One of the oldest dualisms in Western thought is the mind and body. As a matter of fact, it dates back to the olden Greeks; therefore it's not fair to pin the entire thing on René Descartes, the seventeenth-century French philosopher. However, it's become recognized as Cartesian Dualism; therefore, his name is now related to it.

According to history, it's also come hand in hand with a different dualism: reason and emotion. We are being told that the reason is the area of the mind, working at its peak, most purely logical level. Whereas, emotions are found in the lowly area of the body, busy with its chaotic, irrational passions.

In one way or the other, these dualisms remain to even up till now. A lot of scientifically minded individuals would reject any belief in the mind-body area. According to scientists, they say that the mind is only a product of the brain. However, a lot of them would then divide the brain from the remaining part of the body. Also, they'd carry on to separate reason from emotion.

But, as we're about to find out, none of these dualisms challenge scientific examination. The brain, the body, reason, as well as emotions are inseparably connected together into a human web.

Chapter 1 - We can know the roles of the brain's various parts by looking at the repercussions of brain damage.

Assuming you're an engineer, and you've been provided with a difficult machine. Your duty is to understand how it functions. As you look at it closer, you notice that it has a lot of various parts working together in apparently mysterious manners. Therefore, what would you do about it?

You could begin by taking out one part of the machine and observing what occurs. Say you remove thingy X and the machine stops sparking, you could deduce that thingy X has a thing to do with spark creation. Repeat the exact same process with the remaining parts, and you can progressively understand how the machine functions.

The exact same logic goes for figuring out the machinery of the human brain – with one significant warning.

Definitely, it would be very unethical to go into a person's brain and take out a part only to notice what occurs. Luckily, for science, we don't have to.

At times, brain-damaging injuries, tumors, as well as can affect certain areas of the brain. Also, if they occur in just the appropriate manner, they can essentially eliminate a single part of the brain without destroying any other thing– nearly as if a wicked scientist came around and removed it with a scalpel.

Let's say the victim survives, his brain will carry on to work; however, in a different manner from before. For example, impairment to a part of the brain known as the third frontal gyrus causes a language disorder called aphasia. People that have this condition find it hard to understand or convey themselves in speech. As a matter of fact, the third frontal gyrus has a vital part to play in the brain's capability to process language.

This way, by likening how the brain works before and after one of its parts have been impaired, we can begin mapping out the function that part usually plays in the brain's total machinery. This is the way the area of experimental neuropsychology deals with the study of the brain. Also, as we'll learn in the next chapters, it has brought about some extraordinary findings.

Chapter 2 - The story of Phineas Gage offers an intense illustration of how brain damage can offer us with scientific hints.

In order to learn about the brain through the eyes of experimental neuropsychology, we have to first look for some before-and-after stories of people who have experienced certain kinds of brain damage. There are a lot of those kinds of stories –however, few of them are as intense, grisly, or strange as that of Phineas Gage.

Gage, a nineteenth-century railroad construction foreman who worked at the Rutland & Burlington Railroad company in Vermont. Extremely considered as an efficient, dependable, and hard worker, Gage was trusted with one of the industry's most delicate, challenging, and

risky responsibilities: putting explosive charges for demolitions. If you didn't put the charges appropriately, they could basically blow up in your face.

Sadly for Gage, that's precisely what occurred during the summer of 1848. Although putting a small explosive charge to assist clear the path for a railroad track, an unexpected mistakenly triggered explosion sent a slender iron rod flying right through his head. It went through his left cheek, entered the bottom of his skull, went through the front of his brain, and shot out through the top of his head, reaching some 100 feet away.

What occurred after was even more dreadful: Gage didn't just survive the accident; however, he was able to sit up and talk for only a few minutes after. A doctor treated his injury, and Gage lived on for over a decade. During that period, he showed normal brain functioning in most parts of cognition, as well as perception, memory, language, and intelligence.

However, in other ways, "Gage was not Gage anymore," as some of his friends said. He didn't respect social conventions anymore and looked to show a small concern for his future. He began swearing like a sailor, lying, disregarding advice, and behaving on impulses. He would think of one scheme after the other, just to drop them and proceed to the following one. He looked unable to abide by any goals or go through with any plan of action.

