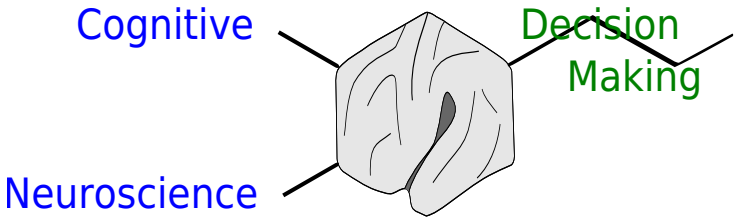


Topic: Executive Function

Cognitive abilities and limitations that affect decision making.

Article Discussed

Rabinovici, G. D., Stephens, M. L., & Possin, K. L. (2015). Executive Dysfunction. *Continuum : Lifelong Learning in Neurology*, *21*(3 Behavioral Neurology and Neuropsychiatry), 646–659. https://doi.org/10.1212/01.CON.0000466658.05156.54

Brief Summary

This article and book discussion give insight to the role that executive function has in cognitive functioning, as well as complications of disorders pertaining to executive function. The article uses executive function as another way to describe the process and combination of cognitive processes necessary for planning and organization, while the book readings look at the process of “mental shotgunning”, and methods used in assessing competence of others.

Two key executive dysfunction disorders commonly discussed in the article are Alzheimer’s and ADHD, which both are conditions that affect inhibition and working memory. Common difficulties with motivation and organization, problem solving, impulsivity, mood disturbances, and memory/attention problems are all symptoms prevalent in both disorders. While ADHD is considered a deficit in attention capabilities, Alzheimer’s is the continuous decline of once functional processes associated with executive function.The prefrontal cortex was concluded to largely contribute to both working memory and inhibition capabilities.

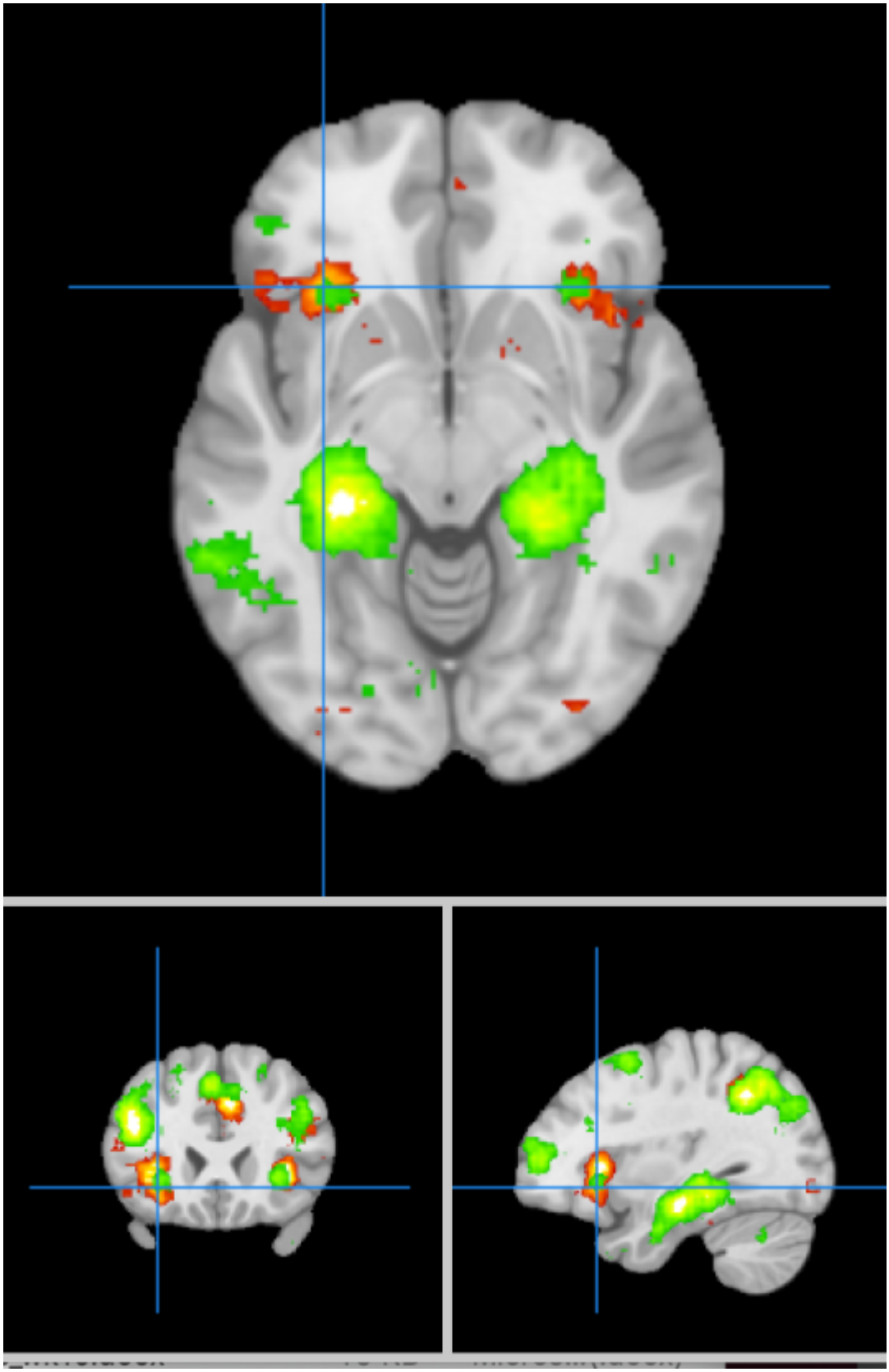
The concept of “mental shotgunning”was discussed by the class and was determined to be a term to define the event where more information is processed by the brain than actually necessary in regards to a specific problem or stimulus, and thus resulting in the continuation or prevalence of other problems while simultaneously attempting to solve the intended problem at hand. The term itself can be explained by how a shotgun spreads small amounts of munition in a scattered format, similarly to how executive functions are scattered in regards to how they are solved, with many specialized processes all having a role. The assessment of competence was concluded to be attributed to many different factors, and in itself is an example of mental shotgunning. Factors that contribute to determine competence can vary in how they are determined, with many different factors and environmental aspects playing a role. One

