Author: Christopher Muzquiz
Adviser: Dr. Alex Madva

The Stimulation Process

In common language, we typically refer to the phenomena of sensation, perception, and judgment as if there were a single cognitive state. That is, we use the terms interchangeably. Doing so makes it difficult to discuss theoretical topics in cognitive science because it creates confusion and facilitates misinterpretation. Therefore, I am proposing that we should consider sensation, perception, and judgment as separate processes that occur in that respective, serial order. Experimental psychologists, philosophers, and cognitive scientists alike need to practice care to distinguish these three cognitive states.

The chronological sequence of sensation, perception, and judgment is a three-step iteration that repeats indefinitely as the mind processes information in an effort to make sense of (understand) sensory stimulation; let us call this overall iterative process "stimulation." When in place, it will become important to emphasize that previous iterations of sensational and judgmental states can influence a current perceptual state. In essence, this finite sequence of processes repeats because of neurobiological actions and consequent cognitive activity to produce psychological phenomena. Note that in the context of this paper, we will think of cognitive states as composing a cognitive process. This distinction will make it easier to distinguish a parent process composed of child states or subprocesses. Also, when developing this framework, think of the sequence as links of a chain so that it can accommodate refinements and additional stages.

We will take a scientific approach in this argument. Here are our assumptions. (1) There exists at least one mental state with existing correlated biological and physical states. (2) The

unconscious mind is a necessary factor in this argument. Essentially, we will proceed with assumption that the unconscious mind exists and that psychological phenomena require unconscious information processing; however, we will neglect to isolate integral functions. (3) Metacognition is linguistically accessible. That is, all metacognitive activity can be expressed in terms of language. (4) People have marginally varied (theoretically comparable) sensational and perceptual states to the same stimulus; that is, different people who perceive the same objects will have similar experience. Even though neurologically there are vast differences between individuals, there is still a natural language in terms of how sensations are encoded electrochemically. Therefore, we will assume that there must be some underlying organic framework at large. A note about Assumption (4): when we say that people have marginally varied sensational and perceptual states to the same stimulus that are theoretically comparable, what we mean here is that if we examine just the human species, we are making the assumption that there exists a theoretical model that can accurately and informatively describe any human psyche. This theoretical model would fundamentally be mathematical. Now that we have our framework in place, let us assign some formal definitions.

Sensation is the unconscious cognitive mechanism that refers to the bio-physical reception of a stimulus. This includes the translation and transmission of the physical reception of stimuli in the form of encoded electrochemical impulses. Note that we also refer to sensory abilities as the senses, that of which are made possible by the use of an evolved anatomical structure; for example, vision is possible because we have eyes which allow for the collection of visual information via photoreceptors. Thus, visual sensations refer to the biophysical reception of light by the photoreceptors in the eye and the sending of visually recorded information to the brain via anatomic pathways.

Perception is a cognitive product that equates to the mental registration of information and subjective psychological experience of a stimulus. The perceptual experience equates to sequences of ineffable qualia or the what-it-is-likeness to experience something like, for example, the experience of seeing yellow banana or smelling a flower. Percepts are instantiations of phenomenal knowledge. Perception is intimately related to judgment, the next denotation and our concept of interest.

Judgment is an abstract and inferential process that is linguistic in nature. Judgment is a prior-oriented top-down process and is comprised of a postdictive analysis that is preceded by a consciously inaccessible predictive analysis. It is understood that Type I processing occurs naturally without conscious input or intervention, while Type II processing involves the escalation of cognitive resources to include conscious and critical thought patterns. We will soon see how a single perceptual state is indeterminate such that it is possible for a single perceptual state to result in multiple consequential interpretations (or judgmental states). A change in judgmental states is equivalent to a Gestalt switch because it relates to the conscious shift in awareness from one interpretation of a stimulus to another. Lastly, limitations in phenomenology, language, and the pre-judgment process are the cause of restriction in terms of what can be judgmentally formulated.

