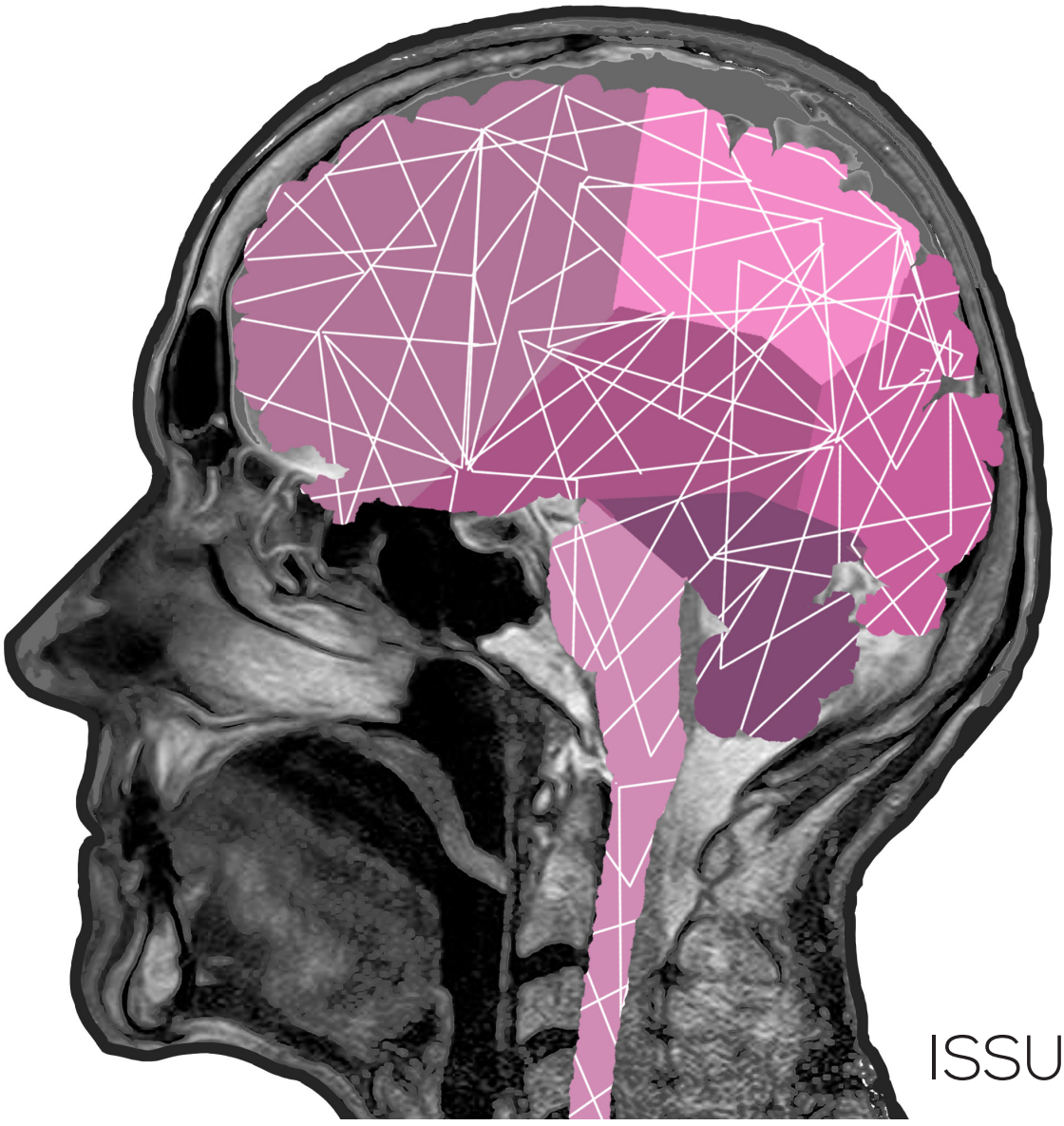
Psynapse

McMaster Undergraduate Journal of Psychology, Neuroscience & Behaviour



ISSUE 2

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Address
Psychology Complex (PC)
Building 34, Room 102
Dept. of Psychology, Neuroscience & Behaviour
1280 Main Street West
Hamilton, Ontario
L8S 4K1

Our Email
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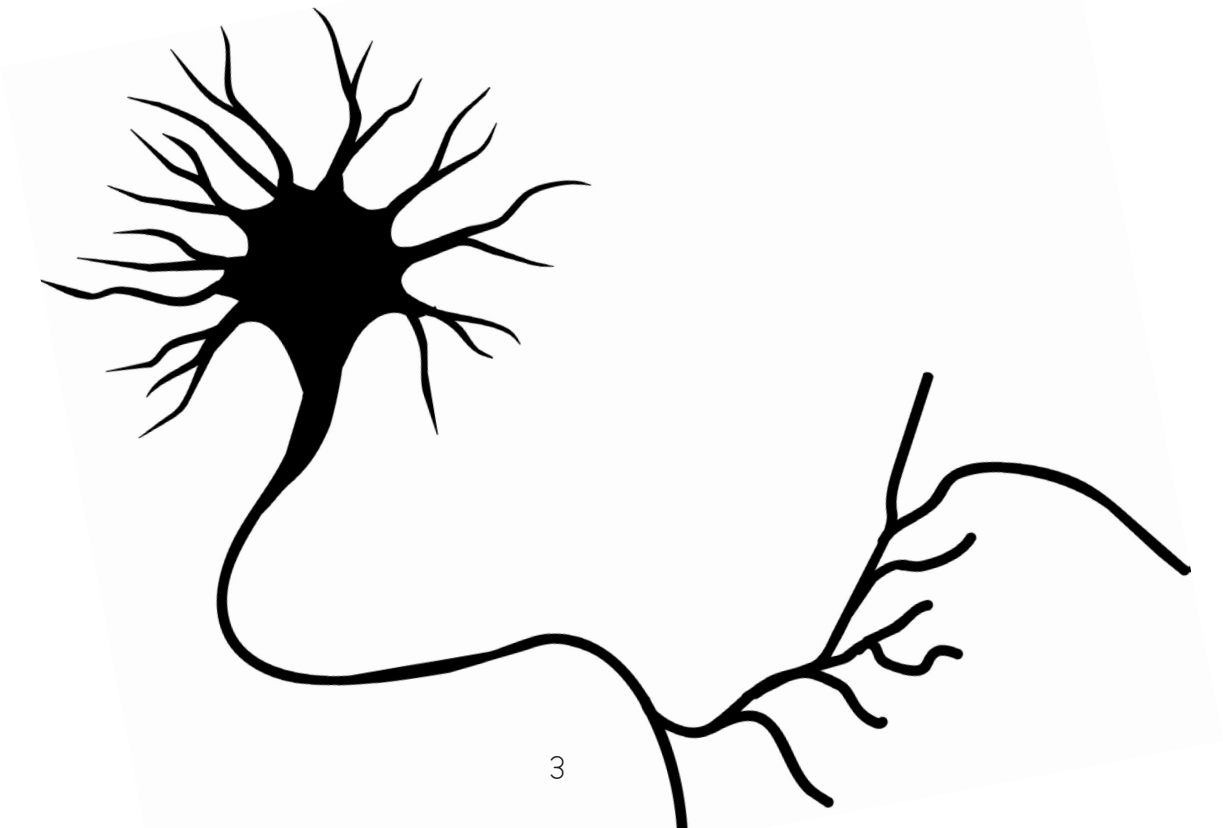

A Letter From the Editor-in-Chief

I used to dislike writing. The thought of penning an essay on a vengeful Venetian merchant sent shivers down my spine. This dislike only increased with the essays and lab reports that permeated university courses, along with the realization that I was not a good writer. Many students in the Psychology, Neuroscience & Behaviour (PNB) program shared this realization after receiving their first précis grade. Instead of wavering, however, we students overcame the challenge and produced wonderful written pieces, of which *Psynapse* is proud to present here. As these students produced masterful content, *Psynapse* provided an avenue to showcase their research.

My predecessor, Kathy Jiang, made it her mission to create an accessible and respectable platform for PNB students to share their undergraduate research. Thanks to the efforts of this year's executive team, our newly minted MSU club status solidifies *Psynapse* as *the* PNB journal, ultimately fulfilling Kathy's wish. Thank you, my fellow executive members, for achieving this status, as well as for dedicating the time and effort to the creation of this issue and the overall growth of *Psynapse*.

I would also like to express my gratitude to both the Editorial and Design teams for their dedication to the journal. Without their tireless work over the summer and the first half of the 2018-2019 academic year, *Psynapse* would not have a sophomore effort to showcase this year. In like manner, I want to extend my thanks to the authors of the articles. The works within this journal not only showcase the research within the department, but also the students of PNB: the sharp minds that dwell the halls of Psychology Complex, and hone their skills in cutting edge research.

There are many fields of research within the PNB department, and I hope the articles within this issue of the *Psynapse* reflect this diversity. From a study on global sleeping patterns, to a deep dive into the science behind Botox, there's something for everyone within these pages. Thankfully, reading these articles will not require a pound of flesh—just a moment of your time.

Dayle Parker

ADVANCED TOPICS

The Advanced Topics section contains scientific papers that paint a nuanced portrait of an emerging or controversial topic in psychology, neuroscience, and behaviour. Whether made from the author's own research or produced for a class, the papers in this section allow the readers to delve deep into emerging topics in PNB without sacrificing clarity. The papers often cover emerging and controversial topics in both academia and the society at large. Thus, we hope this section succeeds in inspiring readers to critically analyze and explore these various topics.

Tracking the Dark Triad

MICHAEL FRANCISCO

Personality research has changed drastically since its conception. Type approaches were originally favoured because they are simple: each person is placed into a distinct category. Unfortunately, there are always people who fit into more than one category. To address this issue, personality models have changed and use spectrums to define individual traits (Barlow, Durand, Hofmann, & Lalumière, 2015). Three of these traits are narcissism, psychopathy, and machiavellianism. Narcissism is an obsession with the self, and the exploitation of others to benefit the self. Psychopathy is an inability to form or maintain meaningful connections due to a lack of empathy. Machiavellianism is the tendency to manipulate others for personal benefit. Possessing one of these traits in a high degree can cause trouble; altogether, they form the dark triad (DT). While DT individuals vary in race, gender, and religious views, they all share a similar life trajectory.

In childhood, dark triad individuals are bullies (van Geel, Goemans, Toprak, & Vedder, 2017). Children who rank highly in both psychopathy and machiavellianism also show a higher level of cyberbullying and traditional bullying behaviours. As children, DT individuals have poor theory of mind abilities and struggle to understand other peoples' emotions, wants, and beliefs (Stellwagen & Kerig, 2013). For example, a DT child that steals a peer's chocolate bar would not understand why their peer is crying, but would cry if that peer took their chocolate bar back (Stellwagen & Kerig, 2013). This combination of bullying and poor theory of mind abilities is dangerous since DT children will not feel guilty for their actions. In fact, the DT child in the previous example was rewarded for their cruel behaviour as they have the chocolate bar. If left unchecked, DT children may remain bullies for their whole lives.

In university, DT individuals tend to enroll in programs that will lead to status and power. Business and economics are the programs that they are most attracted to, while law and politics are the next most common (Krick, Tresp, Vatter, Ludwig, & Wihlenda, 2016; Vedel & Thomsen, 2017). The number of DT students in business and economic fields does not typically change between enrollment and upper years (Krick et al., 2016). This suggests that DT individuals are drawn to these fields naturally, rather than swapping into these programs after being exposed to the benefits of doing so. DT individuals choose academic fields which advance them in their journey towards status and power.

Figure 1.1 A photo of a young child

As adults, DT individuals pursue positions of power. With years of bullying and a business or economics degree under their belt, the next milestone in a DT individual's life is their career. The jobs a DT individual is most attracted to is based on their most dominant DT trait (Jonason, Wee, Li, & Jackson, 2014). DT individuals with high psychopathy prefer jobs with no supervision and little social interaction. Highly narcissistic DT individuals prefer jobs that increase social admiration towards themselves. DT individuals who are machiavellianistic prefer jobs that have, or will lead to, status and power (Jonason et al., 2014). Once they have a job, DT individuals are more likely than other workers to get promotions (Templer, 2018). DT workers progress their careers through political skill instead of a strong work ethic. DT workers could easily waste a shift playing tetris then charm

the boss into believing they have been working hard (Templer, 2018). A DT individual's strong drive and manipulative skills equip them well for positions of power.

Powerful people are disproportionately DT individuals. 1% of the world's population is wealthy, and usually hold the most power. The DT individuals' desire to join this group, combined with their unique skill set, allows them to be in the 1% more often than the general population. DT individuals' tendency to be bullies makes their frequency in the most powerful group quite unsettling. People working under DT leaders are unlikely to get promotions (Volmer, Koch, & Göritz, 2016). While narcissistic DT leaders can provide rewarding job opportunities to their subordinates, hoping to gain social admiration for their kindness, DT leaders with high psychopathy and machiavellianism often make their subordinates work lives difficult and unrewarding. Their lack of empathy and willingness to manipulate others for their own gain prevents those working under them from reaching their full potential (Volmer, Koch, & Göritz, 2016).

DT individuals tend to follow a certain life course. In childhood, their poor theory of mind abilities makes them likely to bully others. In post-secondary education, DT individuals enroll in business or economics programs more often than in others, hoping to obtain high status jobs. With their degree in hand, DT individuals pursue positions of power, aided by their manipulative prowess and lack of empathy. Once in these positions of power, DT individuals set their goals higher and attempt to join the 1%. What happens when they meet this goal? Will they accept their highly sought after position and settle down, or strive for even more than excellence?

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Illusory Control in Human Behaviour: Implications for Conceptualizations of Mind Wandering

BEN CHARLES SCLODNICK

SUMMARY

In mind wandering research, intentionality is becoming integral to explanations of attentional focus and engagement. Using self-report, researchers have reported trait and behavioural dissociations based on intentionality. Such research has emphasized the need to delineate intentionality as a scientific construct. Neither cognitive nor neurological explanations sufficiently address intentionality; does human consciousness (the mind) have the capacity to influence future thoughts and behaviours? It is well known that cognitive systems bias thoughts and actions without our conscious awareness, yet there is an indomitable tendency for humans to perceive intentional actions as being generated by an objective decision maker. I argue that until new evidence suggests otherwise, we ought to assume behaviours we experience with a feeling of intentionality may be formed by underlying processes to which we are unaware and cannot control. Conscious intention should not be assumed to cause behaviour or thought. The implications of accepting different theories of intentionality are explored, with particular interest in how these ideas impact conceptualizations of accountability.

INTRODUCTION

If a colleague asked you, "Why are you reading right now?" you might respond, "Because I decided to."—and it would feel wrong to attribute your behaviour to anything other than your conscious choosing. People feel control over their decisions and behaviours. We can navigate our minds, move our bodies, and communicate logical reasons for sitting down to read an article. Conscious control is so intuitive that it is easy for people to believe—based on their daily experience—that thoughts and decisions cause their behaviours. This is why we ask people, "Why did you do that?" The idea that our control may be illusory is both counterintuitive and frightening, deterring us from considering alternate theories of human consciousness and behaviour. It is currently impossible to empirically demonstrate that the sense of control we feel actually precedes and causes our behaviours (Libet, Gleason, Wright, & Pearl, 1983; Wegner, 2003), indicating that we should investigate other theories of volition.

The idea that the control humans experience is illusory is not a new concept (Murray & Lombrozo, 2017; Reisberg, 2013; Harris, 2012). Perhaps conscious experience is only a sensation accompanying, or caused by, cognitive processes we cannot control. Consider that, for you to decide to read this paper, you must first think about the paper—it might pop into mind seemingly from nowhere, or you may notice the file on your computer screen—and then you act on the idea. Did you intentionally call to mind the idea to read this paper before you decided to act on it? To deliberately have thoughts enter your mind, it would be necessary to somehow make the decision to have certain thoughts and not others—but evidence suggests that our thoughts are determined prior to our awareness of them (Haggard, 2005; Libet, 1999).

It may be beneficial to consider an alternative view of human behaviour that better reflects our scientific understanding. Despite our every-day feeling of self-agency, the hypothesis that conscious thought causes actions is difficult to support with evidence. That is, scientists would need to demonstrate that our behaviours and decisions depend on preceding conscious thought. Although this may be true, the current literature suggests the opposite: that conscious thought arises in response to the processes that determine our actions (Haggard, 2005). For instance, consciousness may be a by-product (or, epiphenomenon) of other processes inaccessible to the mind (Libet, 1999; Wegner, 2003). Rather than actually exerting control over your behaviours, there may be another part of your brain determining your behaviours and conscious experience in parallel (Haggard, 2005; Wegner, 2003). An exploration of these factors has been conducted by Kevin Simler and Robin Hanson in their book, *The Elephant in the Brain* (2018). They flesh out a convincing theory that human thought and experience of self are primarily social functions, and that our thoughts and introspections do not

necessarily reflect the factors determining behaviour. This alternate view is compatible with empirical findings that suggest our thoughts and behaviours are determined prior to being experienced, rather than controlled by our thought (Cheyne, Carriere, & Smilek, 2009; Haggard 2005; Wegner, 2003).

In our society, people are legally accountable for their actions on the basis that a person's intentions are chosen freely and deliberately. In the case of murder in Canada, a defendant's motives and intentions are considered by the judiciaries before the sentence is decided (first degree murder versus manslaughter). Thus, evidence for a theory of human behaviour that reduces accountability of the conscious mind would have repercussions on how punishment is conceptualized and used in the legal system and other aspects of society.

Until it is possible to understand the relation between conscious experience and behaviour, I suggest that we consider the sensation of control as only a sensation, not as a process that is directly responsible for how our behaviours are formed. This argument is relevant to mind wandering research, that is increasingly concerned with the intentionality of behaviours. Reconsidering the nature of conscious volition will affect the way we conceptualize intentionality.

Figure 2.1 Osgoode Hall (Ontario Court of Appeal), Toronto

MIND WANDERING

What began as an investigation of daydreaming (e.g. Giambra, 1974), is now widely imitated to explore mental experiences associated with memory and attention (Seli et al., 2018). Mind wandering research explores when and why our attention shifts to internal thoughts, what these thoughts consist of, and how they affect memory and task performance (Seli, Maillet, Schacter, Kane, Smallwood, Schooler, & Smilek, 2017; Baldwin, Roberts, Barragan, Lee, Lerner, & Higgins, 2017; Risko, Anderson, Sarwal, Engelhardt, & Kingstone, 2012). Mind wandering, as a construct, typically refers to periods during which attention disengages from a primary task, shifting inward to personal thoughts (Smallwood & Schooler, 2006). However, there is variation in how researchers define (operationalize) mind wandering—there is not yet consensus on what exactly is being measured when we examine mind wandering (Seli et al., 2018).

