Cognitive Science

TERM PAPER

Metacognition and powerful learning methods

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Abstract

This paper is a conversation between a faculty in department of neuroscience, with astonished achievements in cognitive psychology, neural computation and neural biology, and two friends Rutvik and Shivam, who are pursuing management studies in the same college. All three of them had been sitting in a cafeteria with few other fellows whom Dr has invited for a tea talk. In the morning time, during a lecture Rutvik was just scrolling through his feeds and his attention was caught up by an advertisement stating "Learn Python in just one week, from beginner to advance." This sparked out curiosity in him that is it even possible to learn things that fast, and if so then why is everybody not an expert. He only knew about the 10000 hour rule to be an expert in anything. This made him want to know more about the brain and how brain learns and what all the factors, tricks and techniques that can be used to learn things more efficiently. From his curious mind, he raised many such questions to Dr. Chatterjee.

Dr. Chatterjee has been a pioneering researcher in the field and has researched over the tools that can be used for effective learning. He shares various tips and techniques while explaining how brain functions and how to make the most use of it. He answers to the various questions put forward by Rutvik and Shivam, and satisfies their curiosity for understanding the brain and approaches to maximize learning. Let's see what they discuss and how Dr. Chatterjee explains.

(All Persons in this paper are fictitious and do not belong to any living or non living entity, if found that would be pure coincidence)

My goal with this paper is to summarise various such techniques from different sources and pen down all my thoughts in the terms of an engaging conversation between Dr Chatterjee and Rutvik. This paper focuses on different areas pertaining to the leaning and ways to more efficiently achieve it. We'll discuss between the two modes of learning, i.e. focused and diffused modes. Explain the concept of chunk and how it enhances learning capability. What is working memory and long term memory, techniques like Pomodoro, metaphor, story, etc. We'll than discuss on four key tools: Retrieval, spacing, Interleaving and feedback driven Metacognition. And we'll also note down and understand few points in learning at an older age.

Our brain has got some amazing abilities but it doesn't come with an instruction manual. So let's dive deep into how to make our brain learn better and create this manual.

The story begins...

Rutvik: This one is the ad I was talking about, have a look Dr!

Dr Chatterjee: I won't say what they are claiming will be indeed truth but atleast I can say that the designer of advertisement poster must be a talented guy. He has met the criteria of a user friendly ad.

Rutvik: Ha ha! He should have opted for your cognitive science course with a specialization in Usability analysis and designing. But isn't it quite amazing that such a small part of our body can get us involved in all kinds of activities from learning to retrieval to feelings to execution. And there are so many different people in so many varied fields. This makes me think how this same organ is capable of so many things.

Dr Chatterjee: Absolutely Rutvik and this is just a 3 pound organ that utilizes ten times more energy than all the parts of the body combined. And it can be said confidently that this is the most complex machine in the entire universe which we have yet not been able to understand properly. Each individual has a unique brain both physically and biologically. And it gets developed based on our genetics and our surroundings, in which we have been brought up, on the various experiences, life events and all interactions, activities that we have conducted so far in our life.

Rutvik: That's interesting doctor, and we have discussed it in detail in your cognitive class. But one thing that bothers me is that why some people learn things easily and others don't? Why they learn faster?

Dr Chatterjee: Oh! You had taken that class. That's great. Your question is quite an interesting one. And a lot of research has been done on this matter and there is not one particular answer to this question. Different researchers have come up with different ideologies and reasons that make some people learn much faster than others. There are few articles and research which suggests the following:

- One study suggests that being **interested in a subject** is the key to learning. Our brain takes in vast amounts of information but chooses to retain only selected parts of it and we tell our brains what parts to retain, by paying much closer attention to those types of information. Simply having a true interest in a subject and an eagerness to learn about it will cause the learner to pay attention when information is presented. This in turn will lead to increased learning. Another thing which it suggests is excellent memory; people with certain initial facts are more learning oriented and learn better. With conscious efforts even weak memory can be improved.