In short, sensation is the reception of stimuli, perception is the subjective experience of stimuli, and judgment is the interpretation of stimuli. As previously mentioned, past iterations of the stimulation process can influence a contemporary iteration of said process. More specifically, previous sensational and judgmental states can influence a current perceptual state. This implies that previous exposure to a stimulus may change the way it is experienced the next time. On their own, these processes can be difficult to differentiate due to current limitations of language. For

example, the phrase of someone have a *burning sensation* is a vague notion because it can be used to describe the experience of a multitude of things such as putting your hand on a hot stove, hovering your arm over steam, or your tongue in contact with chili peppers. All of these are subject to their own sensational, perceptual, and judgmental states, but in everyday matters we typically do not feel the need to distinguish them. We will proceed to demonstrate why it is necessary to formalize the chronology of cognitive subprocesses active during sensory stimulation. The best approach to elucidate this is to provide examples to illustrate the point.[1]

The famous Necker Cube (Macpherson, 2017)[2] is an ambiguous graphic that, as shown in **Figure 1**, does not have a single correct interpretation such that the image can be interpreted in at least one of three ways: a 3-dimensional cube that is visible from a top angle, a 3-dimensional cube that is visible from a bottom angle, or a connected set of polygons with no apparent depth at all. At first glance, the mind will attempt to understand the graphic being observed and develop a hypothetical judgment about graphic. Subsequently, the first instantiated judgmental state will become part of a previous iteration of stimulation and effectively act as a prior. Therefore, the very first judgmental state that occurs will inadvertently affect the way future judgmental states are constructed, implying that (previous) judgmental states affect attention. For example, judgments can trigger the weapon effect, a phenomenon in which an initial recognition (a judgment of identification) of a weapon in sight will draw resources from the attention span in an effort to maintain knowledge or awareness of the current location and state of said weapon.

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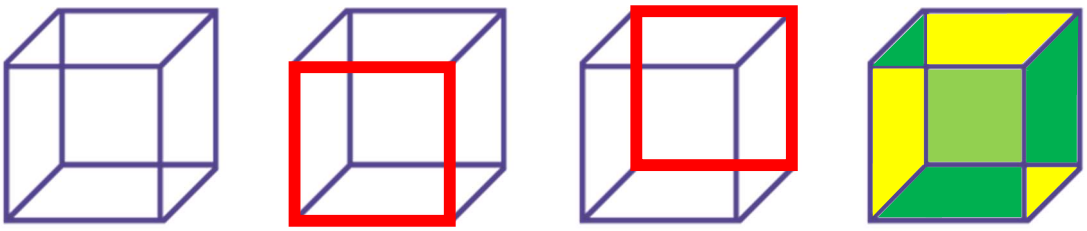
[1] It should be pointed out that there is a consciously inaccessible intermediary process that occurs after perception and before judgment. This intermediary state would extend our three-step process into a four-step process. As it will eventually become clear, it would make sense to designate this as the conception process (conceptual state).

[2] Donaldson, J. and Macpherson, F. (July 2017), "Necker Cube" in F. Macpherson (ed.), *The Illusions Index.* Retrieved from https://www.illusionsindex.org/ir/necker-cube.

Thus, the weapon effect comes as a result of witnessing a weapon. Another such example is confirmation bias, which refers to the propensity of an individual to interpret and accept information that is in accordance with their beliefs as well as a tendency to reject or dismiss information that goes against their beliefs. Hence, the weapon effect and confirmation bias are instantiations of past judgmental states influencing a current perceptual state.

Figure 1



The first figure is the original Necker Cube. The second and third figures each highlight a possible frame of reference and aid the illusion of a 3-dimensional cube. The last figure has added colors to help distract from the dimensionality of the figure and is an attempt to present a depthless figure.

Practically speaking, we can safely account for a Gestalt Switch when a person can affirmatively express when they have witnessed something different. The judgmental state, though, is the consequence of subjectively experiencing a stimulus and occurs after the unconscious mind has already *decided* what to make of it. What a person reports that they see at first exposure to the Necker Cube is a choice (for example, they can choose to lie); however, the true initial judgement about the Cube is not a choice. This unconscious decision of how to interpret a stimulus highlights the fact that there is some sort of unconscious conception that happens before being able to make a judgment about it.