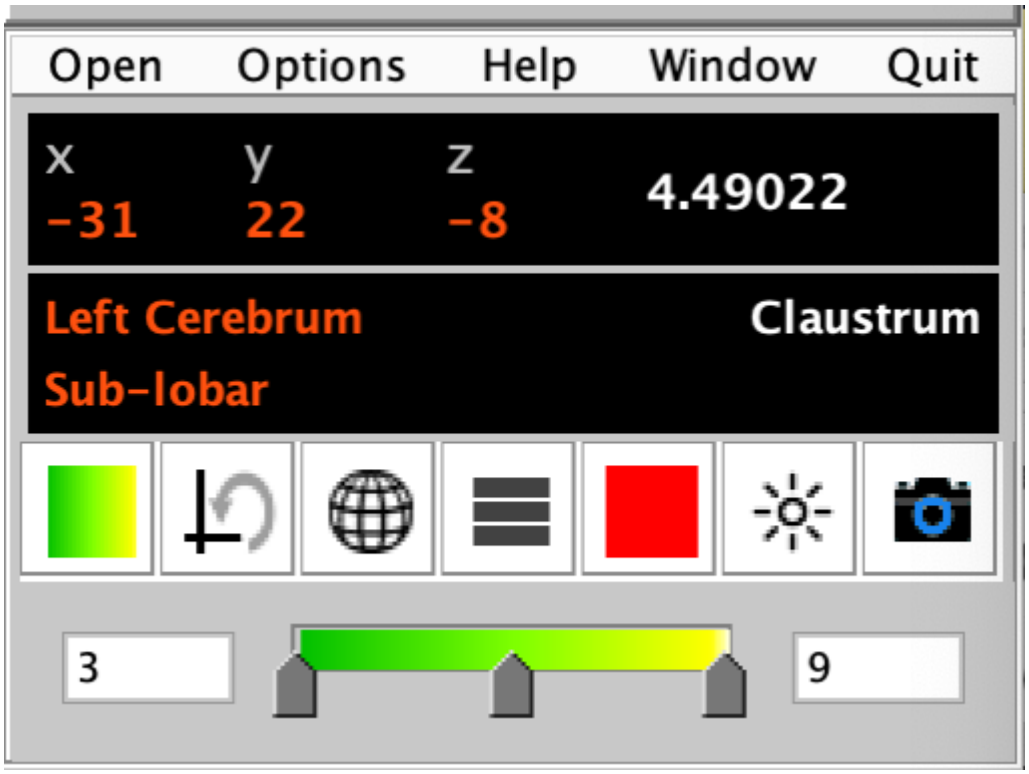
notable example was the perception of competence in political candidates, and what qualities were deemed to assume a candidates competence, such as education, background, social skills, as well as subliminal factors such as body language and appearance.

Cognitive Process Neuroimaging Analysis

Neurosynth terms: executive function and memory.

Neurosynth map for the terms





Questions posed by the class

Neural processes related to executive function

Q: What is synaptogenesis?

