Remarks on Memory, Metamemory and their effects on improving students' learning performance: A literature review

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ABTRACT

One of great question for student's learning process is: how can one improve his/her memory in order to improve learning performance. And one's memory can be distinguished between short term memory and long term memory (STM and DTM). But there is also metamemory. The study of metamemory examines people's awareness and understanding of their own memory and learning. One goal of this research is to learn how people predict their memory performance, usually when they first encounter to-be-learned material. Therefore, a typical experiment in metamemory has participants learn items one at a time in preparation fora later test. This paper discusses some basic concepts of STM, DTM, metamemory and how they can be used to improve students' learning performance. This is an early investigation into this large body of knowledge.

Steven Wright — '**Everyone has a photographic Mem**ory, some just don't **have** film.'

Introduction

As time wears on, it becomes more and more important to improve one's memory. Think about what you ate for lunch yesterday. Now think about what you ate for lunch today 20 years ago. If it's a bit difficult to recall such minute details from the past, don't worry. Memories become fuzzy as we age, as our diets and physical activity decline, and as we stuff new information into our brains. But just how much can the human mind handle at once?

The hippocampus—or part of the brain responsible for memory regulation—is thought to have about seven slots that hold an unknown amount of memories at a time. Our short-term memory

allows us roughly 30 seconds to process and use information we receive before it's squeezed out for something better. If we use it in time, we can log it into our long-term memories, where it can stay with us forever.

And although most of our memories before age three or four are gone, there are plenty of ways we can contribute to brain health moving forward. Did you know a whiff of rosemary can help trigger memory? That's not to say you should run to your spice rack to recall old tidbits of information. Instead, view this playlist for useful tips and tricks to maximize your mental storage space.

STM, DTM, and metamemory

Memory and memorizing are crucial parts in one's learning process, although for certain subjects thinking and logical analysis may play greater role.

Let us begin by recalling an information theory model of human memory:

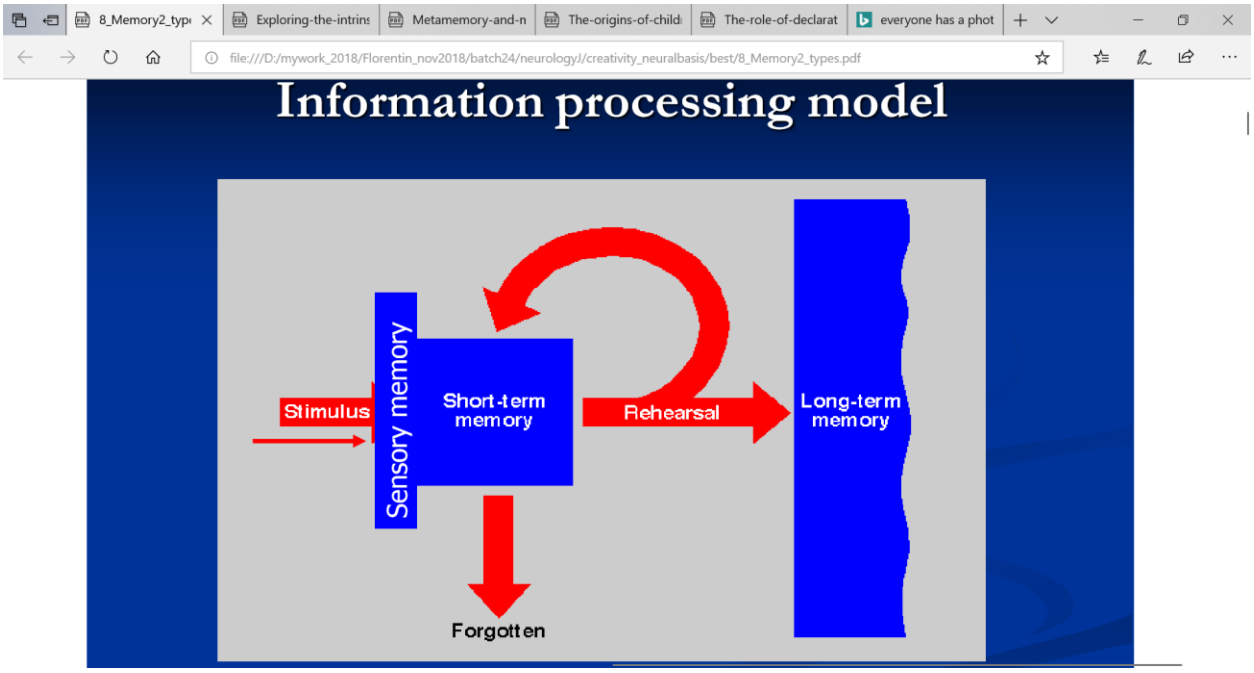

Figure 1. Information processing model of human memory

Memory performance depends on three stages:

- Encoding
- Storage
- Retrieval

Form of information: Verbal (acoustic), Visual (picture). Part of these is known as visual or photographic memory. Then as a funny quote goes: '**Everyone has a photographic Mem**ory, some just don't **have** film.'