If we observe Japanese web designer Nobuyuki Kayahara's spinning dancer Silhouette Illusion, we find a GIF that is effective at providing an illusion of ambiguous rotation because of "the lack of visual cues for depth" (Wikipedia, 2003)[3]. When viewing the image, there are at least two salient ways to judge the behavior of the graphic: the dancer can be spinning clockwise (C) or counterclockwise (CC). The multiple salient interpretations of the graphic are illusive of the indeterminate property of perceptual states. The implication here is that there can be situations in which two people can perceive the same stimulus but judge it differently. Alternatively, it is completely plausible that there are individuals who can view this graphic but only see depthless silhouettes of moving shapes and are unable to identify a spinning dancer in the figure at all. The indeterminate property of perceptual states emphatically suggests the theoretical need to discuss the cause of variation in resulting judgmental states.

Suppose that we have found someone who reports that upon viewing the graphic, they interpret it as the silhouette of a spinning dancer (either (C) or (CC)). The judged direction of spin is not exactly a choice, and neither is it a choice to judge the dancer as having changed its direction of spin. Instead, it comes rather incidentally after refocusing attention on the graphic. One can desire and concentrate on mentally trying to interpret a change in behavior, but this does not mean that doing so causes a Gestalt switch. We know that the GIF is a graphic that loops, so it is a fact that sensation of viewing the spinning dancer never changes. The perception is the raw image that *appears* in "the mind's eye." In theory, this also never changes such that the greyscale colors remain constant and the stimulus is a continuous display of the same sequence of images in rapid succession. It is unknown, however, what exact cognitive mechanisms cause our

[3] "Spinning Dancer." *Wikipedia*, Wikimedia Foundation, 30 Dec. 2019, en.wikipedia.org/wiki/Spinning_Dancer.

hypothetical person to interpret (C) or (CC) upon viewing the graphic, nor is it known if the cause of a Gestalt switch is attributable to the same mechanisms. Currently, a change in judgmental states can only safely be accounted for when a person can report that they have witnessed the graphic switch from (C) to (CC) or from (CC) to (C). Unfortunately, this is a severely limited ability to monitor Gestalt switches because it relies on a person's willingness and ability to punctually report when they have experienced a change of states. Take the opportunity to recognize that it is very tempting to say that what is occurring here is a change in perceptual states. In terms of colloquial vernaculars, this will likely suffice to get the point across. But if we wish to become rigorous in discussing cognition, it is important for us to be pedantic and recognize that is what is actually happening is not a perceptual switch but rather a change in judgmental states.

The stimulation process being described is being developed to investigate the mechanics of psychological registrations of stimuli, but first it might be helpful to understand the distinction between a cognitive product and a cognitive mechanism. Cecilia Heyes is a cultural evolutionary psychologist that investigates the core aspects of human cognition in her publication *Cognitive Gadgets* (2018)[4]. Heyes introduces new invaluable technical vocabulary: grist and mills. "Grist" refers to cognitive products such as memories, whereas "mills" refer to cognitive mechanisms such as logic that give rise to cognitive products (Heyes, 3). From a biological perspective, sensation (mills) gives rise to perception (grist); but from a psychological perspective, it is unknown exactly what cognitive mechanisms (mills) produce judgment (grist). It appears that there is a black box problem presented to us because our minds somehow extrapolate information from perceptual states without our conscious input to produce judgments. How this

[4] Heyes, Cecilia. *Cognitive Gadgets*. *The Cultural Evolution of Thinking.* Belknap, 2018.

is done is not yet clear, but by creating finer divisions in information processing, we are formalizing the chronology of cognitive states to hopefully make them possible to study scientifically.

The stimulation process applies more than to just visual information processing. Think about what it means for a food item to be an acquired taste. Generally speaking, a food item being an acquired taste means that a person has to have a specific palette of taste to enjoy that particular food item. Suppose we are considering a hypothetical spicy salsa. It is assumed that the sensations produced by consuming this particular salsa are more or less the same for everyone and that the resulting perceptions will be marginally different. The consequential reaction to (judgment of) the taste, however, may vary significantly from person to person. Somebody who typically dislikes spicy food is predisposed to not enjoy the spicy salsa. This aversion may come as a result of natural preferences or a traumatic experience with spicy food, but in any case, the opinion of the flavor (not the flavor of the actual food) will depend on priors. On the other hand, someone who enjoys spicy food is more likely to enjoy the spicy salsa because it aligns more with their preferred tastes. As such, it is easy to see how preexisting priors play a role in constructing judgmental and opinionated states.