Paint level: Synaptogenesis is the formation of synaptic connections, thus increasing synaptic density in the cortex. In the human neocortex, this occurs during the third trimester of gestation and the first two years of life.

Huttenlocher, P. R. & Dabholkar, A. S. (1997). Regional differences in synaptogenesis in human cerebral cortex. *The Journal of Comparative Neurology, 387*(2), 167-178.

Coolactive: Synaptogenesis is the process involving the formation of a neurotransmitter release site in the presynaptic neuron and a receptive field at the postsynaptic partners, and the precise alignment of pre- and postsynaptic specializations.

> Jin, Y. (2005). Synaptogenesis. *WormBook*. https://doi.org/10.1895/wormbook.1.44.1

Q: What do the noradrenergic, serotonergic, and dopaminergic neurotransmitter systems do?

PolarisUnique: Noradrenergic: “A neuronal system that is responsible for the synthesis, storage, and release of the norepinephrine neurotransmitter. Norepinephrine, also known as noradrenaline, consists of a single amine group and a catechol nucleus (a benzene ring with two hydroxyl groups) and is therefore referred to as a monoamine or catecholamine. It exists in both the central and peripheral nervous systems. Norepinephrine is the primary neurotransmitter released by the sympathetic nervous system, which mediates the “fight or flight” reaction, preparing the body for action by affecting numerous physiological functions, including cardiovascular function, gastrointestinal motility and secretion, bronchodilation, and glucose metabolism. Within the central nervous system, norepinephrine has been associated with several brain functions, including sleep, memory, learning, and emotions. The major clustering of norepinephrine-producing neuron cell bodies in the central nervous system lies in the locus coeruleus. This center, located in the pons with extensive projections throughout the brain, produces more than 70% of all norepinephrine in the brain.[1)]”

Serotonergic: “The serotonergic system is one of the oldest of the amine systems in the brain. It is also one of the most mysterious. It is very hard to say in a few words what the serotonergic system does. It originates in two midbrain areas called the dorsal raphe and the median raphe. They both innervate forebrain and midbrain structures in kind of complementary ways that are a bit complicated to go into. The serotonin system seems to be very much involved in inhibition. It opposes, in function, most of the other amine systems and it’s inhibitory both in terms of sensory input and in behavioral output. So, let me try and illustrate that - LSD is a drug which works via serotonin receptors in the brain and of course it produces amazing visual hallucinations by working with serotonin receptors and presumably, disinhibiting those neurons. On the output side, we know that serotonin is very much involved in impulsivity, that is to say, behavior occurring without foresight. We know in our own research with rats that if rats have low serotonin, they simply can’t restrain themselves from responding when they shouldn’t. So, this is a very intriguing function in terms of psychopathology. And in indeed in human terms, serotonin functions have also been linked to aggression, for example. So, low serotonin produces behavioral disinhibition leading to aggression.[2)]”

Dopaminergic: “Dopaminergic signaling is associated with reward-motivated behavior and motor control with dysfunction of the dopamine system leading to numerous diseases. For example, degenerative Parkinson’s disease is caused by the loss of dopamine-secreting neurons that leads to motor impairment.[3)]“

Baudic, Sophie, Gianfranco Dalla Barba, Marie Claude Thibaudet, Alain Smagghe, Philippe Remy, and Latchezar Traykov. “Executive Function Deficits in Early Alzheimer’s Disease and Their Relations with Episodic Memory.” *Archives of Clinical Neuropsychology* 21, no. 1 (January 1, 2006): 15–21. https://doi.org/10.1016/j.acn.2005.07.002.

Mynlieff, Michelle, Dennis S. Charney, Alan Breier, and Steven Southwick. “Noradrenergic System.” *Access Science*, 2018. https://doi.org/10.1036/1097-8542.456150.

Perry, Richard J, Peter Watson, and John R Hodges. “The Nature and Staging of Attention Dysfunction in Early (Minimal and Mild) Alzheimer’s Disease: Relationship to Episodic and Semantic Memory Impairment.” *Neuropsychologia* 38, no. 3 (March 1, 2000): 252–71.

https://doi.org/10.1016/S0028-3932(99)00079-2.

Stopford, Cheryl L., Jennifer C. Thompson, David Neary, Anna M. T. Richardson, and Julie S. Snowden. “Working Memory, Attention, and Executive Function in Alzheimer’s Disease and Frontotemporal Dementia.” *Cortex* 48, no. 4 (April 1, 2012): 429–46. https://doi.org/10.1016/j.cortex.2010.12.002.