What is capacity of STM?

Capacity measured with memory span task. Rehearsal: use "inner voice" or "inner eye". We shall also examine how we RETRIEVE information: Recall and Recognition.

Now a bit on working Memory: Short-term storage and processing of information:

- Phonological loop: verbal rehearsal
- Visuospatial sketch pad: visuo-spatial rehearsal
- Central executive: controls processing and allocates resources.

Now, let us discuss some basics of LTM divison:

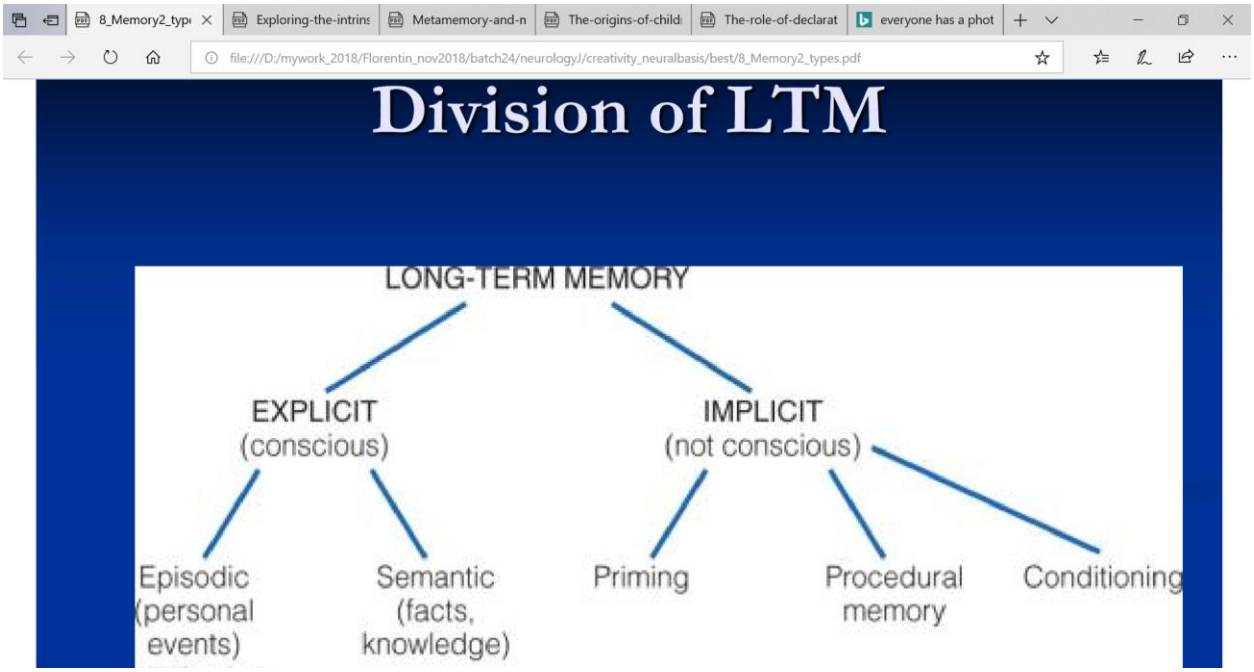

Fig. 2. Division of Long term memory

Of course, there are other models of human memory division. An example is a model developed by one of us (FS). He wrote among other things:

> "Neutropsyche is the psychological theory that studies the soul or spirit using the neutrosophy and neutrosohic theories. In other words: Neutrosophic Psychological Theory. It is based on triadic neutrosophic psychological concepts of the form (<A>, <neutA>, <antiA>). Neutropsychic Personality is a neutrosophic dynamic open psychological system of tendencies to feel, think, and act specific to each individual…"[1]

He goes on to develop a number of implications of this approach, including a model of human memory as follows:

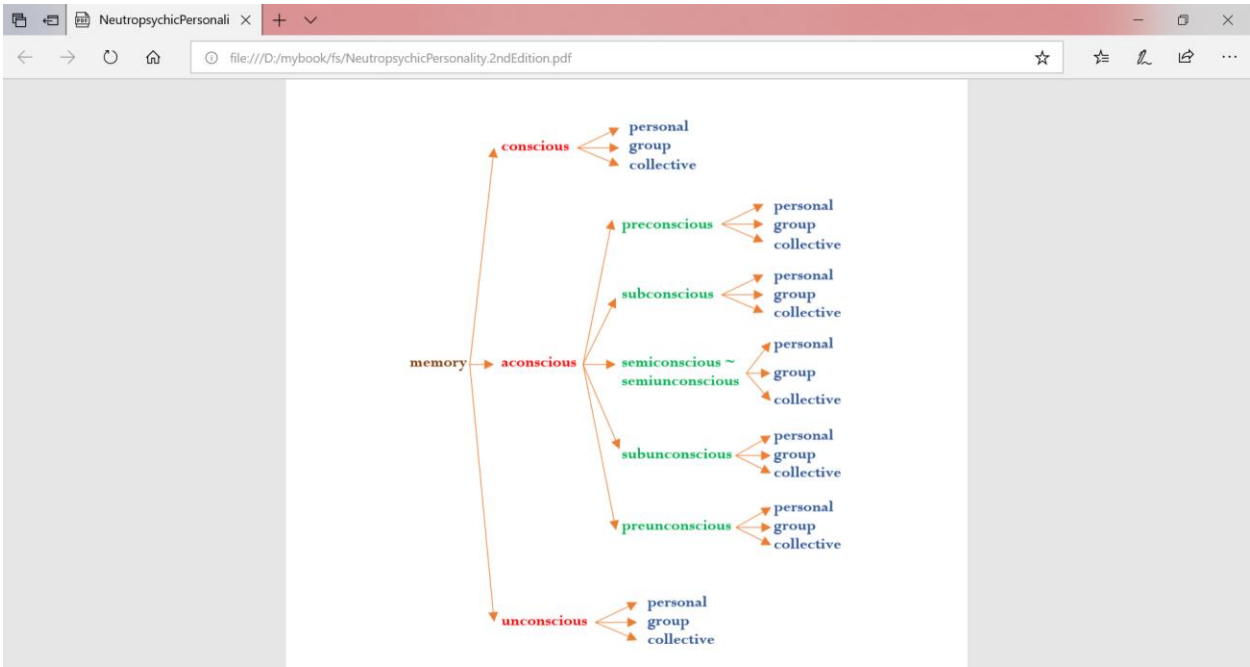

Figure 3. A model of human consciousness based on Neutrosophic Psychology (refined Neutrosophic memory). After F. Smarandache [1, p.41]

While it is rather different from Information storage model, this new model based on Neutropsychic may be thought of as a more realistic model of human memory.

There is one more factor we shall address: metamemory. This will be discussed in the next section.

What is metamemory?

Krishnan Umachandran in RG forum remarks [2]:

> "Efficient memory use requires accurate metamemory: the processes that monitor states of learning, knowledge, and skill, and also control the deployment of mnemonic and other cognitive processes to achieve desired states. That is, one must be able to make accurate judgments about one's current memory state and predictions about future states, and exercise judicious control over the various options at one's disposal, including encoding and retrieval strategies, study time allocation, item selection, and scheduling of study repetitions. Our research investigates the monitoring and control processes that comprise metamemory by focusing on factors that moderate metamemory performance, such as: prior knowledge, task goals and expectations, time pressure, and stimulus characteristics. For example, we are interested in the conditions under which one exhibits "learning to learn"--adaptively calibrating metamemory in order to more effectively assess and deploy memory resources in the context of a specific task. Our interests also concern the development of ever more sophisticated and rigorous approaches to the analysis and measurement of metamemory."

Another researcher in RG, Vaidyanathan responded:

> Prof. Krishnan's reference to "metamemory" got me very interested.
>
> I have enclosed link of a web-page that gives a good number of references about metamemory. Some excerpts from this link:
>
> *Put simply, metamemory is knowledge about memory. More specifically, it is knowledge about how your memory works, the contents of it and how to regulate it. The more you understand about the functioning of memory, the easier it will be to benefit from instruction in your memory skills. There are four aspects of metamemory which play a huge role in memorization and learning no matter what age you are.*
>
> - *The first aspect is factual knowledge about how memory works.*
> - *The second aspect is memory monitoring which is being aware of how you use your memory and the state of it.*
> - *The third aspect is memory self-efficacy, or how well you think you use your memory in stressful or demanding situations.*
> - *The last aspect is memory-related affect which is the emotional states related to the demanding situations.*