As further support of the stimulation process, William James in 1890 proposed the novel idea in *Principles of Psychology* that in terms of the serial order of biological events, bodily expression precedes emotion (Stanford, 2017)[5]. In other words, James is saying that the body reacts before the mind responds. For example, the emotional experience of rage is a reaction of stress and must be preceded by the release of adrenaline into the bloodstream leading to the onset

[5] Goodman, Russell. "William James." *Stanford Encyclopedia of Philosophy,* Stanford University, 20 Oct. 2017, plato.standford.edu/entries/james/.

of a raise in body temperature, increase in heartrate, and bodily shaking. As such, judgment is a metacognitive analysis that naturally comes as a consequence of psychological perception. In accordance to James' proposition, judgmental states describe interpretations of perceived stimuli.

Consider how the mind understands social context and how autism influences consequential interpretation. Social cues correspond to judgmental states and are evaluations of social situations and norms which contribute to intuitions on how one ought to act in those situations. People with Autism Spectrum Disorder have a condition in which they judge social contextual information differently than someone without autism. In particular, autistic individuals are predominantly predisposed to not detect instantiated social cues and have altered conceptions of emotional intelligence. Suppose Person 1 is a person that does not have autism and Person 2 has severe autism. In a conversation between the two individuals, Person 1 and Person 2 should have significantly similar perceptions of what is being said in the course of their interaction. However, the two are very likely to walk away with significantly different interpretations of the conversation. Person 2 is much less inclined to have picked up on relevant social contextual information and this would effectively misconstrue certain aspects of the conversation with Person 1. Hence, an important detail here is that social constructions are higher order judgmental states such that they are not something that can be directly perceived.

Autism is one of the topics that Andy Clark touches on in his book *Surfing Uncertainty: Prediction, Action, and the Embodied Mind* (2015)[6]. Clark proposes the Predictive Processing (PP) model which, in summary, theoretically explains that the mind is always in a constant state of attempting to predict its environment and make sense of stimuli presented to it. There are

[6] Clark, Andy. *Surfing Uncertainty: Prediction, Action, and the Embodied Mind.* Oxford University Press, 2019.

historically two traditional views that have been used to theoretically explain the mind: bottom-up and top-down processing. Bottom-up processing asserts that psychological phenomena arise solely out of biological constructions of all pertinent stimuli and does not rely on preexisting mental states. Alternatively, top-down processing asserts that the mind constructs perceptual experiences strictly out of preexisting mental states and expectations. Clark's proposal asserts that both processes are integral to the structure of the PP framework and claims that attention is the intersection between bottom-up residual errors and top-down predictions. The PP model is elegant in its simplicity and flexibility with the built-in ability to accommodate multiple philosophical interpretations of cognition. Though the PP model does not have a particularly great practical utility, it does help to ascertain cognition from philosophical perspectives. Hence, the PP model may not have significant predictive power, but it does have the intended effect of delivering a systematic approach to reason through the production of psychological phenomena.

The PP model is compatible with this proposal because the processes have a correspondence to sensation, perception, and judgment. Sensations are analogous to bottom-up residual errors, whereas previous judgments are analogous to top-down predictions. Therefore, perception is the continuously updating cognitive state, in this case being identical to conscious attention, and meets at the intersection of bottom-up and top-down processing. Hence, the model is in accordance with the PP model and does not violate Clark's proposal.

Hallucinations are a topic of interest because most (if not all) cases cannot be induced by one's own volition; that is, it is not known for people to have the mental faculty to willingly self-induce hallucinations. If we follow Clark's assertion that hallucinations are instantiations of "uncontrolled perception" (196), then logically speaking, this idea of hallucination makes sense at face value. However, this denotation is not particularly useful in relation to the stimulation

process because sensation is an unconscious process that determines perception. This would imply we are always hallucinating. Clearly, this is not what we are trying to convey. By adopting the stimulation process consistent of the serialized subprocesses sensation, perception, and judgment, we can introduce a refined denotation of hallucination that is logically consistent with our framework.