“The Role of Dopamine as a Neurotransmitter in the Human Brain.” Accessed March 26, 2019. http://www.enzolifesciences.com/science-center/technotes/2018/november/the-role-of-dopamine-as-a-neurotransmitter-in-the-human-brain/.

“The Serotonergic System :: DNA Learning Center.” Accessed March 26, 2019. https://www.dnalc.org/view/813-the-serotonergic-system.html.

Wong, Christina G., and Michael C. Stevens. “The Effects of Stimulant Medication on Working Memory Functional Connectivity in Attention-Deficit/Hyperactivity Disorder.” *Biological Psychiatry* 71, no. 5 (March 1, 2012): 458–66. https://doi.org/10.1016/j.biopsych.2011.11.011.

Q: What is the salience network?

WindowComrade: The salience network (SN) is a large scale brain network of the human brain that is primarily composed of the anterior insula (AI) and dorsal anterior cingulate cortex (dACC). While the main function of the salience network is unknown, it has been implicated to be involved in detecting and filtering salient stimuli, as well as recruiting relevant functional networks. With its interconnected brain networks, the salience network contributes to communication, social behavior, and self-awareness through the integration of sensory, emotional, and cognitive information. There has been dysfunction seen in the salience network in various psychiatric disorders. These include anxiety disorders, PTSD, schizophrenia, frontotemporal dementia, and Alzheimers.

(Salience network. (2019). In *Wikipedia*. Retrieved from https://en.wikipedia.org/w/index.php?title=Salience_network&oldid=883558768)

How is executive function different from cognition in general?

Q: Are working memory, inhibition, set shifting, and fluency all part of System 2?

RavioliJaguar: System 2 is thought to be the route in the cognitive decision making scheme that requires deliberate activation. It requires attention and effort and does not last for long periods of time. Working memory is thought to be a temporary processing procedure that allos us to store, process, and manipulate information under conscious awareness thus making this a system 2 function. Inhibition also requires control and effort over reactions and responses that maybe be more or less automatic. These characteristics puts inhibition in the system 2 category because it is an effortful, conscious decision. Set shifting is the ability to manipulate and control attention and behavior based on changing circumstances.

Once again, this capability requires control and even the use of working memory and is a more slow, strenuous activity on the brain. Lastly, fluency is the ability to maximize the production of verbal or visual information in a specific amount of time without repetition. This is a system 2 function requiring thoughtful and careful planning. These component of executive function all fall into System 2 processing individual on their own when asked to do tasks but they all work together in everyday life to allow us carefully plan and execute behavior.

Kahneman, D., & Egan, P. (2011). Thinking, fast and slow (Vol. 1). Farrar, Straus and Giroux New York.

System 1 vs 2 Decision Making for Market Research. (n.d.). Retrieved March 26, 2019, from Upfront Analytics website: http://upfrontanalytics.com/market-research-system-1-vs-system-2-decision-making/

Rabinovici, G. D., Stephens, M. L., & Possin, K. L. (2015). Executive Dysfunction. Continuum : Lifelong Learning in Neurology, 21(3 Behavioral Neurology and Neuropsychiatry), 646–659. //https://doi.org/10.1212/01.CON.0000466658.05156.54//

Q: What are the kinds of cognitive functions that do not fall under the category of executive functions? What are the other categories of functions?

AmbientBenefit: On Wikipedia it lists “Brain Functions” as arousal, attention, consciousness, decision making, executive functions, natural language, learning, memory, motor coordination, perception, planning, problem solving, and thought - although this doesn't seem like a very cohesive list. (“Executive functions,” 2019) I found a different article about “non-executive cognitive abilities in individuals with PKU” (phenylketonuria) that lists information processing speed, fine motor control, and perception and visual-spatial abilities, language, and learning/memory (although they reference the last one as linked to executive function) as functions that are non-executive. (Janzen & Nguyen, 2010). Overall, I’m not sure that there is actually is a widely recognized list of non-executive function.

Q: What kinds of questions would be asked to the individual during a cognitive inhibition task “go/no go task”? And does this task accurately measure a lack of inhibition?

DivideSegment: For an inhibition task “go/no go task” the patient must respond to a certain stimulus while withholding a response if presented with an alternative stimulus. The example given in the paper is the clapping task. During go/no go tasks the individual is given a stimulus that represents go normally, but not a specific questions they have shapes and BMI tasks.

> Drummond, N. M., Cressman, E. K., & Carlsen, A. N. (2017). Offline continuous theta burst stimulation over right inferior frontal gyrus and pre-supplementary motor area impairs inhibition during a go/no-go task. *Neuropsychologia*, *99*, 360–367. https://doi.org/10.1016/j.neuropsychologia.2017.04.007

Another study on children uses auditory stimulus, however go/no go tasks measure inhibition, there are debates on how well the tasks measures it. In this particular study they studied the link between N2 and inhibition in children.