Original mind wandering experiments measured the amount of mind wandering reported by participants during periods of task engagement (Seibert & Ellis, 1991; Smallwood, McSpadden, & Schooler, 2007; 2008). Levels of mind wandering were then used to predict comprehension for material presented during the task (a task might require participants to watch a video lecture), as well as performance on the task itself (a task may include driving, or monitoring; Baldwin et al., 2017; Baird, Smallwood, Lutz, & Schooler, 2014). Measuring such trends of mind wandering during learning, driving, and other monitoring jobs (such as air-traffic control and train operation) has wide ranging implications. Here at McMaster University, mind wandering studies inform faculty on course development and teaching strategies. Pachai, Ogrodnik, and Kim, (2016) learned that integrating participatory quiz questions into lectures reduced intentional reports of mind wandering. At the University of Waterloo, Dr. Smilek uses his mind wandering expertise to advise rail-train companies on best practices and cabin design for train operators.

There are limited physiological indicators of mind wandering (but see Seli et al., 2014 on fidgeting), although people are beginning to predict mind wandering states using brain monitoring techniques (Fox, Spreng, Ellamil, Andrews-Hanna, & Christoff, 2015). Thought-probes (commonly used to collect mind wandering reports) interrupt the participant's task, and collect information on their mental behaviour —prior to the probe appearing, was the participant "mind wandering" or "on-task"? Random probing during an experimental task makes it possible to trace out typical trends of mind wandering. Alternatively, researchers may use a self-caught method to measure mind wandering, wherein participants simply report any instance they become aware that their mind has drifted off task (Smallwood & Schooler, 2006).

Mind wandering studies that use self-report depend on introspective self-reports to measure if someone is mind wandering or not (Smallwood & Schooler, 2006; Seli et al., 2018). This means researchers have to trust participants' ability to accurately report on their own mind wandering. The issue lies in a large body of evidence that suggests that people

do not have introspective access to cognitive processes that guide their thought (e.g. Hume, & Hendel, 1955; Johansson, Hall, Sikstrom, & Olsson, 2005). In effect, people may not be able to accurately say why they performed an action or why they had a thought (see Nisbett & Wilson, 1977 for a review). Further, individuals may have different internal criteria for reporting their behaviours as intentional (or unintentional). Therefore, it is possible that two different participants could report "intentionally mind wandering" despite having very different internal experiences (Seli et al., 2017). In sum, we have yet to "prove" that subjective reports accurately reflect the cognitive processes that drive behaviour (Nisbett & Wilson, 1977; Seli et al., 2017; Tversky, & Kahneman, 1981).

Forgoing the issues with self-report data, mind wandering appears to be a common experience in everyday life (Killingsworth & Gilbert, 2010). Killingsworth and Gilbert (2010) reported that the majority of people likely mind wander for up to fifty percent of waking hours, but they did operationalize "mind wandering" as "any time participants were thinking about something other than what they were currently doing." Researchers collected participants' responses throughout the day using a phone application. Mind wandering reliably relates to numerous factors, such as: class performance (Wammes, Seli, Cheyne, Boucher, & Smilek, 2016), response inhibition (correctly withholding responses in a fast paced task; Smallwood, McSpadden, & Schooler, 2007; Seli, Risko, & Smilek, 2006), reading comprehension (Smallwood, McSpadden, & Schooler, 2008), memory strength (Risko, Anderson, Sarwal, Engelhardt, & Kingstone, 2012), working memory (i.e. short term memory), and even mood (see Mooneyham & Schooler, 2013 for review). This can be taken to suggest that mind wandering reports are a reliable measurement. From this, researchers are beginning to understand what 'typical' patterns of mental behaviour underlie performance differences in such contexts as in the classroom, driving, studying, reading, and reaction time tests (Baldwin et al., 2017; Szpunar, Moulton, & Schacter, 2013; Wammes et al., 2016).

Early mind wandering studies failed to address the possibility that people may choose to let their mind wander, especially when they are not heavily invested in a task. Since mind wandering is typically thought of as a state of disengagement from a primary task—where attention is oriented inward to personal thoughts—intentional and unintentional disengagement were conflated. There may be important differences in your performance on many of the abovementioned factors if you choose to intentionally engage in mind wandering, rather than falling into a mind wandering state by accident. Likewise, whether or not someone is aware of their mind wandering bouts could conceivably lead to differences in performance outcomes.

Figure 2.2 Self-report questionnaire

Interestingly, subsequent research has shown that intentionality or awareness of mind wandering leads to statistical dissociations between intentional/unintentional and aware/unaware reports (Smallwood, et al., 2007; Seli, Risko, & Smilek, 2016; Wammes et al., 2016). For instance, Seli, Risko, and Smilek (2016) had participants engage in a sustained attention to response task (e.g. go/no-go task). During the task, participants were intermittently presented with mind wandering probes, asking if they were mind wandering in the preceding moments. When the task was easy, participants reported more intentional mind wandering than unintentional mind wandering; when the task was difficult, participants reported more unintentional mind wandering than intentional mind wandering. Importantly, the authors noted that the overall amount of mind wandering between the two groups was not different. If intentionality was not measured, inferences about how attention differs under easy and difficult tasks would not have been made.

A similar case was demonstrated by Phillips, Mills, D'Mello, and Risko (2016), who found increased levels of mind wandering when a participant was reading a passage for a second time rather than when reading it for the first time; increased levels of mind wandering were associated uniquely with intentional mind wandering reports. These researchers also emphasized that if they had not dissociated between intentional and unintentional mind wandering, they would have reached different conclusions about participants' inner experiences during re-reading. By measuring intentionality, they observed that unintentional mind wandering did not increase when participants were asked to read a passage for

the second time. This suggests that people were choosing mind wander, rather than becoming fatigued (Phillips, et al., 2016).

There is also evidence for meaningful differences between intentional and unintentional mind wandering tendencies at the trait level (see Seli, Risko, Smilek, & Schacter, 2016 for a review). For instance, Seli, Risko, Purdon, & Smilek (2017) have shown that obsessive-compulsive disorder (OCD) and attention deficit hyperactivity disorder (ADHD) correlate with unintentional mind wandering, whereas other investigators have shown that task motivation is uniquely correlated with intentional mind wandering (Seli et al., 2016). It is evident that discerning the intentionality of mind wandering allows us to better understand the possible causes and outcomes of attentional behaviours during tasks. And further, that intentional and unintentional mind wandering are both seemingly reliable constructs. What is unknown, is whether the feeling of intentionality represents conscious volition.

THE VALIDITY OF INTENTIONALITY

Intentionality is such an intuitive construct that we accept it without questioning it. (Not us, of course, after conscious consideration of evidence). This ease of understanding may be slowing us from understanding how our thoughts and behaviours are related. As mentioned, our introspections cannot be relied upon (Greenwald & Banaji, 2017), conscious experience may not be causally related to behaviour (Haggard, 2005; Libet et al., 1983), and it is impossible to control for the individual differences in self-report (Seli et al. 2017). Yet, intentionality is still assumed to be under the control of the person. It is not evident this is so — what is actually measured with self-reports of intentionality? In future research it ought to be asked: what best explains the evolution of conscious control, as we experience it? What factors determine whether a person experiences a behaviour as being intentional or not? It may seem straightforward— intentional behaviours are those which you choose to do on purpose. So far, our understanding of intentionality is based only on subjective experience, or intuition, making it difficult to consider that intentional behaviours may be just as automatic as the behaviours you engage in without the feeling of intention. Accordingly, people may be viewed as accountable for their trends of intentional mind wandering and not accountable for their trends of unintentional mind wandering. This would be a failing given the presented evidence.

CONCLUSION

Modern human societies emphasize individual decisions, with far-reaching effects on the wellbeing of each individual (for example, western judicial systems). We govern societies based on the assumption that people can make good decisions if they want to, and have no problem holding people responsible for every decision they make (especially ones with negative consequences). However, there is no evidence that the sense of control people experience over their behaviours is in fact a product of their conscious deliberation.

In the burgeoning field of mind wandering, emphasis is put on characterizing behaviours in terms of intentionality. As such, mind wandering studies imply that intentional behaviours—the behaviours you are personally accountable for—lead to deficits in myriad situations. Yet, it is unclear whether intentionality is a valid construct or simply an illusion of human experience. For this reason, it is paramount that future research focuses on understanding the internal criteria that leads to people's self-reports of intentional or unintentional behaviour. Not only will this prevent false conclusions from being drawn about the underlying causes of "intentional" behaviour, it will lead us to more accurately consolidate our experiences with our understanding of the cosmos.

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Molecular Underpinnings of Cognitive Deficits in Schizophrenia

KEVAN CLIFFORD, DEZI AHUJA

INTRODUCTION

Schizophrenia is a debilitating psychiatric illness that affects 0.5-1% of the population (McGrath, Saha, Chant & Welham, 2008). Clinical symptoms present in two categories: positive symptoms, which include hallucinations and thought delusions; and negative symptoms, including flat affect, loss of pleasure, poverty of speech, and a loss of goal directed behaviour (Harrison, 1999). In addition to positive and negative symptoms, there are significant cognitive deficits across essential domains of executive functioning. Executive functioning is a broad term for cognitive processes involved in self regulation and goal directed behaviour, such as attention, emotional regulation, and working memory (Heinrichs & Zakzanis, 1998). Currently, typical and atypical antipsychotic classes of drugs are used to treat schizophrenia. While these medications can be effective in suppressing the immediate positive symptoms, they do little to treat the negative and cognitive symptoms (Glausier & Lewis, 2013). The cognitive symptoms are the strongest predictor for recovery and successful reintegration into society, and the inability for current drugs to address these symptoms reflects a need to identify new biological targets for drug development. However, current understanding of the neurobiological underpinnings of the disease are not advanced enough to meet these needs (Glausier & Lewis, 2013).

In order to address this gap, we will be examining tissue samples from the Dorsolateral Prefrontal Cortex (DLPFC) in the right hemisphere of male samples in individuals with schizophrenia and controls. The DLPFC has long been implicated in schizophrenia, particularly because of its role in executive functioning, in processes such as working memory, planning, inhibition, and abstract reasoning (Barbey, Colom & Grafman, 2013). Schizophrenic subjects perform poorly on cognitive tasks requiring DLPFC circuitry, and this performance deficit has been correlated to decreased activation and decreased cortical area in neuroimaging studies (Glantz & Lewis, 2000). These characteristics make the DLPFC a prime candidate for exploring the cellular and structural abnormalities that could underlie the disrupted functioning seen in the negative and cognitive symptoms of schizophrenia.

Several aspects of molecular alterations to the DLPFC have been implicated in schizophrenia—hypodopaminergic activity, altered glutamatergic activity, as well as altered protein expression of mitochondria, cytoskeletal architecture, and oligodendrocytes. However, the common molecular pathways affected by these alterations are poorly understood (Pinacho et al., 2016). For our study, we opted to explore how cytoskeletal architecture in neurons could be implicated in connectivity changes in the DLPFC.

The neuronal cytoskeleton consists of 3 interconnected structures: actin microfilaments, microtubules, and intermediate filaments. Of the intermediate filaments, neurofilaments (NF's) are the most abundant. There are three neurofilament subunits based on sizes—there is NFL (light, 68kDA) which is the smallest, NFM (medium, 160kDA), and NFH (heavy, 205kDa), which is the largest (Perrot, Berges, Bocquet & Eyer, 2008). NFH is coded for by the neurofilament triplet H protein (NEFH) gene in humans (Pinacho et al., 2016). The primary role of NF's is to maintain axon calibre and integrity in neurons. Additionally, they are involved in the changing axonal cytoskeleton during neuronal differentiation, guidance, axon outgrowth, and regeneration (Perrot, Berges, Bocquet & Eyer, 2008). Unsurprisingly, changes to their function and structure have been implicated in many neurodegenerative diseases such as Alzheimer's (Perrot, Berges, Bocquet & Eyer, 2008).

We chose to examine NFH, the largest neurofilament, for several reasons—there are some reports of altered protein levels of the three types of neurofilaments in schizophrenia, but most of them are concerning NFL and NFM—the other neurofilament subunits (Pinacho et al., 2016). However, the aforementioned pilot study also found a reduction in NEFH

protein levels in the grey matter of the DLPFC in the brain tissue of individuals with schizophrenia (Pinacho et al., 2016). The altered expression of these large neurofilaments would likely affect the structural integrity of axons and dendrites, and therefore could be involved in abnormal structure of neurons and the connectivity between neurons in the DLPFC.

With this in mind, the first analysis we performed was on overall gene expression of NEFH in layers 1-6 of the cortex in the DLPFC. We sought to quantify whether there was indeed altered expression across all layers of the cortex, and whether it would result in increased or decreased expression of NEFH. A finding of decreased NEFH gene expression in schizophrenia samples would support the findings of the recent pilot study. While this is a research question in itself, we also chose NEFH for a second reason—NEFH expression would allow us to reliably observe pyramidal neurons.

Pyramidal neurons are the most common excitatory neuron in the brain, making up about two-thirds of neurons in the cerebral cortex (Spruston, 2008). They are glutamatergic projection neurons, with the ability to send axons long and short distances. Morphologically, they have upright posture, apical and basal dendrites, and their large cell bodies average 20 micrometers in diameter (Spruston, 2008). One of the main consistent findings in schizophrenia is abnormal cell architecture in deep layer 3 pyramidal neurons of the neocortex. Specifically, dendritic spine density of the pyramidal cells is often significantly reduced (Glantz & Lewis, 2000). Dendritic spines account for the majority of excitatory synapses in the central nervous system, making them important for neuronal excitability (Glausier & Lewis, 2013). Experimental models of spine deficits result in impaired executive function, suggesting that reduced spine density in the DLPFC could contribute to negative and cognitive symptoms of schizophrenia (Glausier & Lewis, 2013). This could imply that the mechanisms responsible for spine formation and maintenance could underlie the differences.

Pyramidal cells express NFH neurofilaments by default because they are very large (Perrot, Berges, Bocquet & Eyer, 2008), so viewing the expression of NEFH should allow us to reliably see stained pyramidal cells in layer 3 of the cortex. With this in mind, we will also be analyzing cell count and average cell size exclusively in layer 3 pyramidal cells of the schizophrenic and control tissue. We are unable to see fine enough cell morphology for spines or most dendrites—instead we are interested in novel aspects such as cell body size, and cell density of these pyramidal cells.

METHODS

In Situ Hybridization in the Allen Human Brain Atlas

The purpose of the Allen Human Brain Atlas In Situ Hybridization database for schizophrenia is to observe differences between schizophrenia sample brain tissue and control tissue for expression of various mRNA transcripts in the dorsolateral prefrontal cortex (DLPFC). The mRNA transcripts of 60 genes were examined in this study to search for candidate genes in schizophrenia, as well as cell-type and cortical-layer markers.

Qualitative

All images gathered for our analysis were taken from the Allen Human Brain Atlas (ABA) In Situ Hybridization database. These images were of the right hemisphere Dorsolateral Prefrontal Cortex (DLPFC) of males ages 40-49. Three images were from individuals in the control set, and Three images were from individuals in the schizophrenia set. Both sets controlled for past smoking behaviour.

For each individual, the chosen brain slice was magnified to 6400 microns and captured using a screen-capture tool, due to an issue with low resolution on the database images. Next, the image was magnified to 800-microns. Three images were captured of areas that clearly displayed layers 1-6 of the neocortex—one photo from the top, middle, and lower gyri of the original picture. Additionally, at 200-micron magnification, a screen-capture of cells in layer 3 of the neocortex was taken.

This resulted in each of the three individuals in the control and each of the three individuals in the schizophrenia set contributing one full 6400-micron image of the DLPFC, three 800-micron captures of layers 1-6 from the top, middle, and lower gyri of the full image, and one 200-micron capture of layer 3.

The 6400-micron images were qualitatively observed to view general mRNA transcript expression throughout the entire DLPFC. Each of the 800-micron images were observed to see more detailed patterns of expression throughout each of the 6 layers of the cortex. The 200-micron images were observed to see the amount, size, shape, and any visible morphology of the pyramidal cells in layer 3.

Quantitative Methods

Image processing was done using Fiji, a modified version of ImageJ. It was downloaded from https://imagej.net/Fiji/Downloads, and installed on a PC running Windows 7.

Each image was processed in Fiji in the following manner:

1. Select 'Process', select 'Subtract Background', choose 50 pixels, press 'Okay'.

2. Select 'Image', select 'Adjust', select 'Threshold'—the threshold was manually adjusted based on discretion, the level was recorded, including whether the automatic value was used. Select 'Apply', select 'Set'.

3. Select 'Process', select 'Binary', select 'Make Binary'

4. Select 'Process', select 'Binary', select 'Watershed'—at this point, the processed version of the image was saved for later use in the report.

5. Using the 'Line Function Tool', a representative minimum cell body length was chosen and measured—details for size choice are explained further on in Methods.

6. Select 'Analyze', select 'Analyze Particles'. Using the formula (length/2)2 x (3.14), a minimum cell area was defined, a large maximum was selected to incorporate all cells past the minimum.

7. Select 'Okay', check boxes: 'display results', 'summarize'.

8. This resulted in cell counts, cell sizes, and average cell size area. Results were copied into Microsoft Excel, where they were sorted for later analysis and figure creation.