- One interesting study from the from the University of California Santa Barbara (UCSB) in collaboration with the University of Pennsylvania and Johns Hopkins University offers new insights into why some people learn faster than others. The results indicate that people whose brains automate processes, instead of involving areas of higher-order thinking, tend to learn faster. The findings suggest that when the brain **"over thinks"** a problem, it can slow down the learning process.
- Another study suggests that it's all about **practice.** Those who practice quite often in any field have better formation of neural connections in a new task.
- Another study published in *Psychological Science* sheds light on why some people learn quicker from their mistakes than others. Each time we make a mistake, the brain reacts twice. The first reaction, error-related negativity, appears just 50 milliseconds after the mistake; the second, error positivity, occurs later and is associated with awareness of the mistake. While these reactions occur involuntarily, they are influenced by what people believe to be the true nature of intelligence.
- A Dartmouth study finds that some people learn faster not because they're smarter but because they find it more rewarding.

So there are a lot of reasons and studies across globe that has tried to understand this notion of why some people learn faster than others.

Rutvik: So some people are naturally good at learning, and for some cases it's about interest that helps us in learning and factors like overthinking, stress and anxiety can reduce learning.

Dr Chatterjee: Indeed!

Shivam: Is it possible to increase rate of learning? How people can learn in a way that makes them more suited to remembering the facts and how they can learn faster.

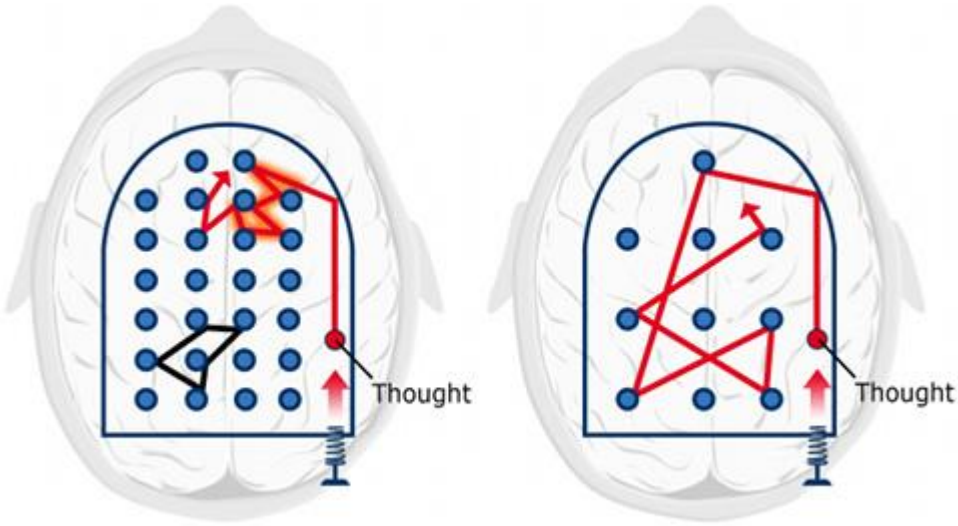
Dr Chatterjee: To understand this we first need to understand just a little bit of some of the basics about how our brain works not in biological form but logically. Once we have that understanding, we can learn more easily and be less frustrated.

So, let's first understand the two fundamentally different modes of thinking according to various researchers. There are these two modes:

- **Focused Mode:** It's when we are trying to learn something by intently concentrating on it to try to understand it.
- **Diffused Mode:** This is more of a relaxed state, which we relate to a neural rest state.

We're going to use an analogy of the game of pinball to help us understand these two thinking modes. Incidentally, both **metaphor and analogy** are really helpful when we're

trying to learn something new. In pinball game we pull back on plunger, release the ball and the ball goes, hits and bounces back and forth between the bumpers. If the bumpers are closely placed near each other, it's the analogy for the focused mode. The orange pattern in first picture represents familiar thought pattern. Which we already know and brain focuses its attention on that particular area to retrieve the information. Since the bumpers are closely placed to each other new ideas cannot be formed, new connections cannot be formed. While in diffused mode the synapses or the ball can go into any area as they are widely spaced. This allows new ideas to be formed; concepts that have not been thought before to come, and it shows a broader picture from a different perspective. In this new pathways are found and new neural connections formed.



Now as far as neuroscientists know right now, we're either in diffused mode of thinking or focused mode, but not in both the mode at the same time. Evidently some famous people from history have used these different modes of thinking to help them in problem solving. People like Salvador Dali, a very well-known surrealist painter of the 20th century, Thomas Edison, one of the most brilliant inventors ever etc have used these modes extensively. When we're learning something new, especially something that's a little more difficult; our mind needs to be able to go back and forth between the two different learning modes. That's what helps us learn effectively.