Barry, R. J., & Blasio, F. M. D. (2015). Performance and ERP components in the equiprobable go/no-go task: Inhibition in children. *Psychophysiology*, *52*(9), 1228–1237.

https://doi.org/10.1111/psyp.12447

Q: What is the Design Fluency test? And, how does it work?

SodaOxford: The design fluency test are a group of test that are limited and need to draw figures or remodel lines to make shapes. The participant is given 5 minutes to draw as many different designs as possible on a blank sheet of paper for the first part. For the second part (4 minutes), the participant is given examples and instructions to limit the drawings to four straight or curved lines. The output score is the total number of unique drawings minus the sum of all errors. This test is used to determine frontal lobe functioning.

Ruff, R. (2011). Design Fluency Test. In J. S. Kreutzer, J. DeLuca, & B. Caplan (Eds.), Encyclopedia of Clinical Neuropsychology (pp. 821–822). https://doi.org/10.1007/978-0-387-79948-3_1426

Q: Do those with troubles in fluency have trouble with conversation?

DecimalSponsor: Although not every problem with fluency incorporates actually speaking, an individual can still certainly experience this. As this article mentions, people can experience this deficit in speaking and being able to have a fluent and flowing conversation, but it's also stated that the brain can have fluency problems with anything that is elongated and needs attention for periods of time.

Fluency Disorder | Johns Hopkins Medicine Health Library. (n.d.). Retrieved March 26, 2019, from https://www.hopkinsmedicine.org/healthlibrary/conditions/otolaryngology/fluency_disorder_134,237

Q: How does set shifting coincide with working memory and response inhibition in executive functioning?

AmbientBenefit: The article defines set shifting as "the ability to modify attention and behavior in response to changing circumstances and demands." The article pretty much answers this question, saying that set shifting "inherently relies on working memory (in order to keep in mind the current goals) and response inhibition (in order to ignore a previously relevant goal or focus of attention)." For more clarification, this is because working memory (as defined by the article) allows us to temporarily process/store/manipulate information in our mind, while response inhibition is the ability to hold back a previously learned response to something. (Rabinovici, Stephens, & Possin, 2015)

Working memory

Q: The article mentions that working memory is a limited capacity system. Is the limit the same for all humans?

ShelfOpus: Although working memory is a limited capacity system, the limit is not necessarily the same for all people. Since working memory plays an important role in human cognition it's expected that the capacity or efficiency of one's working memory would correlate with performance on high-level cognitive tasks and concepts such as reasoning or general fluid intelligence. There are some studies that suggest this view point. For example, research shows that children with specific mathematical or reading difficulties perform worse on working memory tasks. The same is also true of those with generalized learning disabilities and low fluid intelligence. Due to this, the current theory is that individual differences in processing efficiency are primarily what determine working memory capacity.

Jarrold, C., & Towse, J. N. (2006). Individual differences in working memory. *Neuroscience*, *139*(1), 39–50. https://doi.org/10.1016/j.neuroscience.2005.07.002

Q: In the article it states that working memory is "limited capacity system", so how limited is our working memory, and is there a time period for the duration of when we engage working memory?

DivideSegment: From my Cognitive Psychology class we learned that working memory does not have an actual time limit or capacity limit if there are not distractors at all, however in life we generally have a lot of distractors. Working memory is all the things that we can consciously think about. Our perception controls the amount of stimuli that actually get processed in the brain which means that most of our working memory capacity is probably only a few things, many 10 at the most. If you use both auditory and visuospatial systems dual-task capacity is increased.

> Barry, R. J., & Blasio, F. M. D. (2015). Performance and ERP components in the equiprobable go/no-go task: Inhibition in children. *Psychophysiology*, *52*(9), 1228–1237.

https://doi.org/10.1111/psyp.12447

Q: Are there treatments for people with working memory deficits?

MobileSuper: Since working memory deficits are typically found in individuals who have been diagnosed with ADHD they can improve memory with stimulant medication and psychostimulant.

Wong and Stevens, "The Effects of Stimulant Medication on Working Memory Functional Connectivity in Attention-Deficit/Hyperactivity Disorder."

Individual differences

Q: Do people with a stronger drive and motivation to succeed have more executive function capabilities? Do you think people can have more “executive function” in different areas of their life? For example: in a school setting for studying for an exam or maybe in their hobby like perfecting a dance move?