Examples of processed tissue samples

Figure 3.1: Control 3- ID:80935584: 800-microns - Layers 1-6:

Figure 3.1a. 6400-Microns

Figure 3.1b. 800-microns, middle gyri, uncropped

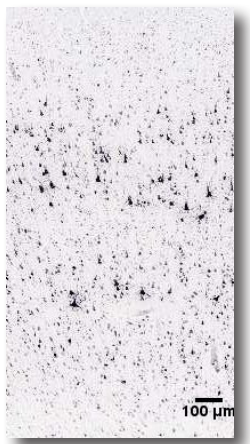

Figure 3.1c. 800 microns, middle gyri, cropped

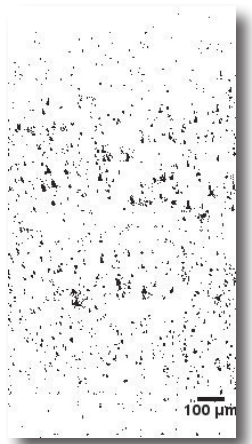

Figure 3.1d. 800-microns, middle gyri, processed

Figure 3.2: Schizophrenia 1– ID:80841454 Layers 1-6

Figure 3.2a. 6400-microns

Figure 3.2b. 800-microns, lower gyri, uncropped

Figure 3.2c. 800-microns, lower gyri, cropped

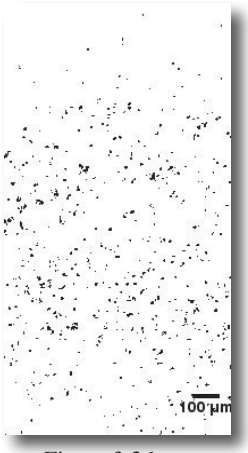

Figure 3.2d. 800-microns, lower gyri, processed

Figure 3.3: Control 3 – ID:80935584: 200-microns - Layer 3

Figure 3.3a. Layer 3 - 200 microns, cropped

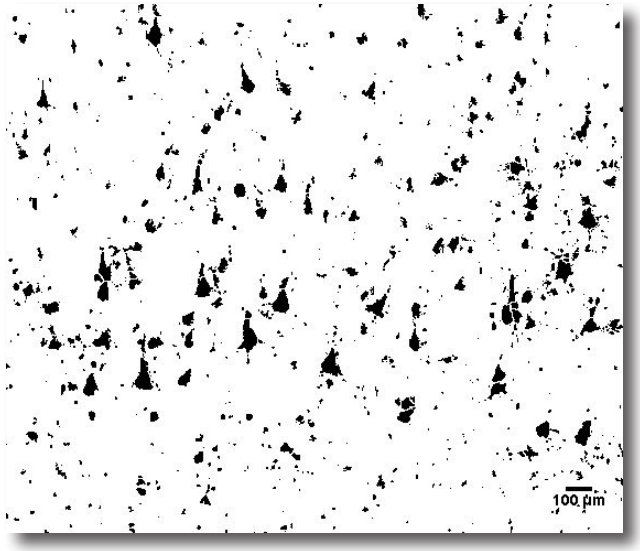

Figure 3.3b. Layer 3 - 200 microns, processed

Figure 3.4: Schizophrenia 1 – ID: 80841454 200-microns Layer 3

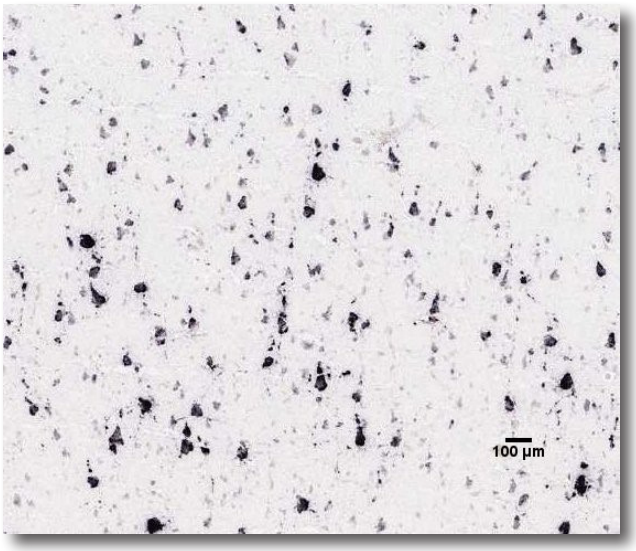

Figure 3.4a. Layer 3 – 200 microns, cropped

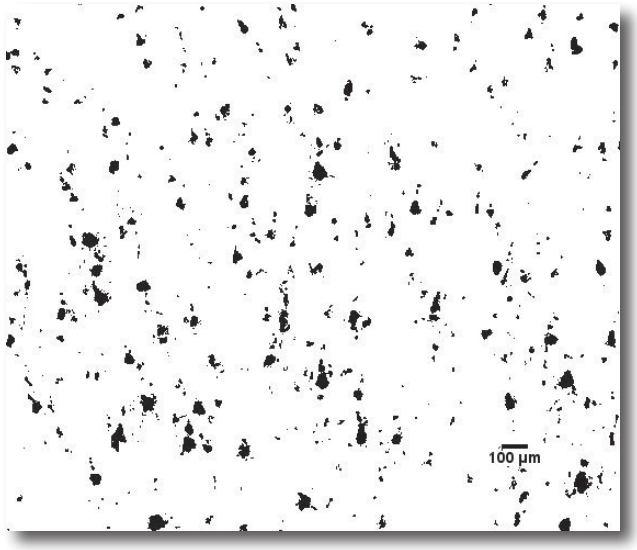

Figure 3.4b. Layer 3 – 200 microns, processed

Calculations *Layer 1-6 Images.*

- Average Cell Counts: Sum of Cell Counts/3
- Cell Densities: Average Cell Count/1 305 989.495µm^2
- Intra VMR: For each of the 3 Control Cell Counts: $(x-\bar{x})^2$ to get variance, $(\sigma^2/\bar{x})$ for 3 individual VMR's, take $\bar{x}$ of 3 VMR's. Repeat for each of the 3 Schizophrenic samples.
- Inter VMR: For all Control Cell Counts: calculate grand mean,
- $(x-GM)^2 = \sigma^2$, (σ^2/GM). Repeat for all Schizophrenic Cell Counts.

Layer 3 Images.

- Cell Densities: Average Cell Count/1 305 989.495µm^2
- Combined Average Cell Size:

  ∑ (cell count x average cell size) / total cells)

RESULTS

Quantitative Layers 1-6

Control Sample	Section	Cell Count	Average Cell Count	Density: Cells/µm^2
ID: 80935564	Top	502	486.333	0.000372
	Middle	503		
	Lower	454		
ID: 80830444	Top	402	340.667	0.000261
	Middle	328		
	Lower	292		
ID: 80935584	Top	352	370.666	0.000284
	Middle	377		
	Lower	383		

Schizophrenia Sample	Section	Cell Count	Average Cell Count	Density: Cells/μm²
ID: 80841454	Top	322	281.333	0.000215
	Middle	268		
	Lower	254		
ID: 80816144	Top	373	328	0.000251
	Middle	323		
	Lower	288		
ID: 80816130	Top	314	241.667	0.000185
	Middle	202		
	Lower	209		

Figure 3.6. Schizophrenia Samples: Layer 1-6

Layer 3

Control Samples	Cell Count	Average Cell Count	Density Cells/μm²	Average Cell Size μm²	Combined Average Cell Size μm²	Number of Cells > 50μm Diameter
ID: 80935564	90	74	0.0000205	1897.981	1804.636	33
ID: 80830444	56		0.0000128	1658.535		13
ID: 80935584	76		0.0000173	1857.392		25

Figure 3.7. Control Sample: Layer 3

Schizophrenic Samples	Cell Count	Average Cell Count	Density Cells/μm²	Average Cell Size μm²	Combined Average Cell Size μm²	Number of Cells > 50μm Diameter
ID: 80841454	56	52.667	0.0000128	1725.188	1685.268	16
ID: 80816144	61		0.0000139	1626.866		15
ID: 80816130	41		0.0000093	1717.634		14