For Gage, the repercussions were terrible. He was sacked from the railroad company and wandered from one job to the other at different horse farms until he eventually became a sideshow at a circus. However, for science, Gage's story has given an interesting opening into the mysteries of the human brain. As we'll realize, it implies that a certain area of the brain plays a vital part in one of our most significant areas of cognition.

Chapter 3 - The story of Gage implies that the ventromedial prefrontal cortex plays a vital part in practical reasoning.

Therefore, what exactly occurred to Phineas Gage?

Without the creation of the time machine, we'll never be certain. Gage died in the year 1861, and his brain is no more in existence for us to take a lot. However, his skull has been well-preserved by Harvard Medical School, and we can study his skull for hints.

With the assistance of innovative computer simulation technology, researchers have been able to trace back the route of the rod that flew through Gage's head. According to their research, we can deduce that it most likely damaged an area of the brain known as the ventromedial prefrontal cortex (VPC), while leaving most other parts untouched.

For more proof in support of this hypothesis, we have to look for a modern-day Phineas Gage to study –a person with related brain damage and symptoms. Enter Elliot – the false name the author has named one of his patients.

Elliot was a cheerful and prosperous businessman, husband, and father in his 30s, until one occasion, just like Gage, he went through brain damage to his VPC. In the situation of Elliot's, what caused the injury was different: a brain tumor. However, the consequences were the same.

Elliot's brain looked completely functional in the author's lab. Tests revealed that Elliot was totally normal or beyond average in a wide variety of areas, as well as visual perception, memory, language, arithmetic, facial recognition, abstract moral reasoning, and overall intelligence.

However, out in the real world, something was clearly not okay with his practical reasoning skills. He couldn't make good choices for himself anymore. At work, he found it difficult to prioritize his responsibilities and handle his time. For instance, if he needed to sort some documents, he'd become obsessed with reading one of the documents or coming up with a new organization system. Then, he would use the remaining of the day on one of these side tasks, completely not remembering the actual task at hand or how much time it needed.

Definitely, we all fall victim to this tendency sometimes; however, Elliot couldn't help himself – and it occurred nearly every time. Due to that, just like Gage, he was sacked from his job. Then, he got preoccupied with a lot of ill-advised and ill-fated money-making schemes, which his

friends attempted to caution him against. From that point, his life shattered. He became unemployed, bankrupt, and divorced – another prey of damage to the VPC.

Chapter 4 - There's more we can say of practical reasoning than only the VPC.

Let's recap what we've understood so far: if you undergo extreme damage to your VPC, you lose your capability to participate in practical reasoning. So, the one, relies on the other, right?

Yes. As a matter of fact, the correlation between the two things has been strongly proven. The author, as well as his colleagues, have examined 12 other patients who show the same kind of brain damage and cognitive symptoms. However, as the old saying goes, correlation does not mean causation; therefore, we have to be careful in making conclusions here.

To start with, we can't simply draw a one-to-one correspondence between a certain part of the brain and a certain function. As we'll understand in more detail later on, any particular brain function is done by various areas of the brain working together. It's their synchronized activity that allows the brain to do any of the things it performs, such as practical reasoning. We can allocate carious jobs to various areas of the brain –however, we have to bear in mind that no single part can do its work alone.

This takes us to the following warning, which is that two other kinds of brain damage can cause symptoms related to those of Gage and Elliot. The first one is damage to the amygdala and the anterior cingulate, which are both areas of the limbic system. These areas of the brain are famous to play a vital part in processing emotions.

Damage to the right side of the somatosensory cortex is the second type of brain damage. This area of the brain is well-known to play a vital part in our ability to feel physical sensations of touch, joint position, pain, temperature, and the supposed "visceral states." The latter comprises of the entire sensations we feel inside our organs, like the skin, blood vessels, lungs, gut, and heart.

Okay. However, can't we just broaden the equation? Practical reasoning = the VPC + the limbic system + the somatosensory cortex. Easy. Finish.

Well, not really, because at this stage, we still don't have any knowledge of how these three parts of the brain really sum up to something that can perform practical reasoning. How do they work with each other to do this cognitive function? Also, we now have a different mystery to solve: what connection do emotions and physical sensations have with practical reasoning? Nevertheless, that's the only thing limbic system and the somatosensory cortex look to be adding to the equation.