At first, it might seem that hallucinations are problematic to the framework of the stimulation process, but providing a refined formal definition makes it clear that the framework itself is robust. We can choose to identify that a hallucination occurs if a person's perception or consequential judgement does not match their true sensation. For example, a person that heavily abuses hallucinogenic drugs is prone to hallucinating, that is, perceptually experiencing things that did not or cannot actually happen. In such a case, our framework does not break down, but rather, the stimulation process tells us that the true stimulation has gone awry. Functionally speaking, if there is something that is breaking the logical progression of the stimulation process from sensation to perception, then we know that the person is hallucinating and is indicative of a foreign substance or of abnormal psychological phenomena.

We will now consider additional applications of stimulation and address some outstanding questions. Related to hallucinations, synesthesia is a condition in which a person will experience additional perceptions in addition to the normal perceptions that come with sensory exposure. For example, this condition is what allows for individuals to see music or taste colors. Clearly, there is an extra layer of perceptual experience that needs to be explained here. It is not clear, however, where the added perception fits in this framework. Is it the case that multiple perceptual states constitute the perceptual process? Is it the case that multiple instantiations of stimulation run in parallel leading to multiple percepts? Or is it the case that instantiations of

stimulation are fast enough to run serially so much that individuals cannot identify which percept comes first? All of these options are reasonable, but it is not clear which is correct, if any of these. In continuation of this process, one should investigate the neurological structures that are active during moments of synesthesia and try to parse local neural activity to determine how stimulation can accommodate psychological synesthesia.

Concretely defining the stimulation process may be useful in studying artificial intelligence because it will allow us to develop an analogous process to separate distinct processes that are taking place. We know that AI's can make predictions (judgments) that surpass our own; for example, Google's AlphaZero can outcompete world class chess players (Lincoln, 2018)[7]. These kinds of judgmental states already exist in inanimate technology. The sensations are analogous to physical inputs to interact with it; in AlphaZero's case, moves made against it in the game of chess are sensational interactions. What now needs to be determined is what kind of cognitive process occurs when it *learns* to beat human players. If it is deemed not suitable to say that computers can never experience a perceptual state, that is one way to say that a computer will never be conscious. Therefore, this argument claims that if a computer becomes perceptive, it becomes conscious.

Can you describe the differences and relationships between the descriptors active, animate, cognitive, sentient, conscious, and self-aware? Briefly, here is a denotation of each. Being active means that something has a duration of activity, but this is distinct from being animate which means to behave (or act) idiosyncratically. For example, obviously a cat is active,

[7] Lincoln, Kevin. "Deep You." *The Ringer*, The Ringer, 8 Nov. 2018, www.theringer.com/tech/2018/11/8/18069092/chess-alphazero-alphago-go-stockfish-artificial-intelligence-future.

but I argue that a battery (that is not fully discharged) is too. Clearly, a cat is also animate, but it is absurd to say that a battery is animate. This is yet another instance of where common language muddles the necessary rigor of cognitive science. To continue, cognition refers to having cognitive states (technically, at least one). I argue that single-celled organisms are technically cognitive because it requires organized and systematic functions to survive (cells are both active and animate). Moreover, in terms of cognition, I would even argue that this could extend to viruses as well because they also operate in organized and systematic methods, but that is another discussion on its own. "Sentience refers to the ability to have positive and negative experiences caused by external affectations to [the] body or to sensations within [the] body" (Animal Ethics)[8]. This would imply that sentience requires cognition since sensation is a cognitive state. Being conscious, I argue, is the same as being perceptive, that is, subjectively experiencing qualia. Finally, I argue that self-awareness equates to metacognition, an even higher order cognitive task, and is something that requires consciousness. This argument suggests that self-awareness is a stronger, that is, more restrictive, requirement than consciousness. The result of this argument is that cognition is required for consciousness, which is required for metacognition.

Now we can proceed to address a problem that arises out of functionalism. If we are to describe any hypothetical AI, what does it mean for an AI to be conscious? How would we determine if we gave consciousness to an AI on accident? What would it need to make it be considered conscious or more impressively, self-aware? Say we just care about designing an AI

[8] Animal Ethics. *The Problem of Consciousness*, www.animal-ethics.org/sentience-section/introduction-to-sentience/problem-consciousness/#:~:text=To%20be%20conscious%20is%20to,experience%20or%20awareness%20of%20something.&text=The%20word%20%E2%80%9Csentience%E2%80%9D%20is%20sometimes,to%20sensations%20within%20our%20body.

that is conscious; that is, we do not really care about making it self-aware. One problem that we will have is that we are not sure how to identify percepts without it being self-aware. It seems that we need a conscious entity to communicate to us that it is conscious, but the problem is it has to be self-aware to be able to communicate that with us. Thus, the problem of finding the boundary between consciousness and self-awareness needs to be addressed to determine what is necessary to detect consciousness in animate entities.