Figure 3.8. Schizophrenia Sample: Layer 3

Figures 3.9 & 3.10 – Cells Counts of Layers 1-6, 800-microns

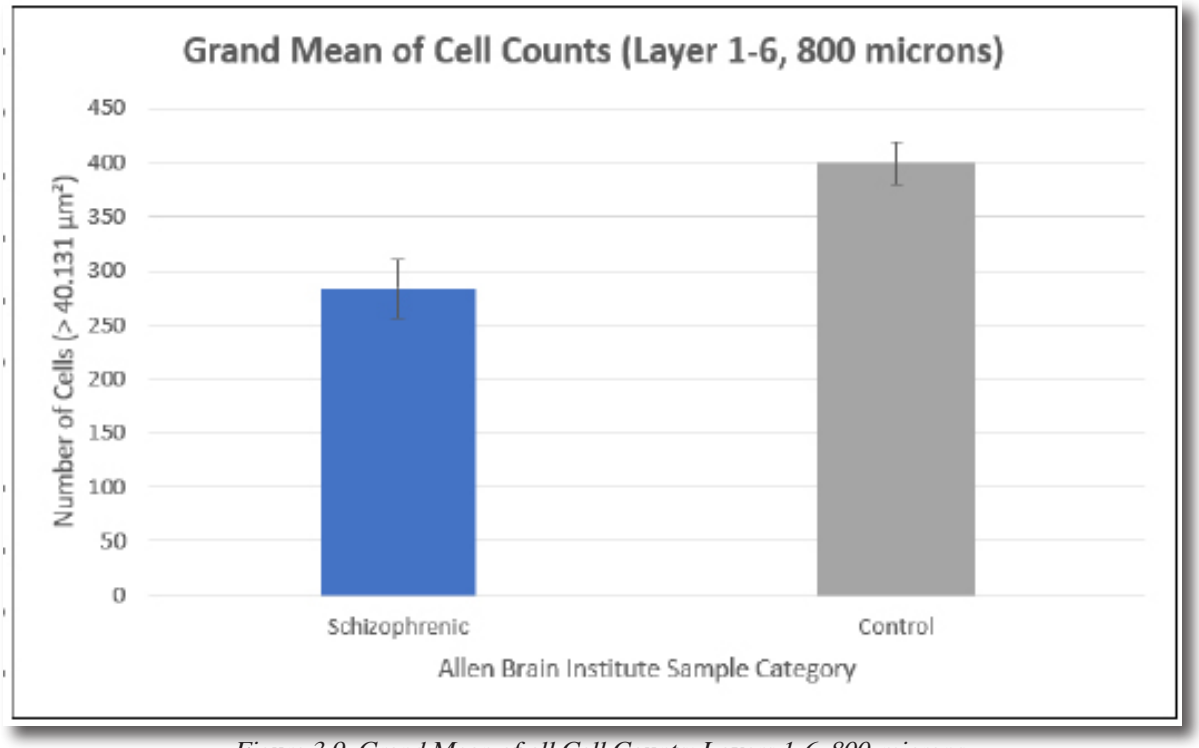

Figure 3.9. Grand Mean of all Cell Counts: Layers 1-6, 800-microns

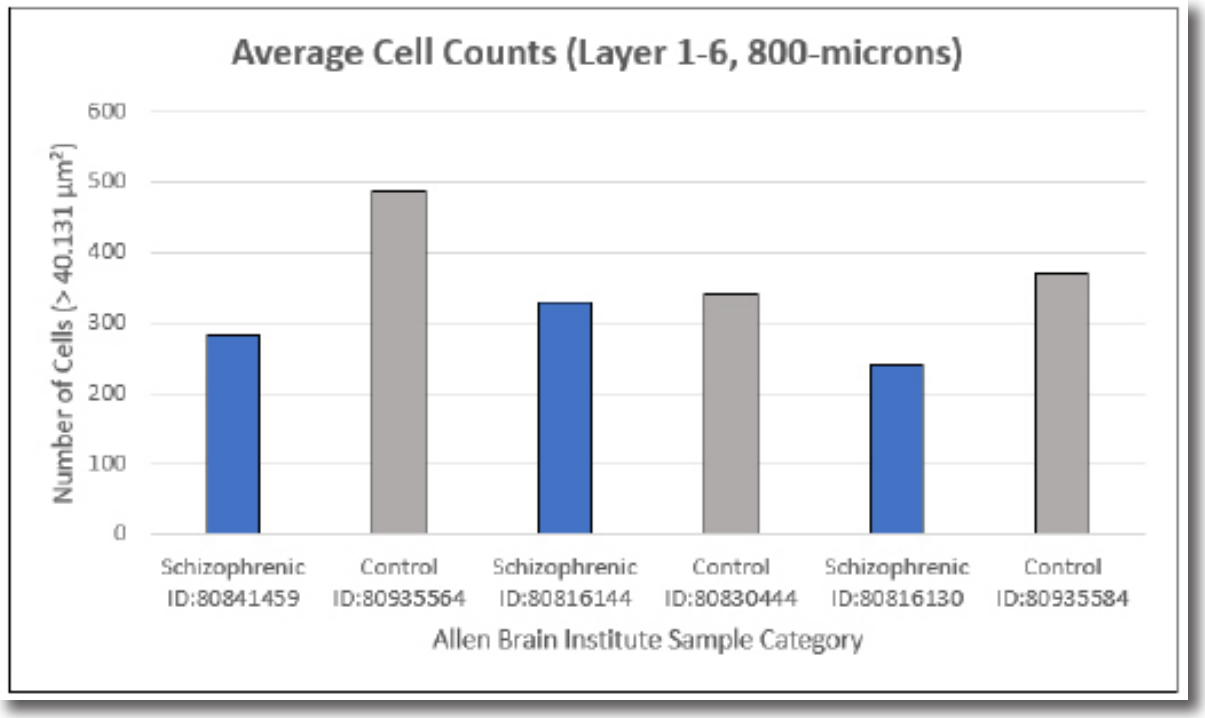

Figure 3.10. Average Cell Counts: Layers1-6, 800-microns

Figures 3.11 & 3.12 - Cell Counts: Layer 3, 200-microns

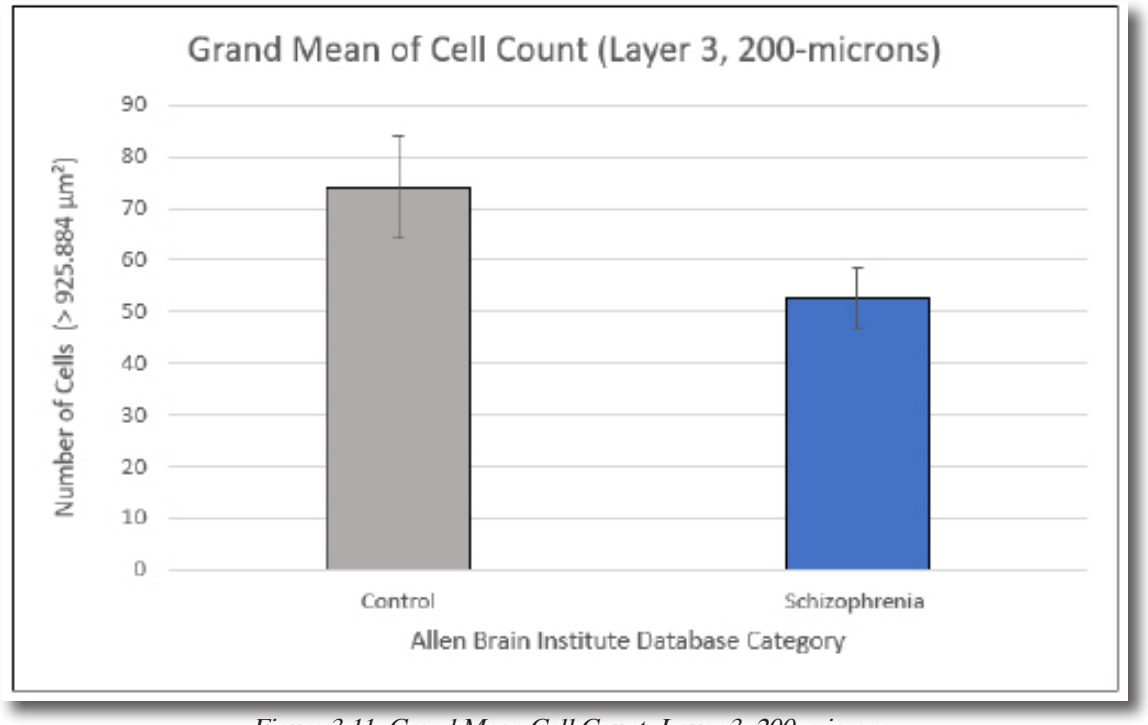

Figure 3.11. Grand Mean Cell Count: Layer 3, 200-microns

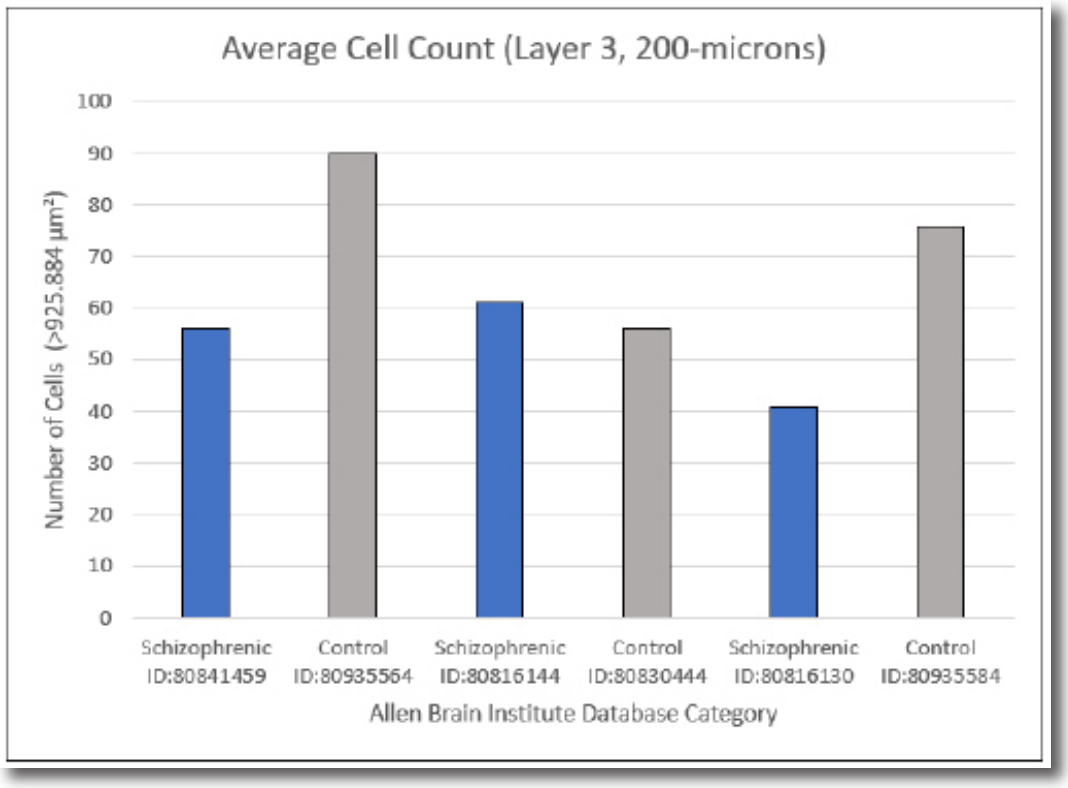

Figure 3.12. Average Cell Count: Layer 3, 200-microns

Figures 3.13 & 3.14 – Average Cell Size: Layer 3, 200-microns

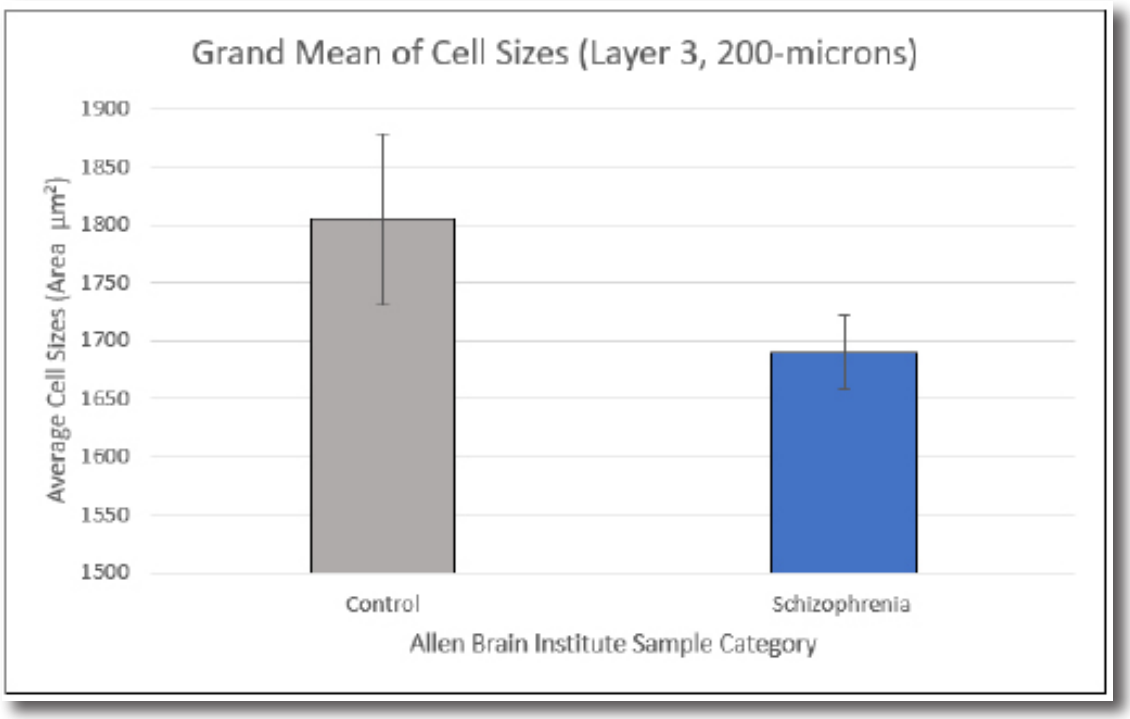

Figure 3.13. Grand Mean of Cell Sizes: Layer 3, 200-microns

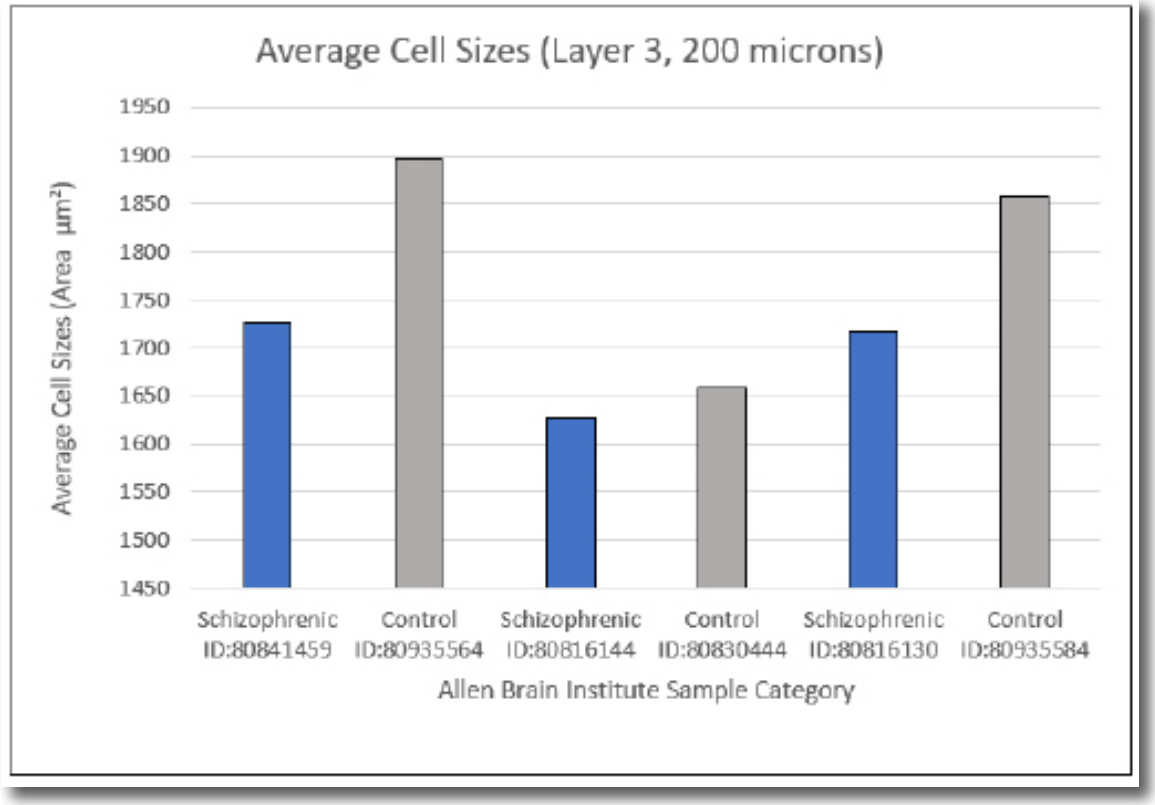

Figure 3.14. Average Cell Sizes: Layer 3, 200-microns

DISCUSSION

For the tissue samples in layers 1-6 in the DLPFC, our qualitative observations were supported by our quantitative findings. There was a prominent tendency towards lower cell expression of NEFH in the schizophrenia samples in comparison to the controls. This is apparent by comparing the average cell counts and the average cell densities (*See Figures 3.5 & 3.6*). This finding is in line with the results of the previously mentioned pilot study (Pinacho et al., 2016). Based on the minimum cell diameters we chose, many of these cells were pyramidal cells, but other cell types were likely also included. This was expected, as we were looking for a general overall expression of NEFH for this measure. Decreased NEFH suggests a decrease in connectivity, specifically for larger axons, and possible changes to cytoarchitecture.

For the layer 3 tissue, there was also an evident trend of less cell density in the schizophrenia samples, as demonstrated in the cell counts and average cell densities (*See Figures 3.7 & 3.8*). This suggests that fewer pyramidal cells are expressed in layer 3 of the DLPFC in schizophrenia brain tissue. This finding is important, because it suggests that it is not just a reduction in pyramidal spine density in layer 3 leading to diminished connectivity, but also a reduction in the number of total pyramidal cells themselves. This would exacerbate the existing deficit in connectivity caused by the spine reduction, and may have consequences on intra- and inter-cortical projections. In addition, there was a slight trend towards smaller cell body size in the layer 3 pyramidal cells in schizophrenia samples (*See Figures 3.7 & 3.8*). This is consistent with a previous study that reported modest reductions in cell size (Rajkowksa, Selemon & Goldman-Rakic, 1998). This reduction in cell body size may be due to the abnormal cytoarchitecture, and we can speculate that this could lead to altered functioning. We also noted that there was a subset of particularly large pyramidal cells within the layer 3, which may indicate a subtype. We recounted for cells with diameters over 50 micrometers, and found similar proportions of them within both control and schizophrenia samples (*See Figures 3.7 & 3.8*). It is possible that these larger pyramidal neurons are a subtype of pyramidal cells, and that they could have unique functionality.

The ABA allowed for a unique opportunity for us as junior scientists. The availability of preprocessed tissues from various healthy and pathologic brains in an accessible database is innovative for research, as the intricate process of tissue fixing and staining becomes expedited. This also allows for researchers without immediate wet-lab resources to explore cutting edge research questions. That being said, there are some limitations to the approach. The main limitation is that while the *in situ* hybridization processing of postmortem brain tissue allowed us to visualize gene expression, this does not directly equate to protein expression or neural function. Therefore, while the molecular findings are interesting and informative, and create new ideas for further molecular research, we cannot fully assume function from the results. Aside from this, we had several other limitations: due to the small scope of the study, our data was all from tissue in the right hemisphere—therefore laterality influence cannot be ruled out. Additionally, our sample size was small due to the size of the project, at three controls and three schizophrenic individuals. It also only included men, in an age range of 40-49. Ideally, a larger study could be run with both sexes, across a wider age range. Lastly, antipsychotic medication use was not controlled for in schizophrenia samples. It is very likely that the individuals were medicated at that stage in life, and this could have affected both the expression of NEFH, and the number and size of layer 3 pyramidal cells.

There are some interesting theoretical implications to our findings. It makes sense that NEFH would be implicated in the abnormal cytoarchitecture of layer 3 pyramidal neurons in schizophrenia. Due to the sheer size of pyramidal cells, NFH is used to comprise their axonal integrity, and in supportive cytoarchitectural roles, as it is the largest of the neurofilament subtypes. This implicates NEFH in the underlying structural changes that could be responsible for the decrease in pyramidal cell spine density. Interestingly, in humans, genes coding for NFL and NFM (the NEFL and NEFM genes) are very closely linked on chromosome 8 (8p21) while NFH is located on chromosome 22 (22q12.2) (Perrot, Berges, Bocquet & Eyer, 2008). Therefore, since NEFH is expressed in all pyramidal cells, perhaps independent mutations to areas on chromosome 22 could attribute to the development of abnormal architecture that is specific to layer 3 abnormalities, where NEFH is highly expressed. These changes could begin early in development, because as mentioned earlier, neurofilaments are also involved in the changing axonal cytoskeleton during neuronal differentiation, guidance, axon outgrowth, and regeneration (Perrot, Berges, Bocquet & Eyer, 2008). This ties in with the general notion of many neurodegenerative and psychiatric illnesses having a developmental trajectory (Glausier & Lewis, 2013).

Another consideration is that molecular approaches are revealing genetic diversity amongst pyramidal neurons, confirming the existence of distinct subtypes (Spruston, 2008). A potential future lead would be to more accurately specify

the subtypes of pyramidal neurons that make up layer 3 in different cortical areas, and to see if they correlate to specific inter-cortical projection pathways, or immediate intra-cortical connections.

In conclusion, using the ABA, we explored general NEFH expression in the DLPFC, and the characteristics of pyramidal cells in layer 3 of the DLPFC. We were able to qualify and quantify specific differences between controls and schizophrenia brain tissue. The general reduction in NEFH expression replicates recent findings, and the finding of lower cell density of pyramidal cells allows us to speculate about NEFH's role in the abnormal cytoarchitecture of layer 3, both in morphology, and intra- and inter-cortical projections. We would like to end with a direct quote from Spruston, (2008). "Thus, pyramidal neurons are the building blocks for high-level functions like memory and consciousness. When they misbehave, the consequences can be profound".

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The Good Side of the Internet: Properly Employing E-Portfolios in the Classroom

REIDUN GARAPICK

Modern technology (including smartphones, laptops, the internet) has been widely condemned to be the downfall of millennials. It is a common enough opinion in the media—young adults spend too much time 'scrolling through life', possibly negatively impacting their education, judgment, and communication skills. As millennials (born after 1980) begin to exit the scholastic environment in favour of Generation Z (born after 1995), academic institutions face the challenge of finding a working exchange between technology and traditional teaching. However, the internet does not have to compete with the modern classroom. When harnessed correctly, online educational platforms should enhance the university learning experience and foster self-reflection and peer-feedback skills in young students. Despite this potential, many academic institutions face obstacles to online learning tools, including a lack of faculty support and software familiarity. Through strategies such as proper software orientation, early introduction, and a complementary curriculum, academic institutions can better introduce online learning through electronic portfolios designed to enhance student learning and self-reflection.

E-Portfolios are an online space in which students can collect, document, and create academic submissions throughout their university career. They offer a variety of materials, such as blogposts, written assignments, and multimedia uploads, while allowing peer and evaluator feedback on each aspect. By encouraging continuous creation in order to form a collection of work, E-Portfolios not only support the final product, but enhance the process of learning itself. Students can be evaluated on the gradual development of their portfolio, rather than just the result. E-Portfolios make gradual learning visible to students, promoting self-reflection practices (Enyon, Gambino, & Török, 2014). When used in conjunction with E-Portfolios, self-reflection allows students to collect, record, and analyze their learning over time, allowing isolation of problematic trends and targeted development of new learning practices. When integrated as part of a greater net-folio system (a shared network of online portfolios), E-Portfolios also allow for instructor and peer comments, promoting effective feedback through open online discourse (Peacock, Murray, Scott, & Kelly, 2011). In 2013, researchers Cheng and Chau found higher scores on a "Motivated Strategies for Learning Questionnaire" to be positively correlated with the E-Portfolio achievement of student participants. These findings provide evidence that E-Portfolio performance is positively related to complex skills such as elaboration, organization, critical thinking, self-regulation, and peer learning (Cheng & Chau, 2013). Proper E-Portfolio use is a complex process that requires sufficient self-regulation and motivation, while simultaneously facilitating deeper learning and self-reflective practices.

While there are many positive aspects of E-Portfolio use, the benefits of E-Portfolios do not come without their challenges. The obstacles surrounding E-Portfolio implementation begin to emerge following the initial interaction between the system's online software and new users — both student and instructor. Improper introduction of online learning resources leads to a lack of understanding on how to use the new software, as well as confusion surrounding how to integrate the software into an existing course outline. In their 2009 study, researchers Imhof and Picard found that students self-reported a need to feel convinced that online educational platforms were worth the time and effort required to use them. These doubts are often further intensified by inadequate integration of the newer, online software into an older, pre-existing curriculum (Light, Chen, & Ittelson, 2011). This doubt and lack of integration may currently be the largest obstacles to E-Portfolio use in university settings. Inappropriate introduction and implementation of E-Portfolios within current academic curriculums stoke user annoyance with the software, leading to a disregard for the importance of the peer feedback and self-reflection practices it promotes (Andrews & Cole, 2015).

The next challenge involves examining practical ways of solving this problem. Evidence suggests that E-Portfolios

provide ample opportunity to improve the education of the next generation of students, but without active effort put into ensuring best utilization of the software, these chances might be missed. Studies have shown that, even at an elementary level, E-Portfolios facilitate improved feedback skills and lead to an overall increase in learning (Nicolaidou, 2013). Researchers in Greece conducted a yearlong study surrounding E-Portfolio implementation in a fourth-grade primary class, finding a statistically significant difference between pre- and post-tests of writing performance, with analysis of subject interviews showing that voluntary involvement in peer feedback increased over time (Nicolaidou, 2013). Furthermore, a self-report survey of students in the first year of a Bachelor of Education degree indicate that E-Portfolio use supports the development of self-regulation and self-reflection (Welsh, 2012). With E-Portfolios shown to provide so many benefits, there comes a question of why this resource is so often overlooked.

Initial problems begin with improper software orientation. In university settings, this problem is frequently exacerbated by large class sizes, as it can be difficult to orient large numbers of students in a new software. New users frequently experience frustration with early attempts to use the software, resulting in an initially negative introduction to E-Portfolios (Gülbahar & Tinmaz, 2006). When users are unable to overcome the initial frustration of learning how to use the software, students and faculty alike tend to develop a sense of annoyance with E-Portfolios, which further impedes their later experience of the software. A possible solution lies in tutorial classes and teaching assistants (TA). Designating small-size tutorials towards developing fluency in E-Portfolio software early in the term will allow students to approach initial assignments without prior negative impressions. Well-trained teaching assistants can provide a more approachable and immediate in-person source of support regarding questions that may arise from students. Teaching assistants can continue to function as a source of support throughout the term, and beyond the initial learning period, ensuring students adapt to E-Portfolio use. By providing early E-Portfolio support in smaller-sized tutorial classes, the common frustration upon introduction can be minimized, avoiding user annoyance with the software and promoting better understanding of the benefits of using an E-Portfolio.

As important as the manner of E-Portfolio introduction is, the timing of this introduction must also be considered. In order to avoid issues surrounding large introductory class sizes, E-Portfolio use is frequently withheld until later years, limiting its use to smaller, upper year courses. While this may seem to benefit student success, later intervention denies students early introduction to the skills developed via E-Portfolio use, allowing them to settle into typical patterns of shallow post-secondary learning. This problem can be avoided by establishing E-Portfolio use at the beginning of the post-secondary period, introducing students to a novel educational environment in which E-Portfolios play an active role. With the introduction of E-Portfolios, online learning has the potential to become an accepted part of the learning culture and function as an immediate intervention in regard to current teaching practices frequently used in large post-secondary classes.

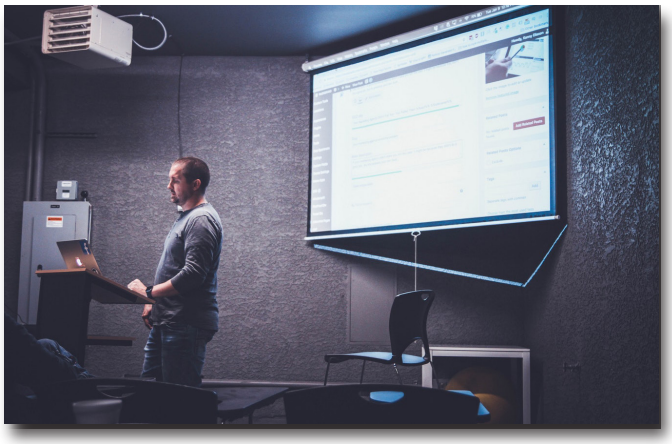

Figure 4.1. Teaching Assistant leading a tutorial

Multiple researchers, including Shada (2011) and Nicolaidou (2013), have shown that earlier introduction leads to higher class averages, earlier graduation, and increased retention rates in a college setting, all while improving overall quality of education (Shada, 2011; Nicolaidou, 2013). A long-term, quantitative study from Metro Academies of Health, a San Francisco learning community for high-risk students, followed first-year students using a newly-implemented E-Portfolio system through their four-year program. E-Portfolio use was linked to overall increases in grade point averages (GPA) and retention rates, as well as a ten percent increase in the program's graduation rate (Watson, Kuh, Rhodes, Light, & Chen, 2016).

Early E-Portfolio implementation develops new learning and thought processes at a critical time in academic development, promoting E-Portfolio-related skills in student learning habits early in the educational process (Shada, 2011). However, regardless of how immediate or comprehensive the introduction, E-Portfolio use must complement the curriculum. When E-Portfolio tasks interrelate with course material, students report that a more obvious connection between

course objectives and online assignments can be identified (Gaitan, 2012). Student attitudes toward E-Portfolios are strongly related to their perception of there being a purpose for E-Portfolio use, therefore this clear connection helps establish an understanding of the platform's relevance to the curriculum (Tzeng, 2011). In contrast, the current method frequently employed in E-Portfolio implementation is to add an online element to a pre-existing course, which often produces a disconnect between classroom and E-Portfolio discussions. As a result, student and faculty support of E-Portfolio use suffers due to the lack of clarity regarding the relevance of E-Portfolios, since they act merely as an "add-on" to already intensive knowledge-based course loads (Plaza, Draugalis, Slack, Skrepnek, & Sauer, 2007). In order to better integrate E-Portfolios into post-secondary curriculums, courses must be reexamined and reconstructed to actively involve and utilize the online aspect of the course (McNeill & Cram, 2011). By allowing faculty to have a hand in properly utilizing online resources to complement their course, E-Portfolio assignments can be better coordinated to course objectives. As a result, students can better understand the relevance of E-Portfolio tasks to course content, increasing the time and effort spent on online projects and further supporting the effective acquisition of E-Portfolio-enhanced skills.

