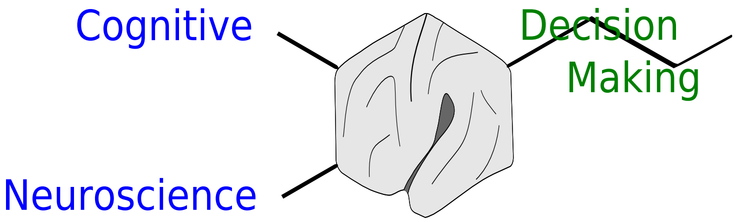


Topic: Consciousness

Is consciousness necessary for decision making?

Article Discussed

Soon, C. S., Brass, M., Heinze, H.-J., & Haynes, J.-D. (2008). Unconscious determinants of free decisions in the human brain. Nature Neuroscience, 11(5), 543–545. https://doi.org/10.1038/nn.2112

Brief Summary

This week's topic was Consciousness and we read the article, *Unconscious determinants of free decisions in the human brain.* The article assessed whether or not a decision is made before it comes into our conscience. It was found that a decision can be encoded within the prefrontal and parietal cortex up to 10 seconds before it actually reaches awareness. Some highlights of our discussion included clarifying the function and location of the involved brain structures such as the supplementary motor area (SMA) and the Brodmann Area 10, the limitations of studying "free" decision within a laboratory setting mentioning that if a participant truly has free decision they should have the option to not only answer what they want, but also not answer at all and lastly we touched on how past experiences take part in how we make future decisions.

Cognitive Process Neuroimaging Analysis

Neurosynth Term: “consciousness”

Top 5 Pubmed Articles

1: Schnakers C, Monti MM. Disorders of consciousness after severe brain injury: therapeutic options. Curr Opin Neurol. 2017 Dec;30(6):573-579. doi: 10.1097/WCO.0000000000000495. Review. PubMed PMID: 28901969.

2: Noormandi A, Shahrokhi M, Khalili H. Potential benefits of zolpidem in disorders of consciousness. Expert Rev Clin Pharmacol. 2017 Sep;10(9):983-992. doi: 10.1080/17512433.2017.1347502. Epub 2017 Jul 10. Review. PubMed PMID: 28649875.

3: Jonkisz J, Wierzchoń M, Binder M. Four-Dimensional Graded Consciousness. Front Psychol. 2017 Mar 21;8:420. doi: 10.3389/fpsyg.2017.00420. eCollection 2017. PubMed PMID: 28377738; PubMed Central PMCID: PMC5359253.

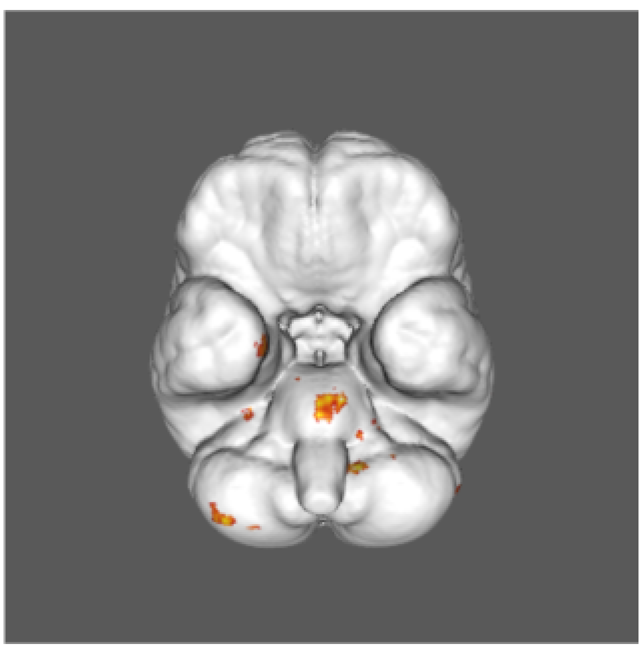
4: Havlík M. Missing piece of the puzzle in the science of consciousness: Resting state and endogenous correlates of consciousness. Conscious Cogn. 2017 Mar;49:70-85. doi: 10.1016/j.concog.2017.01.006. Epub 2017 Feb 1. Review. PubMed PMID: 28160667.

5: Bayne T, Hohwy J, Owen AM. Are There Levels of Consciousness? Trends Cogn Sci. 2016 Jun;20(6):405-413. doi: 10.1016/j.tics.2016.03.009. Epub 2016 Apr 18. Review. PubMed PMID: 27101880.