Therefore, what's happening here? What's the association between these three apparently dissimilar parts of the brain?

Chapter 5 - More observations of Elliot's actions made the author find a shocking revelation.

As we proceed on our path to explain the mystery of practical reasoning; now there are three suspects, rather than only one: the VPC, the limbic system, as well as the somatosensory cortex. What is the common thing among these three parts of the brain? In order to give an answer to this question, let's go back to Elliot's story.

Just like Phineas Gage, after going through damage to his VPC, Elliot could no longer make good choices, abide by goals, or perform plans. However, different from Gage, Elliot was still living; therefore, the author could study him more, think of a scientific hypothesis, and test it.

In the history of science, as it has occurred several times before, the author was driven to his hypothesis by the mixture of an "aha" moment and a guess. Looking back, it looked obvious; however, it took some time to achieve.

This is what occurred. During their several interview sessions together, the author saw something weird about the manner Elliot described the story of his life. It was a sad story, with a lot of personal tragedies – losing his job, his savings, as well as his marriage. Elliot told everything in great detail. However, in their several hours of discussion; never for once did Elliot

show even a sign of emotion: no sadness over his hardships, no irritation with the author's endless questions. Nothing.

Also, this wasn't only the manner Elliot acted in the laboratory. The author spoke to people who knew Elliot, and they mentioned that he behaved exactly the same in his daily life. His emotions were nearly usually flat. Sometimes, he'd show bursts of anger; however, they'd immediately vanish, and then he'd return back to neutral as if nothing had occurred.

After noticing these behaviors, the author did an experiment in which he displayed to Elliot a series of images that would usually arouse strong emotions –images of houses burning, people getting wounded, and so forth. At this moment, Elliot came right out and he mentioned himself that he didn't feel emotions the way he used to before.

Also, it wasn't only Elliot. Recall the other 12 patients with VPC damage who have been examined by the author as well as his colleagues? Additionally to their lessened practical reasoning capabilities, all the 12 patients displayed a flatness of emotion.

Therefore, now there is another correlation – and with it, a new hint.

Chapter 6 - Our emotions offer our brains with significant information as well as guidance.

At first look, the correlation between Elliott's flatness of emotion as well as his lessened practical reasoning capabilities looks very counterintuitive. Nevertheless, we normally see our emotions as obscuring our decisions. Without any disturbing emotions hindering us, shouldn't Elliott be better at practical reasoning rather than being worse?

Eventually, our emotions have lots of practical value than we normally give them credit for.

In order to understand our emotions, we can split them into two main parts. Firstly, there is a collection of transformations occurring inside your body state. This is essentially your body's general pattern of activity at any particular moment. What's happening with your joints, muscles,

and organs? How are they faring? Your brain is asking these questions all the time, and your body responds to these questions by transmitting back chemical as well as electrical signals.

Anytime you sense an emotion, you're feeling a pattern of transformation occurring in your body state. For instance, if you're feeling joyful, you might feel your skin flush, your facial muscles have a smile, and the remaining of your muscles relax. If you're feeling down, you might feel your body doing the opposite – blanching, frowning, and tightening. If you combine these whole feelings of the transformation occurring in your body state, what you acquire is the general feeling of an emotion. It's basically the feeling of your body going from one body state to the other, which we can refer to as your emotional body state.

Simultaneously, you can have a collection of mental depictions as well indicating something that prompts your emotional body state. These depictions could be tastes, smells, sounds, or any other perception – not only visual depictions. Also, they can be memories of those perceptions as well. For instance, the sound of your friend's voice, the sight of his face, or basically the memory of his name could prompt the emotional body state of happiness.

Add this collection of mental depictions with a body state, and there you have an emotion. Also, you have a significant piece of information and a strong source of guidance. Your negative or positive emotion is essentially your brain's manner of telling itself, "Hey, this thing is bad or good for me. See how it's making me feel!"

If your brain believes that it's good, you'll sense a positive emotion, and you'll want to search for it; therefore, you can feel more of that emotion. Perhaps you'll go and say hi to your friend. If your brain sees it as bad, you'll do the opposite. Maybe you'll duck into the bathroom to dodge that man you don't like at the office.

Therefore, that's the simple story of how our emotions function. However, to know how they fit Elliot's story, there are a few other information we have to think through.