While E-Portfolios do provide opportunities to enhance student learning, many obstacles must be overcome before the software can be employed to its full educational potential. By implementing the aforementioned strategies surrounding E-Portfolio use—software orientation, early introduction, complementary curriculum, self-reflection promotion—educational institutions could ensure the importance of peer feedback and self-reflection is properly promoted. Students who believe there are more benefits to using E-Portfolio benefit more in turn from using it, therefore today's educators should embrace the responsibility of convincing students of the value of self-reflection and peer feedback (Hrisos, Illing, & Burford, 2008). With faculty and student support of E-Portfolios suffering as a result of improper introduction, current E-Portfolio practices need to change. As newer generations of students enter the academic environment, the student body is becoming more saturated with technological familiarity. As future workplaces begin to adapt their own practices to a technologically-centered business environment, academic institutions are beginning to feel the pressure to produce graduates that can both compete with and complement today's technology. Given the prevalence of online activity in millennial life, it only makes sense that the millennial classroom complements these technological skills, providing benefits that will last well into the workplace.

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Love is a Drug

TONI ROSE ASUNCION

Kesha was accurate when she sang "Your Love is My Drug". The comparison of love and drugs has been a common theme in media, and this parallel is more than just fiction. Romantic love is an emotional attachment one has for another individual (Fisher, Xu, Aron, & Brown, 2016). Falling in love induces feelings of euphoria, craving and emotional dependence. Addictions experience similar feelings when abusing substances. Addiction is a maladaptive pattern of substance use that causes significant distress and impairment (Burkett & Young, 2012). The motivation to be with a partner mirrors a drug addict's motivation to use their preferred substance. There are disagreements about whether the love can be classified as an addiction — and whether it requires treatment. Though love is not artificially created, there are parallels between love attachment and drug use, which both cause maladaptive behaviours.

Love and drug use are linked to the same neurological pathways. When an individual experiences a reward, such as love or drugs, the mesolimbic dopaminergic pathways activate areas such as the ventral tegmental area (VTA), nucleus accumbens (NA), and insula (Zou, Song, Zhang, & Zhang, 2016). Typically, neurotransmitters such as dopamine and hormones such as oxytocin are released with drug use. These chemicals are associate with feelings of pleasure. This release reinforces the desire of a reward, such as a drug (Reynaud et al., 2010). Stimulus detection functions such as reward prediction and reward experience are associated with these neurotransmitters (Zou et al., 2016). Love attachment is associated with similar neural pathways and chemicals. When participants looked at photographs of their significant other, they experienced brain activation in their reward systems. Similarly, when individuals used drugs, reward brain regions like the VTA were activated (Fisher, Brown, Aron, Strong, & Mashek, 2010). Neurotransmitters such as dopamine are affiliated with reward region activation. Dopamine is released during sexual contact with a partner whereas oxytocin is responsible for maintaining social bonds with an individual. The association between a significant other and feelings of pleasure is reinforced when these neurotransmitters are released, thus increasing the chance of repeating the sexual behaviour (Reynaud et al., 2010). The overlap between drug use and romantic love in brain area activation suggest that the two share similar mechanisms.

Figure 5.1 A drawing of a heart

When we lose a love attachment, we experience withdrawal symptoms. Withdrawal symptoms are maladaptive responses to abstinence after prolonged substance use, and include lethargy, negative emotions and anxiety. In a study of rats, withdrawal symptoms were linked to a release of corticotropin-releasing hormones (CRF) from the amygdala. This is related to the experience of depressive symptoms. When CRF is injected into the NA of rats, depressive symptoms are produced (Burkett et al., 2012). Withdrawal-like symptoms are also seen in the loss of a love. When looking at photographs of their lost partner, the VTA and NA of participants were activated. After a breakup, withdrawal symptoms such as emotional dysfunction, decreased self-concept, and cognitive deficits severely impact one's life (Fisher et al., 2016). The adverse effects of withdrawal can lead to a relapse – a reinstatement of drug seeking after a period of sobriety (Nestler, 2002). Relapses are associated with decreased levels of dopamine, which may be responsible for reinstating drug seeking behaviours (Burkett et al., 2012). Relapse, whether it be returning to a past lover or indulging in one last drink, can itself cause distress. In extreme cases, withdrawal and relapse can lead to clinical depression, suicide, and homicide. The psychological repercussions of the loss of a lover has inspired researchers to look to drug addiction interventions to combat extreme heartbreak.

Pharmaceutical interventions for addiction may treat romantic love distress. Oxytocin and dopamine, hormones linked to both drug dependency and love, play a vital role in creating an addiction– whether it be a lover or a substance (Zou et al., 2016). Current treatments for substance dependence have been tested to diminish love bonds. Selective serotonin reuptake inhibitors (SSRIs) are used to treat mood disorders, anxiety disorders, and alcohol addiction. SSRIs could decrease dopamine-fueled feelings of euphoria by interfering with the release of dopamine. However, these treatments have not been successful in completely diminishing a love bond in humans. This is not the case with some animals, such as voles. Like humans, monogamous voles possess oxytocin and dopamine receptors. By decreasing the number of receptors in voles, long terms bonds are diminished. Despite the success of decreasing bonds to mates in voles, there are adverse effects. One example is decreased levels of testosterone, which can lead to a lower sex drive (Earp et al., 2013). Such animal models may inform interventions for love addiction. By seeing love as a drug instead of a feeling, we can utilize, provide, and create effective treatments for those going through heartbreak.

Figure 5.2 A photo of different kinds of pills

Heartache is a stressor that may give rise to depression and other psychological disorders (Fisher et al., 2016). Addiction to love has serious consequences, namely, the dysregulation of emotion, cognitive deficiency, and even suicidal ideation (Reynaud et al., 2010). Most of the proposed drug therapies are hypothetical at best with limited success of new biotechnology concerning a cure from heartbreak. Moreover, risks, like sexual dysfunction, can discourage patients from seeking treatment (Earp et al., 2013). Love addiction interventions require further study to prevent related mental health issues.

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One Giant Leap for Multisensory Integration

REIDUN GARAPICK

It sounds like the thing of nightmares.

Floating in space, weightless, trying to get to the end of an endlessly spinning hallway. This nightmarish scenario, however, is a daily occurrence for astronauts in spaceflight. No one can deny that trying to orient a spacecraft in microgravity must be a difficult task. Although, many will argue that as long as you can see what is around you, then you can get around. However, things are not always what they seem—with or without gravity. When astronauts enter orbit and experience microgravity, multisensory integration is essential to constructing an accurate perception of the environment, and subsequently orienting oneself within it (Freiderici & Levelt, 1990). Multisensory integration allows the senses to compensate for one another when a critical sensory modality may be lacking (Ernst & Banks, 2002). Using a single dominant sense to navigate oneself through space would lead to gaps in perception and errors in orientation. While microgravity orientation may initially appear to be guided by the same sensory processes as on Earth, the relative weightings of astronauts' sensory inputs are adjusted, altering the perception of an environment and subsequently affecting subject orientation within it.

What if I told you that space is not zero-gravity? Contrary to popular belief, the weightlessness of space does not result from a lack of gravity, but rather from gravity itself. The feeling of weightlessness is caused by a spacecraft's constant freefall towards Earth, while the planet's surface perpetually rotates out of the way. This creates a constant state of freefall and means that, in orbit, astronauts are exposed to a state of microgravity because gravity now exists at less than one-g. The lack of a constant downward gravity vector causes adaptation of the sensory and perceptual systems that rely on gravitoreceptors. Gravitoreceptors are sensory receptors that transduce gravitational input to control body motion and perception (Reschke, 1992). On Earth, visual and spatial cues generally align, such that if a surface is at your feet, it is the floor or the bottom of the scene. In microgravity, however, the same rules can no longer universally apply. When in negligible gravity, visual and gravitational cues no longer reliably indicate orientation. On Earth, the human dependence on sight and gravitational input for orientation can lead to the assumption that visual and vestibular senses are critical to orientation in microgravity. However, in space, the conventional senses are but a few of the modalities essential to microgravity orientation.

It is easy to fall prey to the assumption that an astronaut's orientation in microgravity relies solely upon visual input. While vision plays a critical role in determining one's orientation, the effects of microgravity alter visual perception and, subsequently, visual accuracy. Space Motion Sickness (SMS) has been reported by astronauts initially entering orbit, and includes symptoms such as disorientation and visual reorientation illusions (VIR). VIRs can occur when an astronaut is working upside down in a spacecraft, or when an astronaut is working upright but sees another person floating upside down. In both situations, astronauts report that the ceiling of the spacecraft suddenly seems to become the floor, while the floor is now perceived to be the ceiling (Oman et al., 2003). The VIR phenomenon is just one of many instances demonstrating microgravity's effects on visual perception. In addition, a study by Clément, Lathan, and Lockerd (2008) demonstrated that visual perception itself is affected in microgravity by analyzing depth perception in parabolic flight. Results showed that cubes appear taller, thinner, and shallower in microgravity than normogravity, as well as closer to the observer in space (Clément et al., 2008). Vision is also critical to the perception of the upright, and a recent study found that long-term exposure to microgravity decreased the weighted significance of visual cues in determining the perceptual upright (the cognitively relevant upward direction) (Harris, Jenkin, Jenkin, Zacher, & Dyde, 2016). These findings support the hypothesis that visual perception is altered in microgravity, with visual input being less reliable and thus weighted less than other modalities.

Vision is not the only sensory modality to experience readjustment in microgravity. On Earth, judgement of one's orientation in and relative to an environment is augmented by additional input from the gravitoreceptors of the vestibular system. The vestibular system is composed of three semi-circular canals that transduce angular acceleration, and two otolith organs that transduce linear acceleration. In microgravity, the semi-circular canals continue to function properly, however the otolith organs can no longer correctly interpret sensory information (Reschke, 1992). This alteration of vestibular function manifests in astronauts' altered orientation in microgravity. Similar to visual input, vestibular input must now integrate with other senses in order maintain adequate postural control in space. A study of post-spaceflight loss of postural coordination in astronauts demonstrated that, while in microgravity conditions, static posture and balance control are mediated by vestibular input. These findings support the theory of increased vestibular contribution to postural orientation in microgravity (Paloski, Reschke, Black, Doxey, & Harm, 1992). Conversely, prior research on astronauts early in spaceflight demonstrated decreased vestibular weighting and increased visual, proprioceptive, and haptic weighting during body motion (Young, 1984). While these findings conflict with one another, both studies highlight the sensory adaptation in space over different periods of time. In microgravity, both perceptual and postural orientation rely upon reweighting of sensory inputs, which differ from task to task and change over time.

These changes in vestibular weighting over time stem from the inaccurate transductions of the otolith organs in microgravity. The reduction of gravity in space allows otoliths to float, suspended in the fluid of the inner ear, which negatively affects transduction accuracy. This decreases the reliability of vestibular input in situations involving awareness of one's orientation in space. When vestibular information constantly aligns with the gravitational upright in normogravity, one can assume vestibular signals indicate the orientation of their body relative to outer surroundings. However, when this external congruency no longer applies in microgravity, astronauts' neurosensory systems adapt to focus more on other, more reliable sensory modalities. The result of this adaptation is that, over time, astronauts rely less on vestibular input to assess spatial orientation (Paloski, 1992). This adaptive phenomenon can be operationalized by testing postural instability when astronauts return to Earth. Studies show that astronauts demonstrate a high degree of postural instability, with recovery taking up to 10 days post-flight. An interesting note from Fregley's (1974) study is that this postural instability persisted with eyes both opened and closed, indicating that the integration of both vestibular and visual input is altered while in space (Fregley, 1974).

Figure 6.1 An astronaut on the moon

To compensate for the loss of reliable visual and vestibular input weighting of haptic input is increased. Haptic receptors in and underneath the skin sense texture, pressure, vibration and skin stretch – therefore, in this context, haptic input can be equated to the "touch" sensation. The brain often links haptic and vestibular feedback together, as both can be directly affected by gravity. For example, it may seem intuitive that pressure at the soles of the feet increases the accuracy of astronauts' orientation judgements, as while on Earth, the pressure of the ground provides consistent haptic input as to which direction is down. As a result, when in microgravity, the relative weightings of haptic and vestibular inputs must be efficiently allocated in order to maintain perceptual integrity (Mergner & Rosemeier, 1998). However, research has shown how influential haptic feedback can be in microgravity, both in natural cue areas (i.e. the feet) and novel cue areas. Carriot et al. (2004) measured arm movement to represent judgement

of the upright when orienting the body with varying haptic feedback during parabolic flight.

Results indicated that haptic sensation on the soles of the feet significantly increased non-astronaut subjects' ability to correctly indicate the upright orientation in microgravity. Interestingly enough, subjects with spaceflight experience were accurate in judging orientation, regardless of the gravity condition or presence of haptic feedback. Multisensory integration must therefore be utilized in body orientation in microgravity since astronauts performed better than non-experienced subjects. In other words, astronauts are better at employing senses not frequently involved in orientation perception on Earth, such as haptic input, in order to compensate for and thus overcome the loss of visual and vestibular input. This indicates that subjects with space experience have practice using altered multisensory weightings for sensory integration in order to better perceive their orientation in microgravity, in comparison to non-astronaut subjects (Carriot et al., 2004). When in microgravity, weighting of haptic input must increase to maintain perceptual accuracy, as reliability of visual and vestibular input is compromised in space.

Without gravity, even movement must adapt and integrate information from numerous senses to compensate for lost gravitational inputs (Polastri, Barela, Kiemel, & Jeka, 2012). Neuromotor systems must adapt to this sudden loss of the constant downward, biomechanical force of gravity by modifying motor command strategies. On Earth, gravity provides a vector reference to which the angle of the body's joints can be compared in order to determine balanced body and posture orientation. In microgravity, every posture orientation is in equilibrium without any muscle forces (Mergner & Rosemeier, 1998). This demands the adaptation of kinaesthetic integration for motor control. This adaptation often manifests as altered baseline activation of flexor-extensor muscle pairings in microgravity as compared to normogravity. Tonic activity in extensor muscles, such as the soleus, tends to decrease while activation of flexor muscles, such as the tibialis anterior, increases (Lestienne & Garfinkel, 1988). Proprioceptive function, the ability to conceptualize the positioning of the body and limbs in space, was assessed in astronauts in spaceflight via tendon vibration and compared to measurements made pre-flight. Results indicated that while muscular receptors remain functional, the motor and perceptual responses originating from proprioceptive input underwent considerable reorganization. Roll et al.'s (1993) study demonstrated the sensory reorganization that proprioception must undergo in order to contribute to astronauts' orientation in microgravity. The change in baseline and voluntary muscle activation changes how proprioceptive input and motor control are integrated into overall perception, therefore maintaining a holistic interpretation of the body's position and desired movement through space.

The loss of the sensory effects of gravity in space deprives the senses of critical input, and sensory re-weighting must occur in order to account for the gaps. In microgravity, the vestibular, visual, and proprioceptive senses that are usually dominant in determining spatial perception and orientation on Earth become unreliable. As a result, over time, astronauts adapt by increasing the weighting of more reliable senses, such as haptic and motor sensation, in order to maintain an accurate interpretation of the environment around them and their orientation within it. Multisensory integration assists in the process of effectively compiling the various sensory inputs that are critical to orientation. Situation-dependent reweighting of each sensory input allows the more reliable senses to have greater impact on perception of a situation, which increases overall accuracy of orientation in varying microgravity environments (Hwang, Agada, Keimal, & Jeka, 2014). If astronauts relied upon one sense alone to guide orientation within microgravity environments, perception and performance would suffer. Think back to trying to float to the end of that spinning hallway. The domination of one sense alone would mean other senses could not compensate for the loss of reliable visual, vestibular, proprioceptive, and other sensory inputs that occur when in microgravity. Imagine not being able to identify the floor, or sense the orientation of your head, or know where your limbs were in space. I bet you are grateful for all your senses now.

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Botulinum Toxin

AKSHAT PAI, NIKOO AGHAEI, SABRA SALIM, SABRIN SALIM, EZZA JALIL

ABSTRACT

Botulinum toxin (BoNT), or 'botox', is a neurotoxin that interferes with neural transmission. Botulinum toxin is produced by a bacterium in the genus Clostridium, specifically BoNT type A, which is often referred to as the "miracle poison" due to its wide variety of applications. Although BoNT is primarily known for its use as a cosmetic aid, this toxin has been employed in unlikely clinical areas of research including behaviour, urology, and dystonia. Nevertheless, BoNT still remains poisonous to humans in large doses in a condition referred to as botulism that induces paralysis and possible lethality unless treated with antitoxins. Considering the wide range of BoNT applications and its unique biochemical characteristics, a closer look at its mechanism of action, along with its interactions with our organs, could open up many avenues for neuroscientific research and clinical advantages.

ORIGINS OF BoNT

Botulinum toxin is produced by a multitude of bacterial strains within the Clostridium genus. An anaerobic, spore-forming, gram-positive bacterium, C. botulinum produces eight serotypes of botulinum toxin; A, B, Cα, Cβ, D, E, F and G. Of the exotoxin family, botulinum toxin type A has been classified as the most biologically potent and lethal (Nigam and Nigam, 2010). BoNT type A is encoded by two particular chromosomal locations in the bacterial genome: the arsC and oppA/brnQ operons for the three BoNT genes (Hill and Smith). Initially inactive after translation, the polypeptide sequence is cleaved by a clostridial trypsin-like protease into two subunits, a heavy (H) chain and light (L) chain that are then connected by a disulphide bond (Caya, Agni, Miller, 2004). Using the natural biological production of BoNT-A, commercial preparation of BoNT requires cell colony growth, lysis and subsequent purification. Cultures of C. botulinum are developed in a nutrient-rich medium where they are allowed to produce the BoNT compound. These cultures are then chemically lysed where the crude mixture is taken and then later purified through multiple rounds of crystallization for isolation of BoNT-A (Schantz & Johnson, 1992). Overall the process of BoNT extraction is complicated and includes many biochemical steps as outlined.

FUNCTION AND BIOCHEMICAL ACTIVITY OF BoNT

Botulinum toxin works primarily in the nervous system to inhibit neural transmission. All serotypes of BoNT inhibit the release of the neurotransmitter acetylcholine at four sites: the neuromuscular junction, the autonomic ganglia, postganglionic parasympathetic nerve endings and the postganglionic sympathetic nerve endings (Nigam & Nigam, 2010). This inhibition subsequently leads to temporary chemical denervation. Acetylcholine (ACh) is primarily involved in muscle contraction, thus when inhibited, the muscle relaxes. At the neuromuscular junction, there are numerous pre-formed vesicles containing acetylcholine. As an action potential reaches the terminal boutons in the nerve endings, an influx of calcium induces the docking of acetylcholine-containing vesicles (Small, 2014). The vesicle membrane then fuses with the synaptic membrane and releases acetylcholine into the synaptic cleft through the process of exocytosis (Figure 1). Acetylcholine then binds with the acetylcholine receptors on the muscle cells to initiate muscle contraction (Montecucco & Molgó, 2005).