SocialAnvil: From what I can tell, a strong drive and more motivation might be more closely linked to intrinsic motivation, which we cannot exactly define why the person feels this strong desire to succeed. However since executive function is defined by the ability to plan, organize and complete tasks, this could be related. Furthermore, executive function is located in the prefrontal lobe, which develops later in men and for both sexes continue to develop into the 20’s. So, someone who has more executive function may be further into development of their prefrontal lobe.

Johnson, S. B., Blum, R. W., & Giedd, J. N. (2009). Adolescent Maturity and the Brain: The Promise and Pitfalls of Neuroscience Research in Adolescent Health Policy. Journal of Adolescent Health, 45(3), 216-221. doi:10.1016/j.jadohealth.2009.05.016-

Brain injury and diseases

Q: What is a “white matter injury” and how does it affect executive functions?

WindowComrade: White matter injuries occur when white matter tracts are damaged. This damage limits communication between areas of grey matter to the rest of the brain. An example would be a spinal cord injury. The outside of the spinal cord is made of large white matter tracts. If these tracts are damaged, it can lead to paralysis because information from the brain’s motor cortex (grey matter) is no longer able to reach the spinal cord and muscles. White matter injuries impact executive functioning by slowing the rate of cognitive processing, axonal damage, loss of oligodendroglia (form myelin), and even low levels of neurotransmitters created in the brain - these can result in reduced processing speed and attention.

(What’s the Matter? (n.d.). Retrieved March 26, 2019, from Hydrocephalus Association website: https://www.hydroassoc.org/whats-the-matter/)

(The Relationship Between Executive Function and Processing Speed – Brainy Behavior. (n.d.). Retrieved March 26, 2019, from http://www.brainybehavior.com/blog/2009/07/executive-function-processing-speed/)

Q: Is there an area of the brain that would have to be injured for executive functions to cease, or is the whole brain involved?

TelecomElegant: The whole brain is most likely not involved. Executive functions cease to exist most commonly with damage to the frontal lobe and the frontal lobe alone (Levine et al., 2011). Specifically,

damage to the frontal lobe results in difficulties with planning, regulating self, and motivated behavior which would all be executive functions also sometimes known as frontal lobe functions (Levine et al., 2011). However, many neurological diseases can disrupt the interconnectivity of the brain, and this may play a role in loss of executive functions as well (Levine et al., 2011).

Levine, B., Schweizer, T. A., O'Connor, C., Turner, G., Gillingham, S., Stuss, D. T., … Robertson, I. H. (2011). Rehabilitation of Executive Functioning in Patients with Frontal Lobe Brain Damage with Goal Management Training. *Frontiers in Human Neuroscience*, *5*. https://doi.org/10.3389/fnhum.2011.00009

Q: What is the most commonly injured brain region that leads to executive dysfunction?

TwinNevada: Although executive dysfunction is a common problem among many brain injury survivors, it is most commonly experienced following an injury to the frontal lobe. Executive dysfunction is used to collectively describe impairment in the 'executive functions' - the key cognitive, emotional and behavioral skills that are used to navigate through life, especially when undertaking activities and interacting with others. The most common effects of executive dysfunction are difficulties with motivation and organization, rigid thinking, poor problem solving, impulsivity, mood disturbances, difficulties in social situations and memory/attention problems.

MEDIAmaker. (n.d.). 7 signs of executive dysfunction after brain injury. Retrieved March 26, 2019, from https://www.headway.org.uk/news/national-news/7-signs-of-executive-dysfunction-after-brain-injury/

Q: In the many conditions listed that are associated with executive dysfunction (such as ADHD or congestive heart failure) would you actually be able to see the damage (to white matter connections, regions associated with executive dysfunction, or neurotransmitter systems) in the brain that the article says causes executive dysfunction?

WelcomeSoda: Neither ADHD nor congestive heart failure can be diagnosed using evaluation of white matter. From my understanding, the way doctors diagnose serious white matter injuries is by evaluating symptoms and by use of an MRI of the brain to show a section of the brain as a very bright white if a white matter injury is involved. If this was an effective way of distinguishing between different diseases or other cognitive issues, I think it would be used.

> Congestive Heart Failure: Diagnosis. (n.d.). Retrieved March 26, 2019, from National Jewish Health website:
>
> https://nationaljewish.org/conditions/congestive-heart-failure/diagnosisCDC. (2018, December 20). Symptoms and Diagnosis of ADHD | CDC. Retrieved March 26, 2019, from Centers for Disease Control and Prevention website: https://www.cdc.gov/ncbddd/adhd/diagnosis.html

Q: What physical/bodily symptoms are prevalent in patients with cognitive disorders? Do these bodily symptoms vary between disorders such as Alzheimer's and ADHD, or are they all relatively similar?