Top 5 Neurosynth Articles

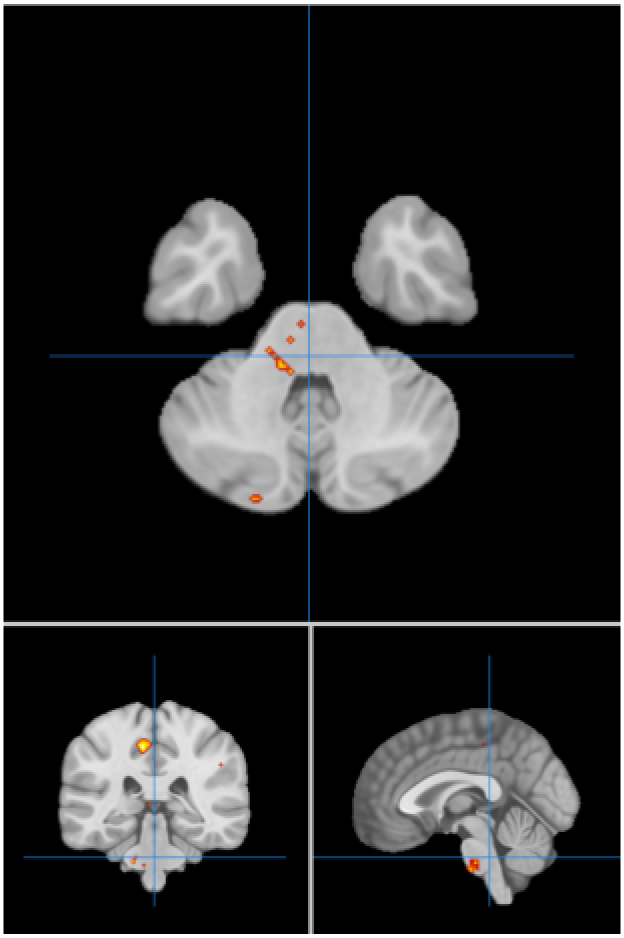
Adaptive top-down suppression of hippocampal activity and the purging of intrusive memories from consciousness.	Benoit RG, Hulbert JC, Huddleston E, Anderson MC	Journal of cognitive neuroscience	2015	25100219
A frontal but not parietal neural correlate of auditory consciousness.	Brancucci A, Lugli V, Perrucci MG, Del Gratta C, Tommasi L	Brain structure & function	2014	25344118
Anterior cingulate activity and the self in disorders of consciousness.	Qin P, Di H, Liu Y, Yu S, Gong Q, Duncan N, Weng X, Laureys S, Northoff G	Human brain mapping	2010	20336686
Consciousness and cerebral baseline activity fluctuations.	Boly M, Phillips C, Balteau E, Schnakers C, Degueldre C, Moonen G, Luxen A, Peigneux P, Faymonville ME, Maquet P, Laureys S	Human brain mapping	2008	18465800
Correlation between resting state fMRI total neuronal activity and PET metabolism in healthy controls and patients with disorders of consciousness.	Soddu A, Gomez F, Heine L, Di Perri C, Bahri MA, Voss HU, Bruno MA, Vanhaudenhuyse A, Phillips C, Demertzi A, Chatelle C, Schrouff J, Thibaut A, Charland-Verville V, Noirhomme Q, Salmon E, Tshibanda JF, Schiff ND, Laureys S	Brain and behavior	2016	27110443

Neurosynth map for the term



Brain region chosen for the term

Brain Region: “brainstem”



Other Neurosynth terms associated with this brain region

	Individual voxel	Seed-based network		
Name	z-score	Posterior prob.	Func. conn. r	Meta-analytic coact. r
gamma	8.7	0.87	0.31	0.47
mm	8.03	0.87	0.21	0.41
sources	6.23	0.77	0.24	0.32
noise	5.85	0.76	0.01	0.07
beta	4.91	0.78	0.07	0.1

finger movements	4.88	0.8	-0.07	0.02
stroke	4.8	0.76	0.04	0.08
muscle	4.31	0.78	-0.01	0.02
somatosensory	4.18	0.67	-0.11	-0.01
finger	4	0.7	-0.08	-0.01

Questions posed by the class

Background vocabulary

Q: What is a Gaussian Normal Distribution?

CoolActive

Gaussian Normal Distribution is the same thing as normal distribution - distributions with symmetric, bell-shaped curves (Normal Distribution, n.d.).

Q: What is BA10?