So, when we're learning, what we want to do is study something. Study it hard by focusing intently. Then take a break or at least change our focus to something different for a while. During this time of seeming relaxation, our brain's diffuse mode has a chance to work away in the background and help us out with our conceptual understanding.

So there are a lot of techniques to help us learn efficiently.

- Procrastination is an issue with almost everyone. When we look at something that we really rather not do, it seems that we activate the areas of our brain associated with pain. Our brain, naturally enough, looks for a way to stop that negative

stimulation by switching our attention to something else. But here's the trick. Researchers discovered that not long after people might start actually working out what they didn't like, that neuro-discomfort disappeared. So it seems what happens when you procrastinate, is something like this; first, you observe, and get a cue about something that causes a tiny bit of unease. You don't like it, so to make the sensation go away you turn your attention from whatever caused that unease. You turn toward something more pleasant. The result, you feel happier, temporarily. One effective technique to cure this is called **Pomodore** technique. All we need to do is set a timer to 25 minutes, turn off all interruptions, and then focus. That's it. Almost anybody can focus for 25 minutes. The important thing is to give ourselves a little reward when we're done. A few minutes of web surfing, a cup of coffee, or a bite of chocolate, even just stretching or chatting mindlessly, allowing our brain to enjoyably change its focus for a while. Using the Pomodoro technique is very effective. It's a little like doing an intense 25 minute workout at a mental gym. Followed by some mental relaxation.

- It's important to practice with ideas and concepts for more abstract concepts like that of in maths or science, just like anything else you're learning to help enhance and strengthen the neural connection you're making during the learning process. One reason to do more practice in these areas is that they have more abstract concepts like multiplication, division, etc. So why practice helps is that, when we learn these new concepts we cannot relate to anything that is already in our head, so new neural connections are made. And when we practice, we deepen that neuron pattern. Thus practice makes those abstract things permanent.

Rutvik: But doctor love, hate, hope these are also abstract terms, still we understand those better. Why so?

Dr Chatterjee: Yes, you are correct, although these are abstract terms but these are associated with how we feel, therefore we tend to understand them better. Now before I tell you about other tools, we'll take a look at understand what memory is. There are different explanations, but let's focus on the two major memory systems: working memory and long term memory. Working memory is something that has to do with immediate thinking and conscious processing in our mind. It's centered out of the prefrontal cortex and is connected to various parts of brain. Working memory is like an inefficient mental dull blackboard that needs lot of repetition to keep something in it. **It is divided into four blocks.** The other memory is the long term memory, which is like a warehouse distributed over a large area. It's an immense portion and got room for billions of items. In fact so many that they bury out each other, so it's difficult to find the information unless we practice and repeat at least few times. We have already seen two tools above, continuing further:

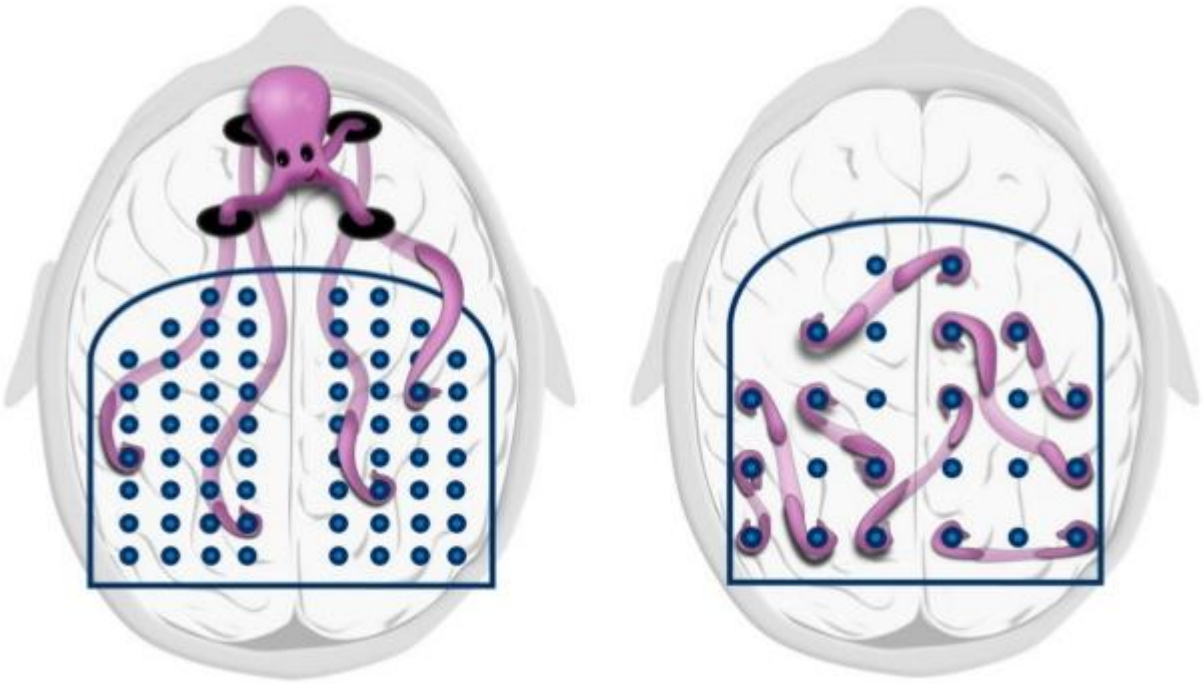
- So there's another tool called **spaced repetition**. Long term memory stores the concepts and techniques about whatever we are learning, but while encountering something new, our working memory handles it. If we want to move that to our long term memory, we can use this technique called spaced repetition. This technique involves repeating whatever we're trying to retain, but what we need to do is space this repetition out. Research has shown that if we try to glue things into our memory by repeating something 20 times in one evening, for example, it won't stick nearly as well as if you practice it the same number of times over several days.
- **Sleeping:** It's rather surprising that by just being awake creates toxic products into our brain. To get rid of this, what body does it shrinks out our brain cells, which in turn causes the space in between the brain cells to increase. Fluid can flow past the cells washing out the toxins. These poisons or toxins hinder our thinking ability. This can even cause conditions like depression, headaches, diabetes, heart diseases, etc. Not only this, sleep is an important part of the memory and learning process. During sleep our brain tidies up ideas and concepts, erases less important parts of memory and strengthens area that we want to remember. It sometimes helps in deepening neural patterns, figuring out difficult problems. It deactivates the conscious us and starts to figure out connections in deeper parts of brain. Now important thing is we have to first plant the seed for diffuse mode by first doing focused mode work. So if we're going over what we're learning right before we sleep, it increases the chances.

Shivam: I had read a blog few days ago; it was regarding the chunking technique. I find it quite interesting.

Rutvik: Chunking! What's that?

Dr Chatterjee: I was about to come to this technique, of all this is very crucial to efficient learning.

- Chunks are pieces of information that are easily accessible by our mind. So it's kind of uniting the bits of information together through meaning. The new logical whole makes the chunk easier to remember, and also makes it easier to fit the chunk into the larger picture of what we're learning. Basically just memorizing the fact without the overall context doesn't help us much in learning. Let me make you more clear by using octopus analogy. We talked about four slots in our working memory which are in our prefrontal cortex. So now when we focus on something, it's like we have an octopus of attention with four tails. This octopus slips tentacles through four slots of working memory that helps us to make connections to information present in different parts of brain. Picture on left is chunking and different from picture on right which is of diffuse mode which are random connections.



So when we focus on a task, it connects to the ideas in the brain and helps to get us started in creating the chunk. Interestingly, when we are stressed, this octopus begins to lose the ability to make some of those connections. This is the reason our brain doesn't work well in times of stress and anxiety.

So one of the first step towards gaining expertise in academic topics is to create conceptual chunks, mental leaps that unite scattered bits of information through meaning. In simpler terms chunk is a network of neurons that are used to firing together so we can think a thought or performs actions smoothly. Chunking helps our brain run more efficiently. Once we chunk an idea, a concept, or an action, we don't need to remember all the little underlying details. We've got the main idea, the chunk, and that's enough. Chunks can get bigger and more complex. But at the same time, they're a single easy to access item that we can fit like a ribbon into the slot on our working memory.

Rutvik: How to form these chunks? Are these automatically formed in the brain?