Physical symptoms attributed to possible cognitive dysfunction are considered to be heavily behavioral, with the prevalence of agitation, confusion, anxiety, delusion, and disinhibition are all symptoms commonly prevalent in those diagnosed with Alzheimer's disease, and are considered to be neuropsychiatric symptoms. While these are not necessarily physical on their own, they can attribute to additional symptoms, such as degenerative loss in motor function. Symptoms of ADHD are primarily behavioral as well, with few strictly physical symptoms being prevalent. Most notably, symptoms of ADHD can include forgetfulness, agitation, distractibility, and restless and impulsive behavior. Some of these symptoms can be emanted physically in the form of excessive fidgeting, while effects of ADHD show impaired functioning in at least two settings, such as at home, work, or school, for an extended period of at least six months. While epidemiology and pathogenesis tend to be varied when comparing Alzheimer's, ADHD, and other cognitive disorders, similarities in symptoms such as agitation are often a byproduct executive dysfunction prevalent with many disorders relevant to cognition.

References:

Dillon, C., Serrano, C. M., Castro, D., Leguizamón, P. P., Heisecke, S. L., & Taragano, F. E. (2013). Behavioral symptoms related to cognitive impairment. *Neuropsychiatric disease and treatment*, *9*, 1443–1455. doi:10.2147/NDT.S47133

Wilens, T. E., & Spencer, T. J. (2010). Understanding Attention-Deficit/Hyperactivity Disorder From Childhood to Adulthood. *Postgraduate Medicine*, *122*(5), 97–109. https://doi.org/10.3810/pgm.2010.09.2206

Hugo, J., & Ganguli, M. (2014). Dementia and Cognitive Impairment: Epidemiology, Diagnosis, and Treatment. Clinics in Geriatric Medicine, 30(3), 421–442. https://doi.org/10.1016/j.cger.2014.04.001

Q: What diseases or disorders may affect inhibition?

BanditMeter: "impairment of ADHD children in inhibition and working memory tasks and of ASD children in planning and flexibility abilities. The Autism Spectrum Disorder + group showed similarities to the ADHD group with regard to inhibitory but not to working memory deficits." Thus, Autism and ADHD are examples of disorders that affect memory inhibition.

> Sinzig, J., Morsch, D., Bruning, N., Schmidt, M. H., & Lehmkuhl, G. (2008). Inhibition, flexibility, working memory and planning in autism spectrum disorders with and without comorbid ADHD-symptoms. *Child and Adolescent Psychiatry and Mental Health*, *2*(1), 4.

https://doi.org/10.1186/1753-2000-2-4

Q: What is the average annual cost of an individually tailored dysexecutive disorder treatment?

DivideSegment: Due to the necessity of individually tailored treatment there is no way to determine the average cost, however specific to Alzheimer's 67% of Medicaid and Medicare spending goes towards this disease, it is the most expensive disease for senior citizens. It costs on average $57,000 per person per year according to the Alzheimer's Association 2018 Fact Sheet. Parkinson's disease averaged around $5,000 per year and ADHD around $2,500 per person per year. As you can see there is a great variety in the cost of individual treatments.

Q: Can trauma lead to inhibition deficits? If so, what specifically are the reasons for this?

MileImport: The first example of trauma that came to mind regarding inhibition deficits was Phineas Gage, who had a brain lesion in his left frontal lobe that caused profound impacts to his personality. His colleagues and family reported extensive changes to his ability to inhibit emotion, language, addiction, etc., all as a direct result of the injury.

Q: Patients can have Alzheimer's without episodic memory loss, and just executive function problems?

VideoSport: It appears that executive function generally and working memory specifically (distinguished because there are multiple regions of the brain involved in working memory that are impacted, while the frontal lobe is considered most prominent for executive function) can be early signs of Alzheimer's [4]. Studies demonstrate that specifically episodic memory is impaired in early stages of Alzheimer's but that general executive dysfunction related to attention difficulties is also sometimes reported[5]. "Episodic memory and executive deficits occur in the very early stage of AD and precede impairment" in other areas[6].

ExactTulip: "For reasons that are not well understood, early AD pathology frequently targets large-scale neuroanatomical networks for episodic memory before other networks that subserve language, attention, executive functions, and visuospatial abilities (Weintraub, Wicklund, & Salmon, 2012)."

"In the usual case, AD pathology is initially selective for limbic regions that subserve episodic memory, which leads to a circumscribed memory deficit in the early stages of the disease"

> Weintraub, S., Wicklund, A. H., & Salmon, D. P. (2012). The Neuropsychological Profile of Alzheimer Disease. *Cold Spring Harbor Perspectives in Medicine*, *2*(4).