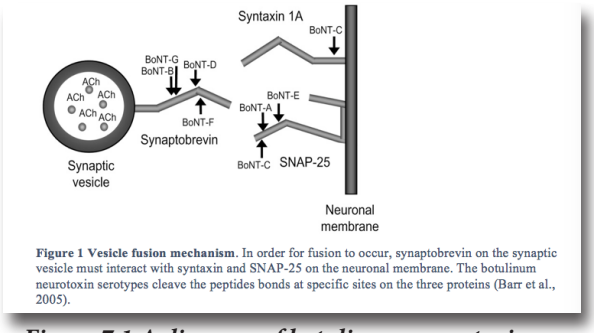

Figure 1 Vesicle fusion mechanism. In order for fusion to occur, synaptobrevin on the synaptic vesicle must interact with syntaxin and SNAP-25 on the neuronal membrane. The botulinum neurotoxin serotypes cleave the peptides bonds at specific sites on the three proteins (Barr et al., 2005).

Figure 7.1 A diagram of botulinum neurotoxin

The fusion of the membranes is facilitated by the synaptic fusion complex composed of a group of proteins known as the SNARE proteins. One of the SNARE proteins, called synaptobrevin, is located on the ACh containing vesicles. Synaptobrevin is a part of the vesicle-associated membrane protein or VAMP family and is involved in the formation of SNARE complexes. Other SNARE proteins, particularly SNAP-25 and syntaxin, are present on the neuronal membrane. SNAP-25 (Synaptosomal-associated protein 25) is the most important protein since it functions by fusing the synaptic vesicle and plasma membrane. Synaptobrevin, SNAP-25 and syntaxin then form a trimeric complex by winding around each other to form a stable, four-helical, coiled-coil structure that permits fusion of the synaptic vesicle membrane and the plasma membrane. This subsequently releases BoNT into the synaptic cleft (Montecucco & Molgó, 2005). The SNARE complex formation is an energy releasing process that may provide the free energy for membrane fusion (Small, 2014). The vesicle fusion mechanism would not be possible if it wasn't for the structural aspects of BoNT.

BoNT is composed of a light (50 KDa) and heavy chain (100 KDa) that are joined together via a disulphide bond. It is the C-terminal portion of the heavy chain that binds to synaptotagmin. Once attached, the process of receptor-mediated endocytosis takes place, leading to Botulinum toxin being engulfed into the neuronal membrane. The toxin is contained in a membranous vesicle inside the cell. The light chain separates from the heavy chain and is released into the cytoplasm of the nerve terminal. Through enzymatic processes, the light chain then cleaves SNAP-25 from the neuronal membrane. This process inhibits the formation of synaptic fusion complex, hence the acetylcholine containing vesicles do not fuse with the neuronal membrane. As a result, muscle contraction ceases since acetylcholine is not being released in the synaptic cleft (Montecucco & Molgó, 2005).

To restore normal neuronal transmission, new, smaller unmyelinated nerve endings called peripheral sprouts are formed. Normal neurotransmission is re-established after approximately three months of exposure to BoNT; once normalized, the nerve endings that sprouted retract (Montecucco & Molgó, 2005).

APPLICATIONS OF BoNT IN THE FIELD OF NEUROSCIENCE

Behavioural Studies in Mice

As stated above, the gram-positive bacterium C. botulinum is able to produce several types of BoNTs, namely serotypes A to G which vary in both biochemical and biophysical parameters (Macdonald et al., 2008). All the BoNT serotypes interfere with neural transmission by blocking the release of acetylcholine in cholinergic neurons (Luvisetto et al., 2004).

Using BoNT's properties of acetylcholine release-inhibition, behavioural studies have analyzed the effects of this neurotoxin in mice for better understanding of human applications. Although primarily used in muscle contractions, ACh neurotransmission is also involved in multiple neuronal processes underlying behavioural activity: arousal, attention, learning and memory (Fibiger, 1991; Karczmar, 1995; Muir, 1997). A study done by Luvisetto et. al (2004) explored the behavioural effects caused by central administration of BoNTs in mice, specifically serotypes BoNT-A and B, which could possibly affect the cholinergic receptors in the central nervous system.

Figure 7.2 A photo of a mouse used in the lab

Intracerebroventricular (ICV) injection of botulinum neurotoxins is a method used to block ACh transmission in cholinergic neurons. The behavioural effects of this phenomenon were investigated through measuring the performance of BoNT-ICV-injected mice on three distinct cognitive tasks: 1) conditioning of active avoidance to evaluate the effects on associative memory during learning; 2) object recognition test to evaluate the effects on recognition memory; and 3) pharmacologically induced locomotor activity, involving molecular agents Scopolamine and Oxotremorine to evaluate the interaction of BoNTs with the cholinergic system in the central nervous system (Luvisetto et. al, 2004).

The experimenters hypothesized that because BoNT induced cholinergic hypofunction, avoidance performance, recognition of novel objects within a familiar environment, and locomotor activity would suffer. Studies involving anti-cholinergic drugs and brain function supported this hypothesis, as the blockage of ACh release from presynaptic cholinergic terminals negatively affected similar brain functions (Fibiger, 1991).

The experimenters used eight shuttle-boxes, each divided into two 20 x 10-cm compartments, connected by a 3 x 3-cm opening to assess avoidance acquisition. The mice became conditioned to avoid the Conditioned Stimulus (CS), a light bulb being illuminated in one of the compartments in the shuttle-box, due to receiving an electric shock five seconds after the light was turned on. The other compartment was dark (Luvisetto et al., 2004). An avoidance response was recorded when the animal avoided the shock by running into the dark compartment within 5s after the onset of the CS. The results of this experiment showed no significant difference in percent avoidance response between the BoNT-ICV-injected mice and the control group (Luvisetto et al., 2004).

In the second part of the experiment, a memory test consisting of three phases (habituation, sample, and test trials) was used. During habituation, mice had the opportunity to familiarize themselves with their environment freely for three minutes. The sample trial took place 24 hours later, where the experimenters placed two identical objects in the same field and allowed the mice to explore them. Lastly, the test trial was given 4 hours later and involved the presentation of a duplicate of a familiar object (from the sample trial) and a novel object in the same field as the previous stages. The data suggest that the saline-ICV-injected mice spent more time exploring the novel objects, a plausible measure of novel object recognition. In contrast, BoNT/A- and /B-ICV injected mice did not seem to distinguish the novel object from the familiar one as they explored both for an equal time (Luvisetto et al., 2004).

The last measure was locomotor activity. The same apparatus as used in the active avoidance experiment was used. The protocol of measuring locomotor activity involved non-illuminated lamps in the shuttle-boxes with no electric shock in the floor. Mice were firstly split into two groups: saline-ICV-injected, and BoNT/A- and /B-ICV-injected. These groups were further divided into six subgroups, which were intraperitoneal (IP)-injected with either saline or increasing amounts of Scopolamine or Oxotremorine respectively, which resulted in a total of 18 groups of mice with a combination of an ICV and IP-injections. Locomotor activity was recorded 15 minutes after the IP-injections (Luvisetto et al., 2004).

Scopolamine blocks the cholinergic receptor and results in an increase of locomotor activity. The researchers believed that in BoNT-ICV-injected mice, the inhibition of the presynaptic ACh release could counteract depression caused by Oxotremorine. Increasing amounts of Scopolamine or Oxotremorine produced an enhancement or a depression of locomotor activity, respectively. Compared to saline-ICV-injected mice, each dose of Scopolamine induced a higher increase of locomotor activity in both BoNT/A- and /B-ICV-injected mice. Scopolamine acted as an antagonist, blocking the cholinergic receptor which resulted in higher motility. This hypermotility was enhanced by inhibiting the release of ACh, aligning with the results from BoNT-ICV-injected mice (Karczma, 1995).

The opposite effect—hypomotility—was elicited by the stimulation of cholinergic receptors due to presence of an agonist: Oxotremorine. Moreover, the claim that the inhibition of the presynaptic ACh release could counteract the effect of Oxotremorine was supported by data depicting less depression of locomotor activity in BoNT-ICV-injected mice after IP-injection of Oxotremorine compared to the reduction in saline-ICV-injected mice locomotor activity (Karczma, 1995).

Overall, the results of this study demonstrated that BoNT central administration could influence cholinergic neurons, which could subsequently induce deficiencies in the associated cognitive tasks in mice (Fibiger, 1991). This field of research introduces potential clinical applications regarding neurological diseases related to exposure to BoNT serotypes.

Botulinum Toxin as Treatment for Spasmodic Torticollis

Botulinum Toxin can also be applied to other disorders including; focal dystonias, ophthalmic disorders, gastrointestinal and proctologic disorders. Focal dystonia is a neurological condition that affects motor control and is characterized by excessive muscle contractions in a specific part of the body. A prime example of focal dystonia is spasmodic torticollis. Spasmodic torticollis is a dystonic condition that causes abnormal posturing and involuntary contraction of the head and neck muscles. There have been a variety of medications tested on patients with this condition, which include GABAergic, serotonergic, and dopaminergic agents (Lal, 1979). None of which have resulted in consistent and/or satisfactory results (Tsui et al., 1985).

In a six-month longitudinal pilot study conducted by Tsui and colleagues in 1985, BoNT was examined as a method of treatment for spasmodic torticollis. The sample population included 12 patients with a mean age of 48.8 years that have been diagnosed with torticollis and who have also demonstrated a resistance to conventional medical therapy. BoNT was injected into each patient's muscles that were the most active during clinical observation and palpation, which happened to correspond with the exact sites where the patients felt a muscle contraction. For every session of BoNT injection, a total dose of 25 mouse units (which is equivalent to 10ng) diluted with 0.25ml saline solution was injected into each of the muscles (Tsui et al, 1985).

The patients were then examined 6 weeks and 3 months after they were injected with BoNT. For clinical evaluation, a semiquantitative scale based on the amplitude and duration of abnormal movement was used. The severity of torticollis was the product of amplitude multiplied by the duration of the abnormal movements. Subjective improvements were reported after the initial dose, which lasted about four to eight weeks. Before concluding the data analysis section of this study, the researchers contacted the patients again and reassessed their condition after six months. This study resulted in all the patients, except for one, experiencing a subjective improvement in their torticollis condition. Out of the 12 patients, all six patients who had severe neck pain due to muscle spasms benefited from the injections and reported pain relief. Along with these findings, the BoNT was deemed feasible and would only require focal injection in small doses every two to three months. The frequency of use is considered to be effective in avoiding adverse side effects. Overall, this study revealed that BoNT provides temporary benefit and relief in the treatment of torticollis.

CONCLUSION

BoNT has been found useful for the treatment of various medical conditions and disorders. Its distinct biochemical properties have served as a pathway for researchers to control and examine disorders at a molecular level, more specifically within synaptic transmission. Numerous studies on BoNT in the past decades have established a strong foundation for other scientists to build on and gain a deeper understanding of how the world's most lethal toxin can be useful to humanity.

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Sexual Selection of the Hourglass Body

SOHANA FARHIM

She's got a body like an hourglass. From idolizing Marilyn Monroe's curves to buying waist trainers advertised by Kim Kardashian, society's fixation on the hourglass silhouette is ubiquitous. What makes the hourglass body more desirable than other body types is its low waist to hip ratio (WHR). The WHR, a proxy for body fat distribution, measures the narrowest part of the waist to the widest part of the hips (Singh, 1993). Although societal standards of the ideal body have fluctuated across time, the preference for a low WHR remains universal (Singh, Dixson, Jessop, Morgan, & Dixson, 2010). Evolutionary psychologists suggest this unchanging preference is not due to culture, but biology. WHR has biological consequences for a woman's fertility. WHR predicts a woman's attractiveness.

Women with lower WHRs have higher levels of estrogen (Ridder et al., 1990). Estrogen regulates the body's fat distribution by stimulating fat deposition in the buttocks and thighs, and inhibiting fat deposition in the abdomen. This body fat distribution decreases the size of the waist and increases the size of the hips, creating a lower WHR (Björntorp, 1987). During sexual maturation, a female's estrogen level rises and as a result, her WHR decreases. Before puberty, estrogen levels remain low and females have a high WHR (Ridder et al., 1990). Puberty causes a sharp increase in estrogen levels, and consequently lowers a woman's WHR. During menopause when females become infertile, estrogen levels drop, causing females to regain a high WHR (Ridder et al., 1990). WHR indicates a woman's estrogen levels, and, thus, her reproductive status.

A lower WHR signals greater reproductive potential. The relationship between WHR and estrogen levels predicts a woman's chances of conceiving; women with lower WHRs have higher estrogen levels and are more successful in becoming pregnant (Lipson & Ellison, 1996). Similarly, indirect evidence shows that a 0.1 unit increase in WHR causes a 30% decrease in the probability of conception (Zaadstra et al., 1993). As well, in infertile women who were undergoing in-vitro fertilization treatments, the women with lower WHRs had more successful pregnancies than the women with higher WHRs (Wass, Waldenström, Rössner, & Hellberg, 1997). WHR reliably predicts a woman's chance of becoming pregnant. WHR is also an indicator of past pregnancies. Pregnancy creates stress on a woman's body which reduces the number of children she can have in the future. After each consecutive pregnancy, women accumulate more fat around their abdomen, resulting in higher WHRs (Sohlström & Forsum, 1995). This relationship reveals that women with higher WHRs have lower reproductive potential. A man can detect a woman's reproductive potential from her WHR (Singh, 1993), and this has a bearing on his mate choice.

Figure 8.1: Marilyn Monroe

Women with lower WHRs are perceived as more attractive. Across various ages and cultures, both homosexual and heterosexual men ranked women with lower WHRs as more attractive and more reproductively capable than women with higher WHRs (Singh et al., 2010; Singh, 1993). In contrast, men viewed women with higher WHRs as undesirable for a romantic relationship (Singh & Young, 1995). Men prefer women with high reproductive capabilities, which they can infer through a woman's low WHR. When men see women with low WHRs, areas of the brain associated with reward processing and appetitive behaviours are activated. (Platek & Singh, 2010). This suggests that men possess biological mechanisms leading them to seek out women with low WHRs. The attraction towards low WHRs can be dated back to hunter-gatherer societies where female sculptures possessed low WHRs (Hudson & Aoyama, 2006). Hunter-gatherers projected their idealizations of the female body onto these sculptures, suggesting that they viewed low WHRs as desirable. The unchanging universal attraction towards a low WHR suggests that a low WHR may be favoured by evolution.

A low WHR is a sexually selected adaptation. A man's inability to keep his gaze away from a woman's hourglass figure is not shaped by culture, but rather, evolution. Society's fixation on hourglass figures is not just a trend, but a strategy to increase their reproductive success. Through a woman's low WHR, a man can detect her high level of estrogen and therefore her superior reproductive potential. A man desires an hourglass-shaped woman to fulfill his goal of reproducing as many offspring as possible. Reciprocally, a curvy woman attracts many men, giving her the chance to choose the best mate to father her offspring. A low WHR, embodied by the timeless hourglass figure, is an honest indicator of fertility.

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Low Battery: 'Please Don't Charge Your Device'

BRENT URBANSKI

An average person checks their smartphone 80 times a day or once every 12 minutes (Asurion, 2018). Behind each of these actions sways an array of puppeteers, some pull with strings more deftly wound yet each have a similar effect—to swindle time for 'value'. Within this exchange, a typical smartphone user will trade four hours per day, sixty-one days per year, or one quarter of their waking life for digital utility (Request, 2017). And with an imperfect line charted between hedonistic splurging and necessary usage, the surge behind smartphone addiction runs dangerously covert. We, society, see its detriments each day, across our health, tranquility, and wellness, yet our complacence leaves us blind to its cause. Until our batteries die and it is time to glance up, we will fail to recognize the impact of smartphones on our lives.

Smartphones have become society's self-admitted reliance. Across ages and strata, with the uneducated and youthful over-represented, the smartphone addiction literature shows similar effects: a significant proportion (47%) of people have tried to limit their smartphone usage and yet most have failed (70%) (Deloitte, 2017). To further illustrate, when asked on a self-report metric, 48% of college students described themselves as at least moderately addicted to their smartphone (Kwon, Lee, et al., 2013). Given that the term 'addiction' varies between people, as per its subjective nature, the magnitude of these results are only obvious when viewed against a quantitative scale. Through an experimental smartphone application, which monitored the daily usage patterns of college students, it was found that females and males vary along two dimensions of activity: time accumulation and time allocation (Roberts, Yaya, & Manolis, 2014). For time accumulation, female and male college students spent 10 and 7.5 hours per day, respectively, on their smartphones. When tallied, these data indicate that young females devote 33% more time towards smartphone related activities than do males. This gap can be explained through an external analysis of Roberts, Yaya, & Manolis (2014) data, which coincides with time allocation, where females delegate a higher proportion of their time to organization, social networking, and shopping than males, who instead disproportionally skew towards leisure and music. From an evolutionary perspective, one might broadly conclude, females engage in activity to further their interpersonal rapport (a reciprocal and time consuming process), while males emphasize that which provides instrumental utility (Geser, 2006; Su, Rounds, & Armstrong, 2009). Perhaps by mere coincidence, but more likely by design, smartphones exploit our evolved systems to reinforce digital habits and drain our health.

Figure 9.1 A symbol of smartphone addiction

While smartphones are not an ingestible drug people respond to them much the same (Oulasvirta, Rattenbury, Ma, & Raita, 2010). From impulsive checking to risk blindness, which overlaps with the criteria for substance addiction, the many habits and hours that underlie high-use smartphone activity come with cumulative costs (DSM-5, 2013). An analysis of this activity clearly demonstrates that anxiety, depression, and musculoskeletal deterioration are exasperated alongside smartphone over-use (Hwang, Yoo, & Cho, 2012). While it would be correct to assume that these outcomes partially arise from smartphone induced loneliness and poor viewing posture, an under-considered factor is sleep impairment (Åslund, Starrin, & Nilsson, 2010; Bian & Leung, 2014). Each day, our sleep-wake cycle (circadian rhythm) collects

environmental information, such as nutrient availability and sunlight exposure, and then makes an informed decision as to when sleep should occur (NIH, 2018). This decision is communicated via a brain chemical called melatonin, which acts to induce drowsiness. When a person uses their smartphone before bed, as 81% of Americans do, the light emitted from their screen slows this sleep chemical's production, signals that night has yet to arrive, and, consequently, tricks their brain into believing that they should not be tired. (Deloitte, 2017; Chang, Aeschbach, Duffy, & Czeisler, 2015). If somebody is not tired they will not sleep, and when somebody cannot sleep they will experience the effects of sleep deprivation. When sleep deprived, humans exhibit many of the (psycho-) pathological symptoms that occur within frequent smartphone users—these are anxiety, depression, and musculoskeletal deterioration (Kahn-Greene, Killgore, Kamimori, Balkin, & Killgore, 2007; Demirci, Akgonul, & Akpinar, 2015). For this reason, we cannot definitively conclude that smartphone over-use, by itself, causes negative outcomes, but rather that they encourage an environment of apathy and self-deception where small issues become large threats.