Sincere Zigzag

- Brodmann Area 10
- Rostral prefrontal cortex
- The largest and most anterior region within the human PFC
- Roles: multitasking, the selection and maintenance of higher order internal goals while other sub-goals are being performed, and the ability to infer someone else's feelings and thoughts, often referred to as theory of mind.

- (Roca et al., 2011)

Q: What is meant by double dissociation in the quote, “double dissociation in the very early stages between brain regions shaping the specific outcome of the motor decision and brain regions determining the timing of a motor decision?”

TwinNevada

Double dissociation is when two related mental processes are shown to function independently of each other. A good example of this is speech and language. Both are used in language but the brain structures that control them work independently. By establishing double dissociation, scientists are able to determine which mental processes are specialized to certain areas of the brain. In context of this quote, double dissociation means that even though those two mental processes work together they are controlled by different structures in the brain (Double Dissociation definition, n.d.).

Q: What is figure 2 telling us?

PolarisUnique

Figure 2 shows us the outcome of decisions before and after awareness is reached. The green colored regions shown in the brain on the bottom show the regions where the outcome of a motor decision could be decoded before it was made and the red colored regions in the brain at the top show the outcome of the the motor decision after it had been made.

Q: What is being shown in Figure 9?

ExactTulip

Figure 9 is analyzing the voxel selectivity in regards to decision making. Voxel selectivity is a type of analysis derived from MRI testing that helps to give further insight to what portions of the brain are stimulated in response to different types of stimuli. Figure 9 demonstrates how much either the left or right portion of the frontopolar cortex is used in decision making, within a ratio of both portions of the brain being used throughout. Some stimuli resulted in higher activity of the left portion, with others showing higher activity of the right portion, but both portions are always being used to some degree. This information suggests that both left and right portions are used in long-term predictive information encoding, but rarely in equal amounts. In a similar study, responses to categorically coherent stimuli were recorded using voxel selectivity, and results determined that patterns of activity in parahippocampal cortex were selective for not only scene-based stimuli, but for other nonspatial object categories as well, like faces or toys. This pattern of results coincides with the data shown in Figure 9, indicating that this region is not sensitive exclusively to one or another portion of the brain, but rather a ratio between them (Diana, Yonelinas & Ranganath, 2008).

Q: What is considered a "free decision"?

WelcomeSoda

A free decision is a decision that can be made with nothing predetermined and knowledge of the possible outcomes of the different possible choices. The article below shows that there is strong evidence that the brain functions very differently when making free decisions versus following instructions. The article says that "free choice activates a decision circuit between frontal and parietal cortex" (Pesaran, Nelson & Andersen, 2008).

Libet's clock and the readiness potential

Q: What is Libet's clock?

IsotopeNirvana

The Libet's clock is named after Benjamin Libet, a neurologist that claimed free will does not exist. To prove this true, he conducted experiments that sought to test the claim by neurobiologist John Eccles that a subject must become "conscious of the intention to act before the onset of this readiness potential." In Libet's experiments, he measured the time when the subject became aware of the decision to move their finger. To do this, Libet created a dot on a oscilloscope circulating like the hand of a clock. However, this dot was moving faster than a hand. The subject was asked to note the position of the moving dot when they were conscious of the decision to move a finger.

Although conscious awareness of the decision was found to precede the subjects motion, the rise in Type 2 readiness potential was clearly visible before the flex of the wrist (Benjamin Libet and The Denial of Free Will, n.d.).

Q: Are there any situations in which readiness potential can be eliminated, such as in instances where a subject has a huge adrenaline rush and acts without seeming to be in control of themself?

There are some situations that the RP is not used pre consciously for motor control, and that a lot of RPs occurred without motor movement. "This suggests that the RP measured here is unlikely to reflect preconscious motor planning or preparation of an ensuing movement, and instead may reflect decision-related or anticipatory processes that are non-motoric in nature.". Involuntary movements do not have a strong readiness potential, such as reflexes and eye movement however they are related the to the G. Walter's expectancy wave for conditioned reflexes. Another argument states that readiness potential represents neural markers that we use to predict the movements of the world around us. It is not found if RP is necessary for movement, but it is shown that it is used to help anticipate the sensory information of the world (Alexander et al., 2016; Kornhuber & Deecke, 2016; Vercillo, O'Neil & Jiang, 2018).

Q: which regions of the brain predetermine conscious intentions

RespondLlama

Readiness potentials originate from brain regions involved in motor preparation, such as supplementary motor cortex and premotor cortex (Haynes, 2011). I'm assuming that by "predetermine" you mean the intentions that are determined before we know we determined them.