- https://doi.org/10.1101/cshperspect.a006171This article suggests that episodic memory loss is the first key symptom that could potentially lead to a dementia and/or alzheimer's diagnosis. Therefore considering that one of the earliest symptoms is considered to be episodic memory loss, patients experiencing this symptom will likely further digress into experiencing a loss in executive function as the disease progresses, especially without treatment.

Q: Why is dopamine replacement therapy better for patients with Parkinsons disease over those with Alzheimer's?

Optiontemple: Parkinson's disease (PD) specifically affects how dopamine (DA) is produced in the dorsal and ventral striatum. DA replacement drugs very much benefit PD patients in early stages by adding DA into the dorsal striatum which helps motor function, but eventually the overdose in the ventral striatum begins to affect the rewards system in later stages. PD, however, is normally caused from altered metabolism of certain proteins that leads to the production of amyloid (Aβ) oligomers which are very toxic on neural pathways. AD can affect DA in early stages, but it does not always. My understanding is that where Aβ begins to erode the brain is where the damage starts so if it starts in DA centers these drugs could be beneficial, but this is not always the case. Although, there is not a general consensus on how DA effects AD.

In conclusion the reason it is more effective in PD is that it helps treat the problem of a lack of DA in the brain that helps delay progression and symptoms in PD, but in AD the dopamine is only a symptom of a larger problem involving Aβ.

("Parkinson's disease," n.d.) (Martorana & Koch, 2014)

Heredity and evolution

Q: Is executive function hereditary?

RespondLlama: "Perseverative errors are influenced by a common dominance genetic latent factor and individual specific environmental factors, but the role of environmental factors such as family functioning and parental health can not be ignored."

> Hu, X., Ma, X., Zhu, W., Fu, Y., Zhou, Y., Meng, H., … Li, T. (2014). [Effect of hereditary and environmental factors on the executive function of twin children]. *Nan Fang Yi Ke Da Xue Xue Bao = Journal of Southern Medical University*, *34*(9), 1291–1294.

Q: Are we the only species with executive function? If so, which other species come closest when thinking about its components of working memory, inhibition, set shifting, and fluency?

SincereZigzag: Neuromodulation of frontal-executive function is reviewed in the context of experiments on rats, monkeys and human subjects.

Rats: Williams and Goldman-Rakic (1995) have shown that low doses of DA receptor antagonists sharpen the firing patterns of prefrontal cortical 'memory' cells, predicting that this might lead to behavioural improvements rather than deficits. A number of studies in the rat have suggested that high levels of prefrontal cortical DA activity are associated with poorer delayed alternation performance in the rat.

These results suggest that the relationship between mesofrontal DA function and efficiency of working memory might be characterized by an inverted U-shaped function, with extreme low and high levels of DA activity being associated with impaired performance.

Monkeys:

Table 1 Summary of effects of mesofrontal dopamine depletion on functions sensitive to frontal lobe lesions in monkeys

Function	Effect	References
Spatial working memory (delayed response)	Impaired	Brozoski et al. 1979; Roberts et al. 1994; Collins et al. 1998
Extra-dimensional set-shifting	Enhanced	Roberts et al. 1994
Spatial sequencing	No effect	Collins et al. 1998
Reversal learning	No effect	Roberts et al. 1994

Robbins, T. W. (2000). Chemical neuromodulation of frontal-executive functions in humans and other animals. *Experimental Brain Research*, *133*(1), 130–138.

https://doi.org/10.1007/s002210000407

Research methods and ethics

Q: In Case 4-1 on page 647, how do researchers go about finding people for this cases like these in research papers? Do researchers look for specific people or are the case studies performed for the purpose of supporting the research?

In this case they were able to find someone who had a memory loss issues and were able to highlight the components of executive function. In research papers like these, they have to look for outside outlets such as retired living housing developments or nursing homes. It is important for a research study to have good recruitment. An article in Neuropsychiatric Disease and Treatment says that there are difficulties experienced in clinical trials for recruitment and “can lead to overall reduced sample sizes” which limits the amount of adequately powered studies. (Wise et. al). It is difficult for researchers to find individuals to participate in their studies. When researchers are looking for participants they look for a specific age group or group that could fit the criteria they need for their study. One article states you can “advertise your study in the ‘volunteering’ category” on craigslist as well as in calling for participants (healthpsychtam). Case studies are using to study a specific phenomenon in a certain subject. Researchers look for people who may fall under the category of the case study. For instance, selecting research participants by age, ethnicity or education background. They may have specific techniques to select participants. One article states that “quantitative research requires standardization of procedures and random selection of participants to remove the potential influence of external variables and ensures generalizability”(Sargeant). Researchers may have to use random selection of participants in a sample size to make it more general.

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