Chapter 7 - Individuals that have VPC damage can still feel primary emotions.

After going through damage to his VPC, Elliot's emotional life was extremely weakened –however, it wasn't completely damaged. As we've perceived, he could still feel irregular bursts of anger. However, they were similar to bolts of lightning flashing across an otherwise neutral sky.

The reason is that Elliot could still feel primary emotions. These are the simpler kinds of emotion, wired into us from birth. They comprise of basic, short-lived states of joy, unhappiness, anger, dread, and disgust. Elliot could still experience these emotions just like every other person. If you hid behind a door and all of a sudden jumped out in front of him, he'd still become scared.

In order to understand what is happening here more, let's take a look at an illustration. Assuming you're walking along a hiking trail when, suddenly, you notice a snake. Your brain reads the snake's sliding motion and transmits this detail to your limbic system for processing. Recall, the limbic system is one of our three suspects in the mystery of practical reasoning. Now we can catch it in action!

Your limbic system essentially reacts to the sliding by saying, "Whoa, that's terrifying! Fire up the fear reply!" It then prompts a range of neurological as well as biological processes that immediately change your body into an emotional body state of terror. Your heart begins beating, and your breath becomes shallow.

This takes to one of our other suspects: the somatosensory cortex. All thanks to this area of the brain, you don't only stop and think about the terror of the snake in the abstract. You don't stay there and mention to yourself, "Hm, this seems to be a possibly risky circumstance. I wonder what I should do?" Rather, you experience the sensations of your emotional body state of fear. Due to that, you feel afraid. Also, that inspires you to act fast–maybe jumping away from the snake.

This is a primary emotion working. See how the VPC hasn't come into the play at all. This is the reason why a person such as Elliot can still sense primary emotions, in spite of the damage to his VPC. On the contrary, individuals with damage to specific areas of the limbic system cannot feel primary emotions.

Chapter 8 - However, secondary emotions are a different story. These are more difficult emotions, which we'll look at next.

Secondary emotions are gotten over time and rely on the VPC.

Now assuming you see a snake once again; however, this time around, you're a herpetologist –a person who studies reptiles and amphibians. You've been in the midst of snakes your whole life, and you feel completely at ease with them. Also, now you've just met an uncommon and harmless snake that's been your best species ever since you were a kid.

What emotion are you experiencing now? It's not fear any more; you're overjoyed! What you're feeling right now is a secondary emotion.

There's so much to unravel here. Let's begin by going back to the fundamentals. Recall, emotion is basically a mixture of your emotional body state as well as the mental depictions that prompted it. In our illustration, there are so many depictions that could be at play. You have the visual depiction of the snake in front of you. Maybe there are memories of former encounters with the exact same species. Also, perhaps, there are words signifying information you've learned about this species of snake.

During the course of your life, you've formed a rich collection of pictures of the several things you've come across– snakes, in this illustration; however, it could be anything. Human beings, places, items, events, and so on. With time, you begin to correlate these depictions with various emotions.

Perhaps your best teacher introduced you to snakes while you went for a fun trip to the zoo. That encounter planted a seed of related gladness in your brain, so to say. Then maybe you came across a different snake when you went to a pet store with your dad, and that enabled the seed to grow a bit more. If you're the things you have experienced in life continue watering the seed, it'll ultimately grow into a strong connection between snakes and gladness. At this moment, you've gained a secondary emotion: happiness for snakes.

In order to feel this emotion, you still require your somatosensory cortex to keep you informed of your emotional body state. Also, you require your limbic system to assist form that state. However, you also require something to take all of your several depictions of snakes and join them with several signals going in and out of your limbic system as well as the somatosensory cortex. Also, guess what that thing is?

Your prefrontal cortex – mainly our old friend, the VPC – which is the first suspect in the mystery of practical reasoning.

Chapter 9 - The story of Elliot gives one last hint to the key of practical reasoning.

Now, we are nearly prepared to unravel our case. We've learned how the limbic system, the somatosensory cortex, as well the VPC all unite in creating secondary emotions. Also, we have learned how emotions can offer us significant detail as well as guidance. Now we only have to combine these entire pieces of the puzzle together.