Consider the droid, R2-D2, from the famous Star Wars franchise. How would you classify R2-D2? I would argue that R2-D2 is active, animate, cognitive, sentient, conscious, and even self-aware. For some to be familiar the reference, it would require them to do homework and watch a few Star Wars films, but for the majority of people that are familiar it, think about what you would classify R2-D2 and why. Anyone can say that, clearly, R2-D2 is a pre-programmed robot and more relevantly, is a fictional character. But consider if such a droid was real. Then, would you say that it is conscious or self-aware? Try to formalize your reasoning and determine exactly what qualities or actions make R2-D2 fit into the categories you put him into (yes, R2-D2's pronoun are he/him/his)[9] The bottom line is despite the fact that R2-D2 is not real, R2-D2 is socially relevant in the film and was adopted into social circles such that he acquired pronouns. What makes this bot so special?

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[9] "R2-D2." *Wikipedia*, Wikimedia Foundation, 23 May 2020, en.wikipedia.org/wiki/R2-D2.

Figure 2

R2-D2 is Famous Star Wars character that is a widely known concept of an artificially intelligent robot.

Hopefully asking these questions made the task of identifying and evaluating consciousness in artificial intelligence less abstract. This is my advanced version of Turing's Imitation Game (Turing, 1950)[10] and I urge the reader to consider the technical requirements for recognizing consciousness in conscious entities that lack metacognitive ability. We will now conclude this paper by discussing what comes next.

In the future, there is much that cognitive scientists can do to expand on the theoretical stimulation process. Referring to the black box problem we described previously, the gap to explain judgmental construction requires investigation of what cognitive mechanisms decide how metacognition relates to the perceptual experience. That is, more attention needs to be given to the cognitive mechanism that precedes judgment and is subsequent to perception. This theoretical process would entail conceptual operations with respect to priors including but not limited to logic, emotions, instincts, beliefs, and motivations. These are suitable components that play a key role in judgmental construction because they are essentially what make an intelligent specimen. Advancements in game theory, technology, and neuroscience should hopefully move

[10] A. M. Turing, I.—Computing Machinery And Intelligence, *Mind*, Volume LIX, Issue 236, October 1950, Pages 433–460, https://doi.org/10.1093/mind/LIX.236.433.

this process forward. Unfortunately, our efforts are further hindered by our current inability to safely and ethically study psychological phenomena. What we are left with is the use of simple but provocative thought experiments that argue concepts of theoretical progressions of cognitive states. I hypothesize that studying this in tandem with the simulation process will elucidate frailties in our current understandings of cognition.

When defining cognitive states, there may be a need to refine our process to include unconscious instances of cognitive states. For example, people with Hemispatial Neglect Syndrome are able to detect items without consciously being aware of it (TED-Ed, 2019)[11]. Studies of P.S. suggest that his decisions are *intentional* rather than coincidental in avoiding averse situations because they were unconsciously deemed avoidable and unconsciously guided. Thus, there is a need to define new unconscious perceptual and judgmental states. Either or both may need to exist to accommodate the description of cognitive states of subjects with Hemispatial Neglect Syndrome. Therefore, cognitive scientists should try to apply the stimulation process to cases of abnormal psychology to try a new approach to explain psychological phenomena.

There are clear distinctions between sensational, perceptual, and judgmental states. Cognition is difficult to study because of inherent limitations of phenomenology, but hopefully using the stimulation process framework will help to refine our currently limited conceptions of sensation and perception. Most times in psychology, scientists will study grist and avoid getting into the murky territory of mills. It is understandable why scientists resist getting involved in

[11] Graziano, Michael. "What Is Consciousness? - Michael S. A. Graziano." *YouTube*, YouTube, 11 Feb. 2019, www.youtube.com/watch?v=MASBIB7zPo4.

resolving that complicated mess, but that is the direction we are headed toward if we are to develop better insights of cognition.