnemonist written by the noted Russian neuroscientist, Alexander Luria (Luria, 1987). His mnemonist, like Nadler, never forgot anything. And this man led a horrible life. It seems that if one's mind is filled with details and facts, then it becomes very difficult concentrate on anything or to establish meaningful relationships with other people – or simply to find any pattern or meaning in one's life. Our capacity to forget is one of the most important and adaptive features in our brain. Mother nature got it right when she drew up plans for us to actively select out memories from our daily life during the time when we are asleep.

Our Memory's Dance with the Internet

We are now ready to introduce a new character into this dance that we are choreographing. This new character is the Internet. This new character has a major impact on the way we assimilate and accommodate, on the way in which we engage procedural and declarative memory, and on the way in which we remember and forget. Let's first consider assimilation and accommodation.

The Internet of Accommodation

Unlike human beings, the Internet tends to accept new information without trying to fit it in with what the Internet already knows. While material on the Internet can be modified (such as occurs with Wikipedia), it tends to be just a source of storage rather than a source of interpretation.

Many years ago, it was thought that the information we take in is stored as specific, discrete packets (called "engrams"). A famous neuroscientist, Karl Lashley (1950), went searching for the engram—but couldn't find it. Rather, he (and other neuroscientists) began to realize that memory is much more complex and constructive. There is no memory bank where specific information is stored. In fact, we reconstruct the memory when seeking to retrieve it.

This act of reconstruction (rather than passive retrieval) has led us to a greater appreciation of the assimilative process and to a recognition that accommodation never occurs in isolation from assimilation: we never can recover the original, non-modified memory. Even traumatic events (the so-called "light bulb" events such as the assignation of President Kennedy, collapse of the towers, or more

pleasantly the marriage of our child) are never recalled in their original form—though they are often more readily retrieved and less often forgotten than more trivial events.

It is in our dance with the Internet that we hold the prospect of relying on a helpmate to engage the pure process of accommodation. It is the Internet that can provide us with clean, nonmodified information from the past – what we human beings call "memory." The **Internet is the Engram** for which Lashley searched. What this means is that we can concentrate on other matters rather than always having to hold on to details. We don't have to be a Teddy Nadler, but can instead be adaptive, creative and successful negotiators of a world that wants us to assimilate as well as accommodate. We now have an information bank on the Internet that is equivalent to having full access to the US Library of Congress. What a gift – and what a challenge. We enter the Library of Congress and don't even know where to begin in searching for some relevant information.

This is where our life is truly being changed by the Internet. Put simply, we are becoming not the archivists (holders of information), but rather the **Locators**. We are becoming the knowledgeable and helpful staff members who great us when we enter the Library. They help us locate the information we need by pointing us to the card catalog or (more recently) to the computer that we can access in order to find the location of the book, magazine or video that will be of greatest help to us.

Today, we no longer need the assistance of the library staff as we enter the digital (rather than physical) library. Rather, we are assisted by search engines that are becoming increasingly sophisticated. We are beginning to rely on these search engines and are becoming more knowledgeable and skillful in dancing with these search engines. The term now being bandied about is "The Google Effect'). This effect is becoming a big deal in our 21st Century lives.

The Internet of Exposition

While the Internet is a source of essentially non-changing information for our use, it is also a tool for assisting with our dynamic and creative processing of this information. We don't need the Internet to help us with our procedural memory – though the new self-driving cars will be taken over our procedural memory (a topic for one of our future essays on human-embedded technologies). It is in the selection of relevant information that we are most beholding to the Internet.

One of my colleagues, David Halliburton, who tragically passed away several years ago (having served in seven academic departments at Stanford University) noted that the term "information Sciences" points

to a plurality of "sciences." He noted that we have been quite successful in creating a science of information generation—but have not been as successful in creating the "sciences" or information retrieval and interpretation. Now, in the 2020s we are getting better at the science of information retrieval—but still are having a hard time figuring out how to interpret and find meaning in the information we have retrieved.