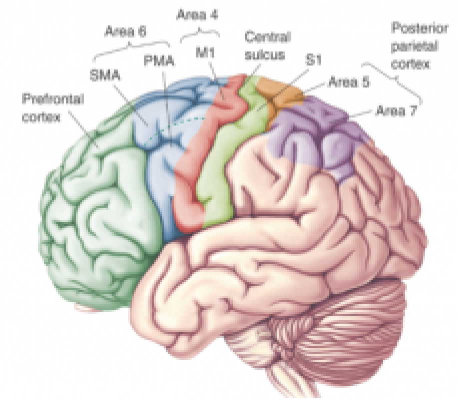
Cortical regions associated with consciousness

Q: Where is the supplemental motor area (SMA) located in the brain?

ShelfOpus

The SMA is located just in front of the primary motor cortex and centered on the midline surface of the hemisphere (Supplementary motor area, 2018).

Q: Can someone insert a clear brain image of the SMA? I find the figure shown in the article to be confusing_consciousness.



SodaOxford

(Supplementary_motor_area, n.d.)

Q: What are the main functions of the SMA?

RavioliJaguar

The Supplementary Motor Area (SMA) plays an important role in the intentional process whereby internal context influences the elaboration of action. It may be viewed as the older motor cortex, derived from anterior cingulate periarchicortical limbic cortex, which, as a key part of a medial premotor system, is crucial in the “programming” and execution of extended action sequences. The SMA has an important role when it comes to the development of intention-to-action behavior and mediates the functions between the medial limbic cortex and primary motor cortex. The SMA is found to be especially involved in self-paced, or well-learnt and predictable movements which can be internally-determined *(*Wiesendanger, 1985; Cunnington, Bradshaw & Iansek, 1996).

Q: Is the supplementary motor area the only brain region involved in motor preparation?

VideoSport

No, as with most functions multiple brain regions are involved in motor preparation. “In comparison with a “rest” condition, which had matched visual inputs, the different conditions of motor preparation were associated with increased rCBF in a common set of cerebral regions: the contralateral frontal cortex (sensorimotor, premotor, cingulate, and supplementary motor cortex), the contralateral parietal association cortex (anterior and posterior regions), the ipsilateral cerebellum, the contralateral basal ganglia, and the thalamus” (Deiber et al., 1996). The SMA and the premotor area (PreMA) both play a role in motor preparation (Lee, Chang & Roh, 1999).

Q: What are some of the functions of the frontopolar cortex?

MobileSuper

The frontopolar cortex (FPC) is a large region occupying the anterior portion of the brain’s frontal lobe, and has been suggested to play a role in complex, higher order behavior. However, the specific contributions of this area toward this type of behavior are still unclear (Boschin, Piekema & Buckley, 2015).

Neuroimaging methods from the study

Q: what does it mean for information to be decoded?

Ambient Benefit

From the article, they used “statistical pattern recognition techniques” to look at “local patterns of fMRI signals”. Decoding seems to be the process of trained people or “pattern based decoders” “to predict the specific outcome of a subject’s motor decision by recognizing characteristic local brain patterns associated with each choice”. For the statistical pattern recognition techniques, they reference Figure 4, which talks about decoding from local spatial patterns using a moving “searchlight” which the authors later describe as “examining information in local spatial patterns of brain activity surrounding each voxel.” To talk about this kind of decoding, I feel like it might be helpful to understand the term voxel, which “represents a value on a regular grid in 3-D space” and is analogous to a pixel. (Voxel, 2019).

To explain voxels better, I found another article that explains them in relation to fMRI. Basically, fMRI’s represent brain activity by showing changes in blood oxygen level, but do not show detail at the level of the cell. But, the fMRI image is actually made of voxels (like an image is made up of pixels on TV)_consciousness. THis is because fMRI’s are too slow to caption every change in the brain, because neurons fire 100 times a second and you need at least one second to take a picture, so you can’t tell exactly when something happens from raw fMRI data. Basically, to break down the raw data, you have to use statistics like the ones the authors keep referencing in order to find significant changes in each individual voxel, and therefore fMRI's are good for "generating these correlations, allowing you to observe associated activity in clusters of neighboring voxels—which correspond nicely to brain regions—as well as activity in more distant areas of the brain." (Yuhas, n.d.)

Q: What are the statistical patterns they were looking for?

Optiontemple

Activation in the fMRI in a way that they would be able to predict the outcome based off of what is activated.

Q: What are the benefits for using fMRI for this specific study?