Dr Chatterjee: So what basically happens when you're trying to learn something difficult, the neural representations that are formed as a result of this task can be considered as a bigger chunk. These are formed by taking small pieces of information or smaller chunks called mini chunks together to form the larger chunk. This approach is applied in academics. When studying subjects like math and science, problems with worked out solution are given. This is to decrease the cognitive load by new information, so we start by worked examples. So by going through steps we create small chunk and when we understand going from one step to other we create connections between the chunks.

- Let’s go through the basic steps in forming the chunk. The first step on chunking is simply to focus our undivided attention on the information we want to chunk. And if we have distractions in the background like, television going on, or we're looking up every few minutes to check or answer our phone or computer messages, it means we're going to have more difficulty in making a chunk, because our brain is not really focusing on chunking the new material. When we first begin to learn something, we're making new neural patterns and connecting them with pre-existing patterns that are spread through many areas of the brain. Our octopus tentacles, so to speak, can't reach very well if some of them are off on other thoughts using up some of the limited slots in our working memory.
- The second step in chunking is to understand the basic idea we’re trying to chunk. This can be done by allowing the focused and diffused modes of thinking to take turns in helping to figure out what’s going on.
- The third step to chunking is gaining context, so we can see not just how, but also when to use this chunk. Context means going beyond the initial problem and seeing more broadly, repeating and practicing with both related and unrelated problems, so that we can see not only when to use the chunk, but when not to use it.
- Summing it up, chunks are best built with focused attention, understanding of the basic idea, and practice to help you gain mastery and a sense of the big picture context. Those are the essential steps in making a chunk and fitting that chunk into a greater conceptual overview of what we're learning.

There are some other tools and some problems in learning:

- **Recall**: One of the most common approaches for trying to learn material from a book or from notes is simply to reread it. But psychologist, Jeffrey Karpicke, has shown that this approach is actually much less productive than another, very simple, technique. Recall. After we've read the material, simply look away, and see what we can recall from the material you've just read. Using recall, mental retrieval of the key ideas, rather than passive rereading, will make our study time more focused and effective. The only time rereading text seems to be effective, is if we let time pass between the rereading, so that it becomes more of an exercise in spaced repetition. Recalling material when we are outside our usual place of study can also help us strengthen our grasp of the material
- **Illusion of Competency**: Learn to recognize when you're fooling ourself about whether we're actually learning the material. The reason why people like to keep rereading their notes or a textbook, is that when they have the book or Google open right in front of them, it provides the illusion that the material is also in their brains. But it's not, because it can be easier to look at the book instead of recalling, students persist in their illusions studying in a way that just isn't very

effective. This is a reminder that just wanting to learn the material, and spending a lot of time with it, doesn't guarantee we'll actually learn it. A super helpful way to make sure we're learning and not fooling ourselves with illusions of competence, is to test ourselves on whatever we're learning

- **Mistakes**: Mistakes are a good thing to make when we're learning. They allow us to catch illusions of competence. Avoid practicing only the easy stuff, which can bring the illusion that we've mastered the material.
- **Transfer**: Transfer is the idea that a chunk we've mastered in one area can often help us much more easily learn chunks of information in different areas that can share surprising commonalities.
- **Interleave**: Interleave our learning by practicing our choice of different concepts, approach, and techniques all in one session. Chunks are very important, but they don't necessarily build flexibility, which is also important in becoming an expert with the material we're learning.
- **Einstellung**: Einstellung is when our initial thought, an idea we've already had in mind, or a neural pattern we've already developed well and strengthened, prevents a better idea or solution from being found. Or keeps us from being flexible enough to accept new, better, or more appropriate solutions. The Law of Serendipity is helpful – Lady Luck favours the one who tries. Just pick one tiny thing out to learn, then another. Just keep trying and you'll be pleasantly surprised at the results.
- **Deliberate Practice:** Deliberately practice is what we find more difficult to gain full mastery of the material. So if we have mastered some material and you revisit it again and again we are just wasting your time. Instead what we need to do is revisit it as later point in time and starts practicing harder materials.