Part of the reason, this interpretative (and ultimately assimilative) process is so difficult, when it comes to a role that the Internet might play in our expository life, resides in a memory-based challenge associated with active versus passive engagement with our environment. We know that our environment is constantly teaching us, but it seems that we are most likely to learn from, remember about and effectively assimilate that in our environment with which we are actively interacting.

If we are merely passive observers of something, then we are unlike to remember it and are clearly less likely to integrate it with our existing expository/declarative memory system. Many studies have conducted over the years that usually involve strapping down an unfortunate lab animal (often a cat, dog or white rat) to some kind of a trolley or cart. The animal is hauled around a large maze or the basement of the building where the psychology department is located in a prestigious university.

Typically, these studies reveal (and further demonstrate that these animals were unable to navigate around these halls when taken off the trolleys. Other animals who could navigate themselves around the maze or basement (even while strapped on the trolley) were much more successful at navigating the maze or basement. They seemed to be learning even without focusing on a specific reward (such as cheese at the end of the maze or a bowl of food at the other end of the basement. This has been labeled "latent learning" and it is often brought forward when traditional reward-based learning is being advocated.

This same process is in effect for human beings as we travel around our own maze-like world. Latent learning is what all of us know regarding traveling by car around a city. If we are driving then it is much more likely that we can recall the street map and specific pathway we have taken then if we are sitting in passenger's seat and are only passively observing our trip through the city. We are confronted yet again with the impact of a technology on our lives. In this case, it is our reliance on the GPS. We aren't learning about the city because we are relying on some other source to direct us. Even as a driver, we have become a passive observer. We have become one of the trolley cats strapped to our automobile.

The story becomes even more intriguing when we turn from our own role as driver or rider to that of highly experienced navigators (cab drivers) of the complex mazes to be found in major cities—such as London. It is precisely the cab drivers of London who have been studied. To be successful at their trade (and to even be granted a license to operate a cab), these drivers must acquire information about the location of every street in London – and this is quite a task.

The key to acquiring what is called "The Knowledge" is their direct experiencing of the 25,000 streets and 20,000 landmarks within a 25 miles radius of London. They drive around the city and learn by doing. Unlike the animals strapped to the trolley and rolled about the maze – and unlike the rider in a car – these is active engagement with their environment. And here is the real "kicker" – the brains of these cab drivers have been tested. It seems that the neural structure of specific areas of their brain that specialize in memory of locations has grown increasingly dense (more neural connections). "Neuroplasticity" is operating at full force. The brains of these cab drivers are changing, so that they might successfully engage and adapt to their challenging world of streets and landmarks.

We don't have to turn just to the impact of passive observation on our ability to navigate as the driver of our car or to the impact of active engagement on the brains of London Cab drives. We can also attend to the impact which passive retrieval of information from the Internet has on our processes of thought, feeling and behavior. In this passivity, we are likely to find it difficult to integrate this information with what we already know (or believe that we know). The new information is likely to be received in isolation (acting like an engram) and set aside or set up as somehow unrelated to our existing schemata.

We learn and expand our epistemological base when we interact with our world—when assimilation and accommodation are being interwoven with our reception of new information from a constantly changing world. Under these conditions, which regions of our brain are likely to grow increasingly dense with greater neural wiring – and which regions might simply wither away or (more likely) be re-purposed (via neuroplasticity) for use in our adaptation to the changing environment of the new technologies.

The message here is actually quite simple: we probably don't want to be wheeled around on an **Internet Trolley**. Our critical capacity to review and interpret documents on the Internet is diminished if we are passive. We become "lazy" in our reliance on a few sources of Internet information that conform to our existing beliefs. We do very little accommodating to information that is changing of our existing mind set. We don't kick the tires of the Internet to see if it is providing information that is valid

and useful. Our assumptive world remains unchallenged—and we live with nothing but passively-received, self-fulfilling and self-sealing thoughts, feelings and behaviors Argyris and Schon, 1974). In many ways, this passivity leads to the dominance of procedural, habitual processing – and to the decline (or even death) of expository mental processes.