Figure 9.2: A dramatization of smartphone overuse

Smartphone users consider themselves an exception to modern trends. When asked to evaluate the usage habits of both an average smartphone users and themselves, 56% of survey respondents stated that the average user spends "too much" time on their smartphone, but that they, themselves, do not—or only 17% believe that they do (Bank of America, 2016). At first, this might appear as an error in reason—like say, the better-than-average effect improving an individual's personal esteem—but generally, with biases stood ancillary, broad social shifts require large phenomenon. What principles, then, would lead a majority of smartphone users to addiction, and yet endow only a few with the necessary awareness to contest (sans college students)? There is no definitive answer, but the social psychological concepts of normative behaviour and fundamental attribution error are apt to begin. These, respectively, indicate that actors imitate one another's behaviour to acquire social validation, and then, following this action, they tend to misattribute positive outcomes to personal volition and negative outcomes to uncontrollable externalities (Jones & Harris, 1967). When pooled together, our social ecosystem encourages the non-critical adoption of destructive habits, and more to their detriment, the eschewing of associated burden. Take, for example, a typical corporate structure where employees are required to fulfill late night technical obligations—i.e. email. Here, as nighttime smartphone usage increases, workers experience poorer sleep quality, which results in impaired productivity and workplace burnout (Lanaj, Johnson, & Barnes, 2014). Despite recognizing the impact of late-night work on their health, these workers largely agreed that the expectations in which they are confined provide no berth for freedom nor autonomy. Now imagine a similar pressure on youth; receiving a text mandates a response, and sending a response initiates a feedback loop—a mechanism that is comparable across many applications. This pattern outlines the general challenge that we face as a society: smartphone addiction is simultaneously recognized and suppressed within the individual but encouraged and rewarded within the collective.

With our batteries drained and our eyes forward, reality zooms back into sight: smartphones are a tool with an unbound limit. At best, smartphones grant us the ability to explore, learn, and socialize; at worst, smartphones drain our time, impede our health, and control our freedom. And yet, with all their merits and flaws, they [smartphones] move forward as an integral part society. To reject them is to avoid assimilation, but to adopt them is to usher in detriment. Just as the emperor strutted his new clothes, the smartphone user twiddles their device. In this game of conformity, nobody wins.

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INFOGRAPH

An infographic is a medium used to visually represent information. With the use of both images and text, knowledge can be conveyed in an easily digestible format. The images in an infographic are usually graphs and charts. Utilizing figures allow readers to comprehend large amounts of data fairly quickly. Effectively educating a lay audience on scientific concepts remains crucial. The infographic found in our journal is an excellent example of how a combination of images and text can be used to explain a complex concept in an engaging manner.

SLEEP AROUND

SIESTA

"Socially acceptable practice of habitual napping, often in mid-afternoon." Barone, 2000

SLEEP CYCLES

While monophasic sleep—one long bout of sleep per 24hr cycle—is considered the norm in North America, there are other ways to organize sleep.

SLEEP

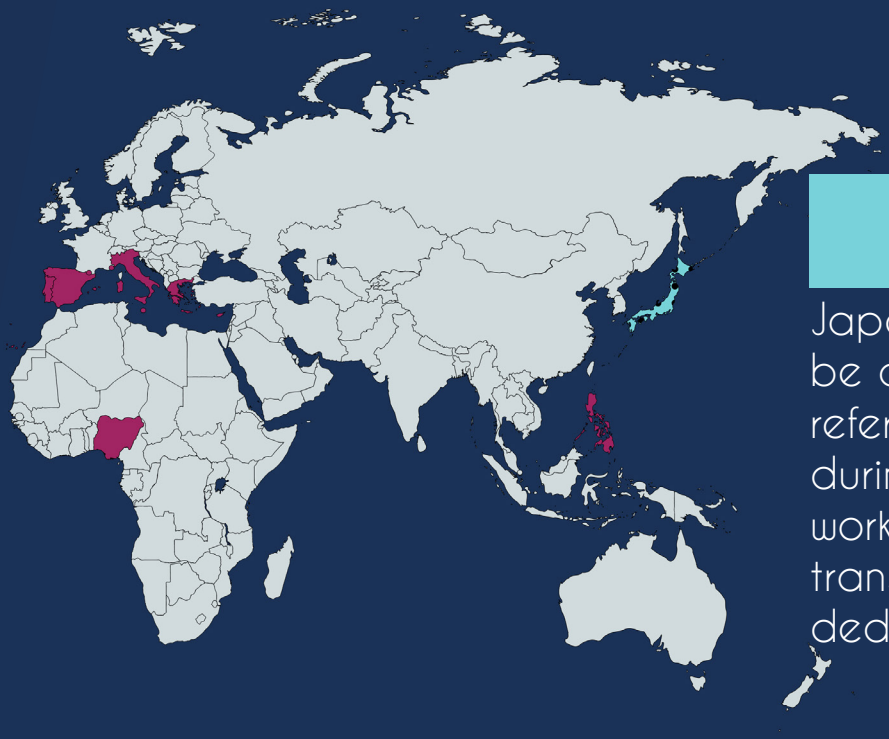
WAKE

Polyphasic Sleep

- Very rare; used in some nomadic groups, or in certain professions
- Japan's **inemuri** for example

THE WORLD

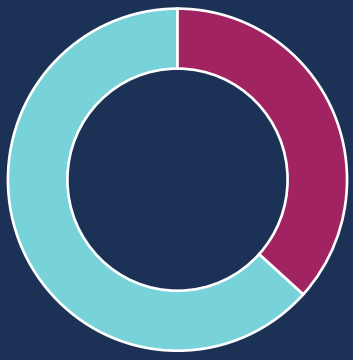
by Stephanie Paoli



INEMURI

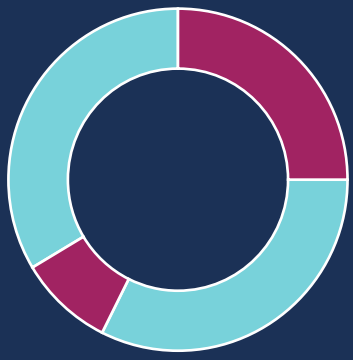
Japanese term meaning "to be asleep while present", refers to a short nap during the day, often at work or even on public transit' considered a sign of dedication to work.

Monophasic Sleep



- Canada
- USA
- Most European Countries

Biphasic Sleep



- Latin America
- Mediterranean
- Parts of South America

PRÉCIS

A précis is a concise summary of the main ideas presented in a research paper, typically in a hundred words. It is a weekly assignment in PNB 2XD3, a mandatory PNB course that hones students' writing and editing skills. In creating a précis, the writer recognizes the importance of flow and brevity in writing. As a hallmark of the PNB academic life, it is only logical that a section highlighting excellent précis pieces be included in the Psynapse.

Menthol Is Cool

Haolin Ye

Menthol, found in mint, induces a cold sensation on your tongue. Typically, we perceive coldness when cold objects activate TRPM8 skin receptors. When the temperature drops, TRPM8 receptors open and sodium ions flow into C neurons. Sodium ion buildup causes C neurons to generate electrical signals, which are sent to the brain. The brain interprets these signals as a drop in ambient temperature, causing a cold feeling. Menthol also binds to TRPM8 receptors on your tongue and sends the same signals to your brain. As a result, the cold feeling from menthol is indistinguishable from cold temperatures. Menthol is a cool compound.

Peier, A. M., Moqrich, A., Hergarden, A. C., Reeve, A. J., Andersson, D. A., Story, G. M., ... & Patapoutian, A. (2002). A TRP channel that senses cold stimuli and menthol. *Cell, 108*(5), 705–715.

Figure 10.1: Mint flavoured toothpaste

Menthol induces a cold sensation because it activates our cold receptors.

Probiotics Alleviate Stress

Sohana Farhin

Gut bacteria influence stress levels. The gut contains bacteria that collectively form an organ called the gut microbiota, connected to the brain through the gut–brain axis. The gut–brain axis modulates the effect of probiotics on the brain. Probiotics trigger the release of neurotransmitters, causing signals to be transmitted from the gut microbiota to the brain. Neurotransmitter release increases activity in brain regions that elicit positive emotions. Thus, probiotic supplements lower the levels of stress hormones and alleviate psychological distress. Probiotics are an innovative form of treatment for distress that can help avoid side effects associated with common medications.

Bienenstock, J., Kunze, W., & Forsythe, P. (2015). Microbiota and the gut–brain axis. *Nutrition Reviews, 73*(1), 28–31. https://doi.org/10.1093/nutrit/nuv019

The Woes of Attraction

Toni Rose Asuncion

Self-perceived attractiveness is influenced by alcohol. Intoxication creates inaccurate interpretations of reality causing individuals to perceive themselves as more attractive than they would sober. Intoxication inhibits attention, which decreases self-awareness. The more drinks one consumes, the more attractive they rate themselves. However, misperceptions about attractiveness cause negative repercussions. Potential rejection induces distress when pursuing potential mates due to a false sense of confidence in one's attractiveness. Dating sober is beneficial: it ensures more reliable measures of attractiveness and reduces possible shame. The more one consumes alcohol, the more attractive they perceive themselves.

Bègue, L., Bushman, B. J., Zerhouni, O., Subra, B., & Ourabah, M. (2013).'Beauty is in the eye of the beer holder': People who think they are drunk also think they are attractive. *British Journal of Psychology, 104*(2), 225–234.

Intoxicated individuals perceive themselves as more attractive.

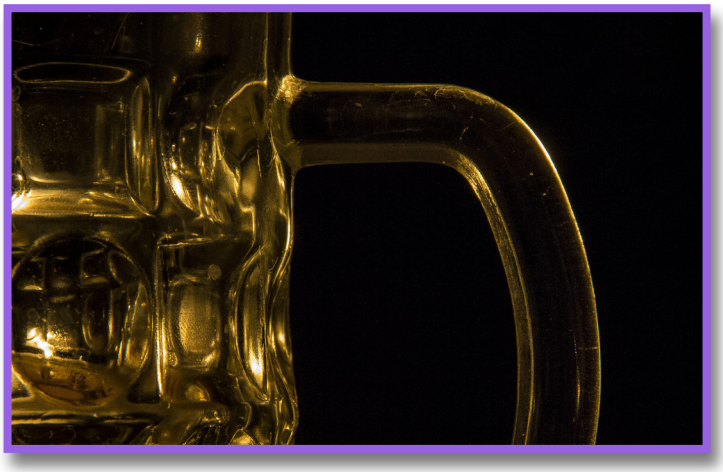


Figure 11.1: A pint of beer

Probiotics increase the activity of brain regions eliciting positive emotions, thereby alleviating stress.

Figure 12.1 Bacterium in gut biome

The Importance of Colour Vision in Cichlid Fish Diversity

Julianna Salvatierra

Human activities threaten the diversity of cichlid fish species by interfering with their colour perception alleviating stress.

Figure 13.1 Cichlid Fish.

Colour perception is integral to the diversity of cichlid fish species. Females use colour perception to choose mates and to distinguish them from other species. This mating strategy increases species diversity, but it is susceptible to disruption from human activities. Activities such as deforestation cause soil erosion, increasing turbidity—or cloudiness—in the water. The loss of water clarity hinders cichlids from discerning different colours and therefore, results in interbreeding—leading to lowered species diversity. Governments must implement policies on industrialization practices to prevent the loss of diversity among cichlid fish species.

Balshine, S. (2018, January 25). The evolution of colour vision [Powerpoint slides].

Seehausen, O., van Alphen, J. J., & Witte, F. (1997). Cichlid fish diversity threatened by eutrophication that curbs sexual selection. *Science, 277*(5333), 1808–1811. doi: 10.1126/science.277.5333.1808

The Cheerleader Effect: Attraction in Numbers

Julianna Salvatierra

Individuals are more attractive in groups than in isolation.

Individual faces appear more attractive in a group than when presented alone. This perception is known as "the cheerleader effect," and is caused by the interaction between ensemble encoding and human preference for average faces. Ensemble encoding occurs when the visual system automatically processes a group of faces as an average face. This face is generally more attractive than the individual faces because the attractive features of the group offset the unattractive features. During face perception, everyone's face becomes more like the group's average face thus appearing more attractive individually. Being in a group increases one's social and personal appeal.

Walker, D., & Vul, E. (2014). Hierarchical encoding makes individuals in a group seem more attractive. *Psychological Science, 25*(1), 230–235.

Figure 14.1 Cheerleaders

THESIS ABSTRACTS

In their final year, most PNB undergraduates have the option to join a laboratory and undertake a thesis course. A thesis course encompasses an entire academic year, allowing undergrads to play a major part in an academic research experiment. Ultimately, these students produce a final research paper to present to their respective professors. While these papers can reach upwards of 40 pages in length, a small part of a thesis paper, the abstract, provides a concise summary of their research. Abstracts in this journal are included to display the cutting edge research, in an easy to read format, done by our own students in PNB.

Learning Benefits Via Hybrid Schedules

MRINALINI SHARMA

Figure 15.1 A stressed student studying for school

One study schedule used among students involves progressing through examples of concepts within a category one at a time. Appropriately named blocking, in this sequence all examples of one concept are studied at once before moving onto to the next (a1a2a3b1b2b3c1c2c3). In contrast, interleaving is an alternative study sequence whereby problems of different concepts within a category are mixed (a1c1b1c2b2a2b3c3a3). Greater learning gains are visible when students adopt an interleaving schedule compared to a blocking schedule. This is arguably because interleaving promotes discriminative contrast—juxtaposing problems from concepts highlights critical differences across them. This benefit, known as the interleaving effect, has been demonstrated multiple times throughout literature. However, some studies also report instances where blocked practice enhances learning compared to interleaved practice, partly due to concept characteristics (e.g., concept structure). In the current study, we shift our focus away from the debate about which schedule is better to when both schedules can be utilized to optimize learning benefits. Specifically, we examined the possible benefits of hybrid schedules (e.g., a combination of blocking and interleaving). In the current

experiment, participants studied six statistical concepts, each with six illustrative problems in one of three randomly assigned conditions: pure interleaved (a1b1c1a2b2c2a3b3c3), pure blocked (a1a2a3b1b2b3c1c2c3) or blocked to interleaved (a1a2b1b2c1c2a3b3c3). In the final test, they were given new problems and asked to identify which statistics concept was illustrated. Final test performance was highest when concepts were practiced through the hybrid schedule, suggesting that perhaps participants need to initially encode within-concept similarities (done through blocking) and gain initial mastery over subject material before they can encode and benefit from learning the between-concept differences (done through interleaving).

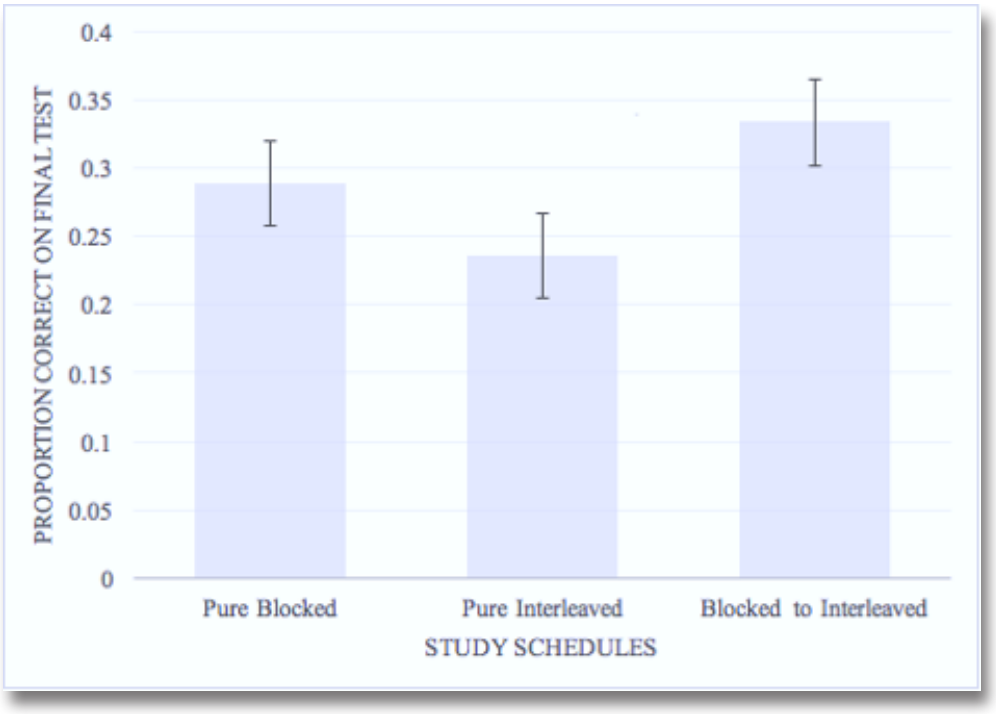


Figure 15.2 Final Classification Performance for Different Study Schedules

Figure 15.2 displays the final classification performance for the three conditions: pure blocked, pure interleaved and blocked to interleaved (hybrid). There is a marginally significant difference of $p < 0.05$ between the pure interleaved and the hybrid condition while differences between other conditions are non-significant. This shows that participants benefitted the most from pure and hybrid blocking schedules. It is possible that learning six different statistical concepts becomes too heavy a cognitive load for participants so blocking serves as a crucial tool to gain initial concept mastery through the identification of within-concept similarities before learning between-concept differences through interleaving can be beneficial.

HUMANS OF PNB

The Department of PNB is comprised of phenomenal individuals, be it faculty, researchers or students. Although the people of this department hail from a variety of diverse backgrounds, they all have one thing in common, being engaged in scientific research and discovery. The purpose of "Humans of PNB" is to achieve an enhanced view of the people behind the monumental work being done here at McMaster. We hope that by providing an inside scoop into the background, interests, and career path of McMaster's current researchers, our readers will gain inspiration to pursue their passions and get involved.

Dr. Joe Kim

ASSOCIATE PROFESSOR

What courses do you teach?

I teach the Mac Intro Psych courses: Psych 1XX3, (we call it the Biological Basis of Human Behaviour) and Psych 1X03, (the introduction to Psychology, Neuroscience and Behaviour). I also teach a level 3 course called Applied Educational Psychology. This is a course on the science of teaching and learning. It provides evidence based practices for teaching, and is actually only open to new, incoming Mac IntroPsych TAs. They learn all about the science and theory of teaching with projects on applying this theory to teaching practice. I also supervise students for lab studies and thesis' in my Education Cognition Lab.

What made you want to study a stream of PNB?