Dr Chatterjee: So these were few tools to tackle the learning problem. I want to get your back to the topic of procrastination, it seems simple issue, but research has shown that most of our study and learning has been affected by this. Let me share you an anecdote. So we all know about arsenic, which is quite a harmful substance and in early times robbers and murderers used it extensively for their acts. But in 1875, at 48th meeting of German association of Arts and sciences two men sat in front of audience and shocked everybody by downing more than double deadly dose of arsenic. The next day they were back at conference smiling and healthy. How did it happen and how is it related to procrastination. Procrastination can be a single monumentally important keystone bad habit, a habit in other words that influences many important areas of our life. If we improve our abilities in this area many other positive changes will gradually begin to unfold. Procrastination shares features with addiction. It offers temporary excitement and relief from sometimes boring reality. It's easy to fool yourself for example into thinking that the best use of any given

moment is. Surfing the web for information instead of actually reading the textbook or doing the assigned problems, as an example. The arsenic eaters started with tiny doses of arsenic. In tiny doses, arsenic doesn't seem harmful. One can even build up immunity to its effects. This can allow you to take larger doses and look healthy, even as the poison is slowly increasing your risk of cancer and ravaging your organs. In a similar way procrastinators put off just that one little thing. They do it again and again gradually growing used to it. They can even look healthy but the long term effects? Not so good.

So as to get temporary relief from the pain of doing hard to do work we procrastinate, and bit by bit this becomes our habit. Now our brain is energy saver and optimized machine, which eventually goes into auto mode and this auto mode, is achieved by what is called habit. For example when someone first starts to learn new thing let's say driving, we are in a hyper alert mode. The information comes seems quite difficult to process, but as we progresses and chunks up how to drive, all we need is to just get on the wheels. Our brain is in a zombie mode, where it is only semi-aware of the few key factors.

Chunking is related to habit, and habit is energy saver for us, thus brain get things into habits if it gets repeated few times. Now habits can be good and bad. And procrastination is a bad habit. Let's see how it's a habit. Habit can be thought of as four parts.

- The first is the cue. This is the trigger that launches us into zombie mode. The cue may be something as simple as seeing the first item in our to-do list. Time to start next week's homework. Or seeing a text message from a friend. Time to stop work. A cue by itself is, neither helpful nor harmful; it's the routine. What we do in reaction to that cue, that's what matters.
- Number two – the routine. This is our zombie mode. The routine habitual response our brain is used to falling into when it receives the cue. Zombie responses can be useful, harmless, or sometimes harmful.
- Number three, the reward. Every habit develops and continues because it rewards us. It gives us an immediate little feeling of pleasure. Procrastination's an easy habit to develop because the reward, moving our mind's focus to something more pleasant, happens so quickly and easily. But good habits can also be rewarded. Finding ways to reward good study habits is important for escaping procrastination.
- Number four – the belief. Habits have power because of your belief in them. For example, you might feel you'll never be able to change your habits of putting off your studies until late in the day. To change a habit, you'll need to change your underlying belief.

This is how we become procrastinator bit by bit and it turns into habit. Researchers have found that non-procrastinators put their negative thinking aside saying things to themselves like: quit wasting time and just get on with it, once you get going, you'll feel

better about it. If you find yourself avoiding certain tasks because they make you feel uncomfortable, you should know there's another helpful way to re-frame things. And that's to learn to focus on process not product. Process means, the flow of time and the habits and actions associated with that flow of time. As in, I'm going to spend 20 minutes working. Product is an outcome, for example, a homework assignment that you need to finish. To prevent procrastination you want to avoid concentrating on product. Instead, your attention should be on building processes. Processes relate to simple habits, habits that coincidentally allow you to do the unpleasant tasks that need to be done. For example, let's say you don't like doing homework in a particular class. So you put off working on the homework. It's only five questions you think. How hard could that be? Deep down, you realize that answering these five questions could be a very lengthy job. It's easier to live in a fantasy world where the five questions, or the ten page report or whatever, can be done at the last minute. Your challenge is to avoid focusing on the product, the answers to the questions. The product is what triggers the pain that causes you to procrastinate. Instead, you need to focus on the process or processes – the small chunks of time you need over days or even weeks to answer the questions or prepare for tests. Who cares whether you finish the homework or grasp the key concepts in any one session? The whole point instead, is that you calmly put forth your best effort for a short period.