There is another challenge offered to the role played by expository processes by the Internet. There is a strong temptation when relying on the Internet to be superficial in our reactions to and contemplation of the content conveyed by this medium. The postmodernist critic. Frederick Jameson (1991, p. 25) describes this as the "heaps of fragments" to be found contemporary thought. It is not just a matter of short attention span—it is also a matter of not connecting the dots and not doing the hard work of incorporating new material in with the existing material (particularly if the new material doesn't fit nicely in the existing schemata). We simply leave things in an undifferentiated mess—what Jameson (1991, p. 25) identifies as a practice of "the randomly heterogeneous and fragmentary and the aleatory."

If there is any integration occurring, it is likely to be done by some "expert" or "guru" of the Internet. We don't avail ourselves of our own life experiences, nor do we take advantage of the rich diversity to be found on the globalized network. We are entering the digital Library of Congress and are likely to feel the overwhelm of too many choices. As a result, we decide to just return to an area of the library where we have sat before and by the books that we already know and have read. To think deeply requires a sustained, reflective process of assimilation which is partnering with an active search for new information that might be discordant and certainly will be challenging and expansive of our own assumptive world and epistemological base.

The Internet of Retention

What finally do we do about the process of forgetting—given that the Internet doesn't forget? On the one hand, as we noted regarding the flashbulb memory, there are certain memories that we should never forget. These memories teach us, repeatedly, what is life-threatening and what is life-affirming. Many of these memories are stored in the Amygdala which does not have any of the neurochemicals needed for us to forget something. The Amygdala is in the business of essentially assessing three things about our entering stimuli (information about our environment): is the entity on which we are focusing good or bad (regarding our welfare), is this entity strong or weak, and is this entity active or passive.

If this entity is active, strong and threatening to our welfare (even our existence) that we need the flashbulb memory so that we can take action in the future to fight against, flee from, or freeze in the face of this threat (Sapolski, 2004). If the entity is inactive or weak then we don't need to save the memory. Conversely, if the entity (say our new wonderful son-in-law) is good for us, strong and active then we want to save (even cherish) this memory (perhaps preserving a memory of his marriage to our daughter in a photo album).

One other point must be considered regarding the Amygdala-based retention of memories. It is not a matter of us suddenly becoming mnemonists like Teddy Nadler. While essentially all of Nadler's brain was operating like the Amygdala without any neurochemicals to wipe out a memory, the process of "light bulb" remembering for those of us not afflicted with Nadler's "illness" is quite different. This is because the lightbulb memories (whether good or bad) come with powerful emotions attached.

These emotions, in turn, impact on the accuracy of the retained memories. The process of assimilation is just as strong as the process of accommodation when a "light bulb" memory is retrieved. We must remember what actually happened—but can't help but modify the memory or fill in the missing details (who else was there, what really happened). We also can't help but add our interpretation and assign the event some important meaning (here is why this occurred) (this is "Gods' way of telling me/us that . . .).

Conclusions

It is precisely when we are confronting these challenging retrievals of important memories that we have to be most diligent, most self-critical, and most in need of sharing and checking out these memories with other people. As we shall note in other essays in the future, the effective engagement with human-embedded technologies requires our collaboration with other people so that we can best discern how best to dance with these technologies.

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References

Argyris, Chris and Donald Schon (1974) *Theory in Practice*. San Francisco: Jossey-Bass.

Bartlett, Frederic (1995) *Remembering: A Study in Experimental and Social Psychology* (2nd Ed), Cambridge, U. K.: Cambridge U. Press.

Jameson, Frederick (1991) *Postmodernism or the Cultural Logic of Late Capitalism*. Durham, NC: Duke University Press.

Lashley, Karl (1950) "In search of the engram." *Society of Experimental Biology* Symposium 4: 454–482.

Luria, Aleksandr (1987) *The Mind of a Mnemonist: A Little Book about a Vast Memory* (Rev Ed) Cambridge, MA: Harvard U Press.

Sapolsky, Robert (2004) *Why Zebras Don't Get Ulcers*. (3rd ed) New York: Owl Books.