WindowComrade

As with many experiments, fMRI imaging has several advantages. The most important being that this imaging technique is non-invasive. It also does not involve radiation. This makes the fMRI imaging technique much safer for patients or those being studied. The other major advantage of fMRIs is the quality of spatial and temporal resolutions. This makes the quality of the images enhanced and easier to interpret_consciousness. The benefit for this experiment was that it allowed separate areas of the brain to be examined as they lit up on the scans. Researchers were able to decode which areas of the brain were involved in specific decision outcomes (read, 2016).

Decisions and free will

Q: Are there different processes or mental structures for split-second decision-making versus longer, more elaborate decision-making?

BanditMeter

One study "found that under low time pressure, participants correctly weighted and integrated all available cues to arrive at near-optimal decisions. With increasingly demanding, sub-second time pressures, however, participants systematically discounted a subset of the cue information by dropping the least informative cue(s) from their decision making process. Thus, the human cognitive apparatus copes with uncertainty and severe time pressure by adopting a “Drop-the-Worst” cue decision making strategy that minimizes cognitive time and effort investment while preserving the consideration of the most diagnostic cue information, thus maintaining “good-enough” accuracy.” Thus, split second decisions don’t necessarily use different processes, but instead drops information to create a faster decision (Oh et al., 2016).

Q: Can we really “change” the decision that our brain wants to make?

MileImport

“Contrary to what most of us would like to believe, decision-making may be a process handled to a large extent by unconscious mental activity. A team of scientists has unraveled how the brain actually unconsciously prepares our decisions. “Many processes in the brain occur automatically and without involvement of our consciousness. This prevents our mind from being overloaded by simple routine tasks. But when it comes to decisions we tend to assume they are made by our conscious mind.” The phrase “to a large extent” implies that though a substantial part of decision-making is handled by our subconscious, it is not entirely controlled by it.

Q: Is there such a thing as free will? (if unconscious determines free will)

TelecomElegant

The article referenced below is highly confusing, but it argues free will is nothing but an illusion. The authors state we are constantly and unconsciously taking in stimuli, and our minds are endlessly creating different options for us yet we pick the one that is most applicable to the situation we perceive at that very instance. Thus, while we feel we’ve made the decision all on our own, our brain did nothing but a super complex calculation to pick our action without our conscious input (De Ridder, Verplaetse & Vanneste, 2013).

Q: If the experience of freedom is said to be caused by our unconscious mental processes, would this be done by System 1 or System 2?

ZeroCanary

The unconscious mental processes behind the feeling of freedom is system 1 doing its thing. However, the physical experience of freedom can be system 1 or system 2 (unconscious or conscious) depending on the situation and environment. I like to imagine hiking and reaching the peak as an example of feeling freedom consciously. Living our daily lives in the United States of America would be a good example of the system 1 unconscious feeling of freedom.

Q: Could the unconscious processes be a result of free decisions that you consciously made in the past?

There is little research to give insight into what exactly influences the unconscious process of decision making however I will review what we know about what influences our conscious decision making process. Stress is one factor that can impact our decision making and possibly even our surroundings. One study looked at the effects of acute and chronic stress on foraging-like decisions about whether to stay with a current option or search the environment for a potentially better one. It was found that both types of stress led subjects to overexploit current options relative to more optimal choices. These findings suggest that “stress biases judgments of environmental quality” (Lenow et al., 2017). Your social environment also plays a role in decision making. A study was done that looked at social influence on people's decisions during a sequential decision-making situation. It was found that people weight social information differentially according to the authority of other decision makers (Schöbel, Rieskamp & Huber, 2016). Lastly, experiences that we’ve had in the past can also influence present decision making. One study looked at episodic sampling which is when present decisions are guided by a few episodic memories of past choices. The findings showed that “when a given memory is sampled, choices (in the present) are influenced by the properties of other decisions made in the same context as the sampled event.” This suggests that we may in fact be able to learn from past experiences in order to make better decisions in the future (Bornstein & Norman, 2017).

Q: How is this unconscious flow of information preceding conscious motor decision similar or different in athletes who must make quick and effective decisions during competition?

SocialAnvil

I think that the illustration with athletes being compared to the preceding conscious motor decision is actually very similar. I think that with athletes before they have done it for many years, need to constantly be thinking about their motor movements before they do them. However, after many years of practice, I think the motion almost becomes like a reflex and then they do not need to necessarily think about it on the same level as they did before. At this point it would be like muscle memory so that unconscious flow described in the paper would be happening before the motor movement. So, in order for the movement to become unconscious-like, I think there needs to be a certain level of practice that has occurred many times before (Oishi, Kimura, Yasukawa, Yoneda & Maeshima, 1994).

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