Let's get the guide to tackle procrastination which is one of the most impactful issue in our learn delay and problems:

- Keep a planner journal so you can easily track when you reach your goals and observe what does and doesn't work.
- Commit yourself to certain routines and tasks each day.
- Write your planned tasks out the night before so your brain has time to dwell on your goals and help ensure success.
- Arrange your work into a series of small challenges.
- Always make sure you get lots of rewards
- Take a few minutes to savour the feelings of happiness and triumph, which also gives your brain a chance to temporarily change modes.
- Deliberately delay rewards until you've finished a task.
- Watch for procrastination cues. Try putting yourself in new surroundings with few procrastination cues, such as the quiet section of a library.
- Gain trust in your new system. You want to work hard during times of focused concentration and also to trust your system enough so that when it comes time to relax, you actually relax without feelings of guilt or worry.
- Have back up plans for when you still procrastinate. No one's perfect after all.

- Eat your frogs first every day. Do difficult tasks first.

Shivam: So Dr we can say that learning well often involves bit by bit, day by day building of solid neural connections. This is why tackling procrastination is so incredibly important. We want to keep up with our learning from the beginning and avoid last minute cramming.

Dr Chatterjee: Exactly! After this idea let's see another important technique that's related to memory. Learning to use our memory in a more disciplined yet creative manner helps us learn to focus our attention, even as we create wild diffuse connections that build stronger memories.

- We already are aware of long term and short term memory. We want to extend our practices to several days. And that's why we discussed procrastination, and importance of tackling it. It helps in building better memory as we starts earlier and don't wait for the end moment.
- We have outstanding visual and spatial memory systems. If you tap into those systems, it will help improve your memory. To begin tapping into your visual memory system, try making a very memorable visual image representing one key item you want to remember. Beyond merely seeing, try to feel, to hear and even to smell something you're trying to remember. The funnier and more evocative the image is, the better. As always, repetition over several days is really helpful.
- Another key to memorization is to create meaningful groups that simplify the material. Try associating numbers with years or with systems you're familiar with like running times. Many disciplines use memorable sentences. The **memory palace technique**, placing memorable images in a scene that's familiar to you, allows you to dip into the strength of your visual memory system, providing a particularly powerful way of grouping things you want to remember. By making meaningful groups and abbreviations, you can simplify and chunk what you're trying to learn so you can more easily store it in memory. And by memorizing material you understand, you can internalize the material in a profound way. You're reinforcing the mental library you need to become a genuine master of the material.

Rutvik: That's so interesting. I can add one more to the list.

Dr Chatterjee: Go ahead.

Rutvik: Physical exercising. I have read about neuroplasticity and how it gets impacted by physical exercise. So there was an experiment conducted on adult rats, where they were shown an image of flower and airplane and made to learn how to distinguish between. Their neural images of hippocampus were taken and after learning new neurons were formed. This is how plastic our brain is. Now coming to exercising, research shows that it's by far the most effective way to not only keep our brains healthy but also other parts of the

body. It improves blood flow to the brain. Exercise helps memory and thinking through both direct and indirect means. The benefits of exercise come directly from its ability to reduce insulin resistance, reduce inflammation, and stimulate the release of growth factors—chemicals in the brain that affect the health of brain cells, the growth of new blood vessels in the brain, and even the abundance and survival of new brain cells. Indirectly, exercise improves mood and sleep, and reduces stress and anxiety. Problems in these areas frequently cause or contribute to cognitive impairment. Although wide varieties of exercise have shown to be beneficial, but aerobic exercises tend to be on the top of the list.

Dr Chatterjee: Well that's some good research on exercise and its effect on brain. In fact there are six pillars for healthy brain. Above we have seen techniques to improve learning, now let's have some insight into making our brain healthier.

- First one is exercising that as you have pretty well described.
- Second is food and nutrition. There is specific nutrition that our brain requires to improve neural connections and increase the neurons. Various fatty acids, like omega 3, etc. seems to be a healthy choice as brain food. Some others include dark chocolate, pumpkin seeds, nuts, etc.
- Then comes sleep and relaxation which we have already discussed.
- There's another pillar called mental simulation. Through research with mice and humans, scientists have found that brainy activities stimulate new connections between nerve cells and may even help the brain generate new cells, developing neurological "plasticity" and building up a functional reserve that provides a hedge against future cell loss. Any mentally stimulating activity should help to build up your brain. Read, take courses, try "mental gymnastics," such as word puzzles or math problems Experiment with things that require manual dexterity as well as mental effort, such as drawing, painting, and other crafts.
- Another one is social interactions; Strong social ties have been associated with a lower risk of dementia, as well as lower blood pressure and longer life expectancy.
- And the last one is mental fitness. We have something called "brain reserve," which helps our brain adapt and respond to changes and resist damage. Our brain reserve begins to develop in childhood and gets stronger as we move through adulthood. People who continue to learn, embrace new activities, and develop new skills and interests are building and improving their brain reserve.