Therefore, it should be clear that metamemory also affects students' learning performance, especially if *it is related to JoL (judgement on learning).*

The study of metamemory examines people's awareness and understanding of their own memory and learning. One goal of this research is to learn how people predict their memory performance, usually when they first encounter to-be-learned material. Therefore, a typical experiment in metamemory has participants learn items one at a time in preparation fora later test. Eventually, participants complete the memory test, and actual performance can be compared with predicted performance in a variety of ways. Over the past couple of decades, researchers have learned what types of information, or cues, influence people's predictions. To do this, researchers often include manipulations that affect actual memory performance to see whether people's JOLs are sensitive to that manipulation. Alternatively, researchers may explore cues that affects metamemory, but not actual memory.[4]

In his cue-utilization framework, Koriat (1997) outlined different categories of cues that people may use when making JOLs. The framework differentiates between intrinsic cues, extrinsic cues, and mnemonic cues. Intrinsic cues are cues that are contained within the study items, such as the relation between items in a word pair. Extrinsic cues are conditions of the broader learning context, such as the interval between the study and test phases of an experiment. Mnemonic cues are the subjective feelings that people experience during studying, such as feelings of ease of processing.[4]

Susser and Mulligan emphasize:

> "Lastly, understanding how people make JOLs and monitor their memory performance is particularly important because of its proposed link to control behaviors, or ways people decide to use their cognitive resources (Nelson & Narens, 1990, 1994; Rhodes & Castel, 2009). For example, if you think you are unlikely to remember to carry out an intention later, do you then take action in hopes of preventing a memory failure? That is, if memory monitoring predicts that you are unlikely to remember something later, do you decide to engage in control processes to try to change that predicted outcome? Within prospective memory, control behaviors range from spending more time encoding intentions, to setting reminders, to allocating more attention to the ongoing task surroundings. Therefore, a critical endeavor in research on prospective metamemory will be to investigate how predictions made at encoding relate to these various control behaviors."[4]

At this point, let us discuss shortly on how one can improve his/her memory.

If the Human Brain Were a Hard Drive, What Would its Storage Capacity Be?

The Brain is the ultimate digital memory.[1]

Since the invention of the written word, humans have strived to capture thought and prevent it from disappearing into the fog of time. In 1945, Vannevar Bush imagined an external memory, writing in The Atlantic:

> *"[The human mind] operates by association. With one item in its grasp, it snaps instantly to the next that is suggested by the association of thoughts... Selection by association, rather than indexing, may yet be mechanized."*

We've already discussed whether it will be possible to access the cloud with our brains, but in doing so, we've opened up a big can of neurons. One big question is this: if the human brain was a computer, how much storage space would it really have? Would that depend on how intelligent the owner of the brain is? How much data could the average human brain actually hold? [3]

Brains aren't exactly like computers, though both do handle many computations per second. It is estimated that the brain can process about 100 million MIPS (million computer instructions per second). But there's no way to actually measure how much processing power a human brain has, and there's a similar problem when it comes to determining its storage space. There are a few theories, however.

One theory from an article on io9.com explains that there are about 100 billion neurons, and each is capable of making about 1,000 connections that represent 1,000 synapses (synapses do the work of data storage). If you multiply each of the 100 billion neurons by the 1,000 synapses, you get 100 trillion data points, or 100 terabytes of info. The problem with this theory is that each

[1] https://www.thebrain.com/products/thebrain/

synapse could potentially hold more or less than the one byte of information assumed in this formulation.

The next theory (from the same article) estimates that the brain's memory capacity is closer to 2.5 petabytes or 2,500 terabytes (equivalent to about three million hours of TV shows or about 2.2 trillion puppy pictures). In the theory we discussed, each synapse was responsible for one data point, but because neurons actually help with many memories at a time, this theory suggests that the number increases greatly because the data isn't restricted to a single point.

The human brain isn't exactly like a hard drive either. It's not prone to filling up, although there must be a point at which it will fill because there are limits to everything physical. Plus, human memory is so prone to fading (I know mine is) that the brain probably keeps plenty of space since not everything is retained indefinitely. The brain is so complex that we're a long way from discovering all of its mysteries, and we might never actually know how much space it has.

Concluding remarks

Studying human memory is very interesting subject. Especially, there are recent papers discussing cue framework to improve metamemory utilization, just like a search engine use "metadata" to find certain info.

This is an early version of literature survey on metamemory. More discoveries may be expected.

Version 1.0: 26 nov, 2018. Pk. 2:56

VC, FS

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