Our mystery goes down to one last question: What is the function of secondary emotions in our practical reasoning? In order to answer this question, let's reflect back to the story of Elliot one final time.

On one occasion, during the end of one of their various meetings together, the author was attempting to fix their next appointment. He suggested two likely dates, only a few days apart. Elliot took out his planner, checked the calendar, and started listing all of the likely pros and cons of each date.

The author controlled himself from interfering curious to know how long Elliot would continue like that. 30 minutes after, Elliot was still pondering over the two choices–thinking about everything from their proximity to other appointments on his schedule to likely weather conditions in the following month. At this moment, the author couldn't take it any longer. He proposed one of the dates. Elliot basically replied by saying said, "That's fine." Then he left.

Obviously, the choice wasn't that significant to him – he basically couldn't decide. However, unluckily for Elliot, that's the entire point of practical reasoning. It's essentially about pondering

through our likely courses of action so as to decide the one that's best for us. Elliot was able to do the thinking aspect of that process ad nauseum; however, the deciding part eluded him.

Now, it basically okay to use 30 minutes on a choice. If it's a thing that is significant to you, such as making a big career choice, even more time might be necessary. However, if it's a thing that is unimportant, such as deciding between two dates that don't have much of a difference to you, then it's clearly a waste of time. Also, in our day-day lives, we typically don't have a lot of time to waste. We have to be able to make quick choices: Cash or credit? Left or right? Yes or no?

In order to make choices swiftly and efficiently, your brain requires a means of going straight to the point. Also, as we'll learn in the following and last chapter, this is the point the secondary emotions come to play to save the day.

Chapter 10 - The somatic marker hypothesis can be used to describe the function of feeling in practical reasoning.

Let's conclude by going back to our last question: What part do secondary emotions play in our practical reasoning?

We've been chasing a mystery whereby the actual suspects are the limbic system, the somatosensory cortex, as well as the ventromedial prefrontal cortex. If you were thinking that the solution would have a more pleasant name, you're probably going to be disappointed. It's known as the somatic marker hypothesis –however, it's very more fascinating than it sounds!

Somatic markers are a special kind of secondary feeling that plays a vital part in our decision-making processes. Essentially, as you ponder all of your choices and their possible results, you feel secondary feelings about each and every one of them. Depending on if the emotions are positive or negative, they pull you toward or away from specific choices. The emotions assist you "mark out" your choices– telling you "go this way" or "don't go that way."

For instance, assuming you see yourself in a circumstance like that of Elliot's. You're attempting to decide between planning an appointment on Monday or Wednesday. Now, say you don't like

fixing appointments on Mondays. Perhaps the mixture of going back to work and going for an appointment on the exact day stresses you out.

These entire life experiences are formed into a negative secondary feeling you've formed toward Mondays. If you considered it, you'd see some really beneficial information about yourself and the choice in question. However, you don't have to waste time pondering through that entire information. Rather, you only feel a nearly sudden negative gut feeling toward the view of fixing the appointment on Monday. A few seconds after, you ick Wednesday. Your choice is fixed.

On the contrary, when Elliot attempts to make this choice, he doesn't have the luxury of somatic markers saying, "go this way" or "go that way." Due to that, he eventually wanders around the landscape of options in front of him, searching for each nook and cranny. Suppose rain falls on Monday? Suppose there's traffic on Wednesday? The questions go on and on like that.

However, the universe doesn't wait for us to think through them. Life continues throwing options at us, and our brains have to make sensible choices in reasonable amounts of time. In order to do this, they require the assistance of the somatic markers given by our secondary emotions.

To summarize: for us to be reasonable, our brains have to pay attention to our bodies and the emotions they show. Reason and emotion. Brain and body. Instead of being at odds with one another, they rely on each other. They have to work together. Or else, we become just like Elliot – lost in a wilderness of infinite options.

Descartes' Error: Emotion, Reason and the Human Brain by Antonio R. Damasio Book Review

By giving us some somatic markers, our feeling plays a crucial part in our practical reasoning. They allow us to think through our choices, consider our decisions, and make our choices in life. Working in union with the limbic system as well as the somatosensory cortex, the ventromedial prefrontal cortex is one of the crucial areas of the brain required in these processes. Since our

emotions are reflections of our body states, the close association between feeling and reason also shows an equally close association between our brains and bodies.

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