Shivam: Dr what is metacognition? Is it related to something that helps us learn better?

Dr Chatterjee: Metacognition is thinking about how we think and learn. The key to metacognition is asking ourselves self-reflective questions, which are powerful because they allow us to take inventory of where we currently are (thinking about what we already

know), how we learn (what is working and what is not), and where we want to be (accurately gauging if we've mastered the material). Metacognition helps us to be a self-aware problem solver and take control of your learning.
By using metacognition when you study, you can be strategic about your approach. You will be able to take stock of what you already know, what you need to work on, and how best to approach learning new material. So basically there are lots of strategies to use metacognition when we study.

- Using our syllabus as a roadmap.
- Summarizing prior knowledge about something when we study it.
- Thinking aloud
- Asking questions to self. Like Does this answer make sense given the information provided?, What strategy did I use to solve this problem that was helpful?, etc.
- Use writing
- Setting goals and planning
- Monitoring and controlling learning
- Concept Mapping and visual study tools
- Reflective Writings
- Organize thoughts
- Take notes from memory
- Review exams
- Figure how you learn and improve it using certain techniques.

Dr Chatterjee: I think we had enough time, we'll continue this sometime further. There are lot of tips and tricks to learn better. Let me share you some final thought on this and few simpler tips on how to better learn.

- Using metaphors and analogy can improve the learning ability two folds. You can easily remember and understand the concepts in many different fields by creating analogy or metaphor for them. Often, the more visual is better.
- Nobel Prize winner Santiago Ramón y Cajal's research shows that if we change our thoughts we can truly change our life. It seems people can enhance the development of their neuronal circuits by practicing thoughts that use those neurons. Like Santiago Ramón y Cajal, we can take pride in aiming for success because of the very things that make other people say you can't do it.
- Always revisit the things you learnt. Our brain naturally tells us not to do this, because it stops us from using parts of brain. Taking test is also important in learning process and it helps us to know where we stand.

- Counterintuitive strategies such as the hard start jump to easy technique, can give your brain a chance to reflect on harder challenges even as you're focusing on other more straightforward problems.
- Our body puts out chemical under stress. These chemicals are same to what body puts out in excitement or fear. So if we can shift our thinking from being afraid to being excite i.e. recall yourself this is exciting, it actually improves performance.
- Breathing and relaxation can help learn better. This can be achieved by meditation or yoga.
- Improving blood sugar levels, cholesterol levels, avoiding tobacco and excessive alcohol, taking healthy diet, checking blood pressure can improve brain health.
- Multitasking damages our brain and career. So build mindset to focus on single thing at a time.
- Recent research in neuroscience, psychology and design shows that doodling can help people stay focused, grasp new concepts and retain information. A blank page also can serve as an extended playing field for the brain, allowing people to revise and improve on creative thoughts and ideas. It can help in to ease tension.
- Studying related skills or concepts in parallel is a surprisingly effective way to train your brain. This is called interleaving effect it boosts up learning.
- Blocking and Interleaving: Blocking involves practicing one skill at a time before the next (for example, “skill A” before “skill B” and so on, forming the pattern “AAABBBCCC”), in interleaving one mixes, or interleaves, practice on several related skills together (forming for example the pattern “ABCABCABC”). For instance, a pianist alternates practice between scales, chords, and arpeggios, while a tennis player alternates practice between forehands, backhands, and volleys.
- Take a walk, it helps in thinking and improves creativity.
- Day dream for creativity. In 1990, a 25-year-old researcher for Amnesty International, stuck on a train stopped on the tracks between London and Manchester, stared out the window for hours. To those around her, no doubt rustling newspapers and magazines, busily rifling through work, the young woman no doubt appeared to be little more than a space cadet, wasting her time, zoning out. But that woman came to be known as JK Rowling. And in those idle hours daydreaming out the train window, she has said that the entire plot of the magical Harry Potter series simply "fell into" her head.
- Listening to music for many cases improves learning. Its researched that Music is a very powerful management tool if you want to increase the efficiency.

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