For me, psychology has a lot of opportunities. First of all, its one of the youngest of the sciences, so we are still, I would say, at the ground floor of making the big discoveries. A much older field like physics, in some ways I feel like a lot of big discoveries have already been made. Not to say that there isn't more to discover but for psychology, we are really still at the ground level, so there are lots of big discoveries that have yet to be made. I think in the next twenty or thirty years we will see really amazing things that we discover about the brain and consciousness.

The next part for me, is that it is so practical. I tell students when they take Psych 1X03 that this is the most important course they will ever take because it will change the way that they see and interact with the world. My area of research is a good example of where we've developed a lot of theory and understand how the mind works in the lab. This is done through very controlled studies on attention, memory, and learning. For me, the most interesting part is how can we take that knowledge and then apply it to a practical situation like instructional design, and education.

What do you like about teaching undergraduates?

Teaching undergrads is a lot of fun! This is especially the case for first-year students, because students coming into their first year are so curious. I love meeting with students after class, and in office hours, because they ask me some really interesting questions. I love it when they ask me a question that I have never heard before. I think, "wow this is an amazing, original question, where I don't know the answer". I love when I get questions where I don't know the answer because it starts a really good discussion, "I will tell you what people know so far, but what do you think is happening?" Teaching first year students is really a privilege. It's such a hard transition too, going from high school to first-year. I meet a huge spectrum of students in first year from super keen students to students that are less motivated. I try to make Introductory Psychology really interesting and exciting while showing my passion and when the class is buying in, it's pretty exciting.

"I love it when they ask me a question that I have never heard before. I think: wow, this is an amazing, original question, where I don't know the answer"

How do you incorporate undergraduates into your research? What is the worth of an undergraduate research student?

Undergraduate students are critical to my research lab. The majority of researchers in my lab are undergrads. I have grad students at the very top who have the most experience, and they can help guide research projects, but we really need hands-on efforts from undergraduate researchers. For me, ideally, I would like undergraduates to come in for a two-year experience, so as a third-year student, or even sometimes as a second year, though it's much more rare. They could join as a lab study, and even get paired with a thesis student, and a senior lab member and gain a lot of experience. There is so much to do like data collection, experimental design, data analysis. They could return the next year as a thesis student and use their experience from the previous year. I find when I get students through a two-year cycle, some of them, the really good ones, can do work almost equivalent to a masters student.

What's an interesting event related to your career you have experienced recently, or in the past couple of years?

I have told this story before, but it's a pretty funny one. So, because I teach this large introductory psychology course, the majority of students at McMaster, take the course. In the last 10 years, over 50,000 students have taken my course so I often get recognized wherever I'm go. The funniest incident was in the washroom. I was in the urinal and the guy next to me does a double-take and he says, "Oh my god, are you Joe Kim?" It happens often enough that sometimes I just have fun with it, and so I respond, " No, I just look like that guy." He later responds with, "No, seriously you look like him." And then he's just kind of thinking about this and as we are washing our hands, and as I leave the washroom, he goes, "Seriously, are you Joe Kim?" and I say, "I guess you'll never know." Just before I leave the washroom he says, "That's exactly what Joe Kim would say."

How does your typical work day unfold?

I really like having a set routine on the weekdays. I am an early riser and I get up at 6:00am and have a morning routine that I go through. I exercise for 20 mins with an app called Streaks Workout, which I love. It just tells you what to do (10 pushups, do 15 sit-ups, things like that). After that, I will take a shower, journal for 5 minutes, (I'll just write what's on my mind) and then I will spend 5 minutes planning my day – what are the major things I need to get done? Then I will spend 45 minutes getting one task done, (usually something that I might have been putting off) get that one task done and then, and only then, I will skim through my email for 15 mins and then I will go to work. Once I get to work, lots of different things can happen. If I'm teaching, I will go to lecture, I might have lab meetings, I might have lectures to go to, journal clubs, office hours, so every day is a little bit different.

How do you deal with the stresses of work and research? (self care, hobbies, etc)

I think work-life balance is a really hot topic, especially when you are in a position in an academic setting, or if you are any

type of knowledge worker. It is one of those jobs that never ends. I think it's really important to have clear boundaries like, "okay, that's as much as I can do today" and when you are home, put as much energy, and time, and passion into life as you do into work. It's definitely an ongoing challenge, and it really helps if you are doing a job that you really enjoy. If I won the lottery, I would still show up for work the next day. I am lucky enough to be in a job where I'm not driven by a paycheck, where there are so many people in the world where the reason why they go to their job is because they need that paycheck, and that paycheck pays for everything in life. Obviously, I have to pay for things in life as well, but I am lucky enough to be in a job that is really fun to do, where if I could afford to, I would do for free. So that would be the best advice I could give to someone, find a job that you would continue to do, even if you won the lottery.

If you could pick one notable individual in history who you think has the most tremendous impact on the field, who would that be?

Probably William James, because he really set the foundation for how psychology should proceed as a new science, the types of questions to ask, the research methods that should be used, I think he was a very influential figure.

What's a moment in your life that has had lasting impact on you? Perhaps even shaped who you are now.

For me, I'm really passionate about giving good lectures and really connecting with students. The biggest moment in my career was at a conference called Society for Neuroscience, one of the biggest Neuroscience conferences. When I first started working as a postdoc for UCSF, my supervisor at the time couldn't go to the conference where she had been invited 1-hour talk. So, she asked me if I could give the talk instead. I had just joined the lab and really didn't know that much yet about cellular biology so, I had to learn everything inside out. For a month I poured my heart into preparing for this lecture and I gave the best presentation of my life. So much so that I had a few people coming up to me afterwards and asking me "What are you doing now in your career? Are you looking for a postdoc?" and I said "Well I'm just starting a postdoc." And that just showed me the power of giving a really strong presentation.

"In second-year, when you are in PNB, you have core courses to take together and the students really bond in second year and you can really see it"

Please share something you find peculiar about the PNB students/Department/your lab.

I think it's amazing that they really form a cohort. In first year nobody is a part of a program yet, (you're just in the faculty of science or social science) but in second-year when you are in PNB, you have core courses to take together. The students really bond in second year and you can really see it. They have gone through all these challenges together, (I.e. PNB2XD3 the writing course, PNB 2XB3 the neuroscience course) so they really feel like they've been through a good struggle together. You can see it in their interactions. Since the students I see the most are PNB students, I can say they really seem, to me, like the students with the most community. You can see it in the lobby, students are hanging out, they see profs coming here all the time so you have daily interactions. I think that's a great part about the PNB students.

Dr. Jonathan Pruitt

ASSOCIATE PROFESSOR

What courses do you teach?

I arrived at McMaster just this past summer and so have a year of teaching relief. Next year I will be teaching an advanced animal behavioural laboratory. It will be a small course of about twenty students where they will be designing independent projects and enaging in research related to animal behaviour.

Did you do your undergrad in a PNB related field, or did you come to PNB later in your career?

I started as an Animal Physiology undergraduate major, then completed a PhD in Ecology and Evolution at the University of Tennessee. Next, I was a professor for the Biology department in Pittsburg, and then a professor for the Ecology, Evolution and Marine Biology department in Santa Barbara. Now, I'm apart of a psychology group.
There are behavioural ecologists in psychology groups, so I always thought that I might be in the psychology department one day. Now I am in a special one where almost everybody does high-end biologically motivated experimental work, so this is the right Psychology field for me for sure.

What do you like about teaching undergraduates?

Well, I like a lot of things about it. One, when you do a good job teaching, it's obvious right away. If I do a great study and then go to publish a paper, I might get a few congratulatory emails, 24 months to 5 years after it's done, (that's a very small number of people to witness the impact of what you have done). If I do a good job in a lecture, I can see the whole room laughing, or being impressed by something in real time. It's immediate gratification that shows me I am doing a good job, and that's what I enjoy.

Also being an adult, you can sometimes be cynical and jaded, and take for granted everything that you live with each and every day. The undergraduates just remind you of the coolness of what you've been doing and allow you to relive it all again, and again, and again. I am totally spoiled. I'll tell my undergraduates that "I have to go to Africa on Saturday, it's going to be lame because I have to spend 18 hours in the sky," and they

will respond with, "That's totally rad, you get to go to Africa, that's sweet!". I guess that they are right. It's nice to travel, it's not a burden, it's a luxury. Students are invigorating.

"Students are invigorating"

What is it like to work at McMaster University? In this department?

I immigrated to Canada in July and out of the 8 weeks that I've been here, I've been gone for about 6. I cannot say I really know what it is like to work at McMaster yet, but others here seem to like each other and no one seems to be fighting over resources. Everyone is funded, seems to have a pretty successful research program, and likes teaching. It feels like a very agreeable place to conduct science and to teach.

How would you describe your teaching style?

I am not that old, and so I basically treat my undergraduates like a group of interested friends who I want to explain these concepts (pertaining to the course) as succinctly and as clearly as possible. Then give examples that I think are the coolest. So that even if you can't quite remember the concept in two years, you can at least remember the example–some glimmers of insight that persists with you. So my teaching style includes sharing cool stories that help convey central concepts in a succinct, clear, and approachable manner. It is my job to be a teacher, so I have a reverence for it, a respect for it. Basically, the only reason why McMaster hires people like me is with the understanding that the leaders in the field are going to be the best teachers. So, I try to be the best teacher possible.

What do you think is the greatest challenge facing students today?

I think it's not endemic to today, I think the same criticism today has been true for forever, that is that at a University, the question is, what are wetraining you for? Are we training you for a specific profession, are we preparing you for a job, or are we to fuel you with a general knowledge base and set of tools for creating new knowledge? The university system is designed for the latter, but it's always struggled with whether or not it should prepare you for a specific sort of job. Something like a business school or a school of engineering take it slightly further in the applied direction, but arts and sciences always had a struggle with what we should be doing with our students? What we should be preparing them for? What they are going to do with their lives? This is a problem of today and a problem for all generations.

From a teacher's perspective, I try to teach you some things that would be useful at some point, and in some sort of applied vocational landscape. As a student, the question is, what are you going to be doing when you are all done? How will you reconcile the education you are receiving relative to what careers actually exist? I think that is the challenge that has been felt for forever. If you go read the papers from the early 19-hundreds about graduate education and undergraduate education, they were basically complaining about the same thing, so it's not new, it's been around for at least 118 years.

Please describe your typical work day.

I get up super early at 5:30am, go to the gym at around 7:00am to see my personal trainer, then I go into work at 9:15am and work usually about 3 hours in the morning answering emails and doing paperwork, (really lame stuff). I then go and have a really sad salad from the food market in the medical school and then go back to my office and do something productive for a couple of hours. I write a little bit, I design a study, or a I go over to a whiteboard and think about a new idea or I scheme in some way. Then in the afternoon, I have meetings with students and with other faculty. I try to relegate to the end of the day. Emails at the end of the day, then productive stuff, then meetings so that when I'm brain-dead, I'm brain dead at meetings where I basically don't have to contribute anything. But I answer emails right in the morning where I still present well to all the people who have emailed me.

How do you deal with the stresses of work and research? (self care, hobbies, etc)

I play elaborate video games and board games. I enjoy going for really, really, long runs. You can see me sweating buckets each afternoon around 5:30 or 6 o'clock on the little bike path on the side of the mountain. Elaborate board games, going out to dinner with friends, loitering and complaining, like a normal person.

How do you incorporate undergraduates into your research? What is the worth of an undergraduate research student?

Undergraduates and graduate students do all of my research now. I sit around and I write papers, and I complain, and I mess things up in the field, and my undergraduate and graduate students fix everything. So basically, undergraduates are the fuel that keeps everything going, they are fond of new ideas, they keep people excited and fresh. They end up doing a ton of the work as well. I would say the average offset of observations that are conducted on animals in my lab are conpleted by undergraduates. They do everything in my lab –washing dishes and feeding animals, designing and implementing

studies, writing papers and doing stats, and giving talks. So, they do all possible aspects of research. Normally, I start them with stuff I think they cannot possibly fail at, and then through time they crescendo the amount of things that they do. I would say about 85-90% of the students I work with in the lab have been co-authors on papers. I view undergraduates as instantaneous collaborators and I try to get them involved as seriously as I can with research, as quickly as I can. Of course, after I know they are going to show up reliably and they'll be sober.

"You should pick something that at least initially, you really, really love, so that it will be worth it even 6 months later"

What advice do you HAVE for students who are aspiring to pursue their PhD. and perhaps acquire tenureship as a faculty?

One, get involved with a lab that does research, but also has a track record of publishing with their undergraduates. There are a lot of dead-ends in the maze between undergraduate research and the product that you can show to a graduate school. I guess there are 4 currencies you could work for as an undergraduate. You can get money, you can get credit, (those are great) but what you really want is a letter of recommendation, (you will need to get two or three good ones) and you need to get published in papers. The best undergraduates, the ones that are the most competitive, are going to get some sort of paper, even if it's just a co-authorship. So being entrepreneurial, and clever and asking your friends "Which of these labs is going to allow me to be independent and treat me with respect, and ultimately allow me to produce product, both a quality letter of recommendation that's turned in on time and possibly a co-authorship on a paper or my own independent project?". So, use your resources wisely, use the experience of others and try to pick something that interests you. So much of science can be incredibly boring; the first time you watch a spider attack a prey item it's amazing, the twenty-four thousandth time you watch a spider attack a prey item, not quite as amazing. You should pick something that at least initially, you really, really love, so that it will be worth it even 6 months later.

Please share a moment in your life that has had lasting impact on you (perhaps even shaped who you are now).

In undergrad, I was lucky enough that when I was interested in doing undergraduate research, someone just gave me a room and a bunch of lizards. At the time I was like, "I think I want to study fighting lizards and maybe there is some sort of science that is linked to this. So, I began to study behaviour lizard fighting".

Somebody just gave me a couple of hundred lizards, an old storage closet, and a bunch of tanks, and basically just let me have my own little lab. At the time, I thought, "look at this flea-bitten place they've given me, this weird storage closet, this is horrible," but now looking back, I had my own lab and I was only 18 or 19! The amount of trust and resources they gave was shocking. I don't think I would've been as prepared for science and possibly wouldn't have gone into science had it not been for Henry Mushinsky who is now retired from the University of South Florida.

Dr. Nicholas Bock

ASSOCIATE PROFESSOR

What courses do you teach?

I teach PNB 2XE3 which is now Data and Descriptive Statistics.

What made you want to study (a stream of PNB)? This profession?

I got into Neuroscience from more of a Physics background. When I was an undergrad, I saw some MRI (Magnetic Resonance Imaging) images of the human brain that were really interesting. I decided to go into Neuroimaging based on that.

What do you like about teaching undergraduates?

The students are very enthusiastic and I like that it keeps me on my toes. I always want to make sure that I'm teaching the latest and greatest.

What do you think is the greatest challenge facing students today?

It's the breath of knowledge that you need in science now. For example, if you were interested in the genetics behind behaviour, you would need to know the behaviour from psychology, the genetics, and how imaging works. That's a lot of science, not just in PNB. Science has become very multidisciplinary. Back when I was an undergrad, science was more segregated. There weren't a lot of people doing genetics and behaviour, it was simply genetics or behaviour.

How do you incorporate undergraduates into your research? What is the worth of an undergraduate research student?

I incorporate undergraduates into the same projects that my graduate students and I are working on, just at a level where they don't need as much expertise. They are important because

they bring a second set of eyes to our research. I'm always impressed with how, we will give them a task, and we think we've got it figured out, and they actually come up with a better way to do it. It's also a great way to recruit graduate students. I've actually had a couple students move from undergraduate thesis projects to successful graduate work.

What is it like working at McMaster University? In this department?

I like working in PNB because it is a very diverse department. There is always interesting research going on right across all fields of psychology, neuroscience and behaviour. I don't think a person like me would actually be in a traditional psychology department. I am more Neuroscience and imaging focused, but I fit well into this department because there are people doing all kinds of other interesting things. PNB does a really great job at supporting the students right across the continuum, from undergraduate to graduate to post doc. The department has a really good feel, and I see that because I always see undergraduates hanging around in the building lobby.

"....we will give them [undergraduate students] a task, and we think we've got it figured out, and they actually come up with a better way to do it."

What advice do you have for students who are aspiring to pursue graduate work?

This is old-fashioned advice, but I still think it actually holds. Students should focus on being apart of published research and trying to obtain continuous funding, which actually starts at the undergraduate level. Things like summer NSERCs and your first NSERC or SSHRC as a graduate student, you want to keep that going. The only reason why I would say that it's old-fashioned advice is because there a lot of people nowadays talking about alternative careers in a PhD. However, if you are still interested in becoming a professor, those two core things —publishing and funding, are really important for your CV. I would also like to add: choose research that you are passionate about, because you might be working on it for thirty or forty years.

"Well, I think it's important to keep family in mind, becuse a research career will consume all of your free time. I also like doing things... outside of science..."

How do you deal with the stresses of work and research? (self care, hobbies,etc)

It's important to keep family in mind, because a research career will consume all of your free time. I also like to do things that are outside of science like reading books, playing video games, and riding my bike.

Please share an interesting event related to your career.

I got bitten by a monkey once in a research setting, which I don't think a lot of people can say.

Richard Xu

GRADUATE STUDENT

What are you currently studying and what made you want to pursue this field?

I am finishing up my first-year at Mac Med and I did my undergrad in PNB. There were three things I found that I was really interested leading me to pursue med. Teaching, research, and the clinical aspect of things. Initially, I was interested in Clinical Psychology, but then I realized that the topics you have to commit to in a Clinical Psychology PhD were specific while I was interested in doing something more general. I wanted to experience the different aspects of the clinicians side before committing more to that, so I ended up applying to Med and am very fortunate to be pursuing that this year.

If you could go back in time, what is the one piece of advice you wish you could give your undergraduate self?

I would tell myself to eat healthier and to stress a bit less. I focused a lot on things that are really inconsequential today. I feel like I could've gotten through my undergrad a lot more stress free if I had that attitude before, but it's hard to say that because when you are in the midst of it, the stress is very real. That being said, I don't know if my former self would appreciate that, and if I had my future self tell me that today, I probably wouldn't appreciate that advice either.

What do you think is the greatest challenge facing students today?

I feel like the toughest part right now is just figuring out what you want to be doing in the end. When I started my first year of Life Sci at Mac I wanted to do Biochem, as well as medicine —but I guess now it's cyclical, I ended up doing it anyway. I fell in love with PNB after taking IntroPsych and ended up pursuing that. Figuring out what really excites you and what gives you that drive is tough and the only way to really find it is to try out more things. That's what I'm trying to do right now. I'm in my summer rotations and I'm trying to figure out which specialty is most aligned for me, and that has been a process.

Who in the field has influenced you the most?

Definitely my thesis supervisor - I've worked with him for three years and I'm still in contact with him. Dr. Lewis Schmidt was a great supervisor. He was clearly passionate about his field of study, personality and developmental psychology, and it was just infectious. He was a great mentor and he wholeheartedly supported his students. The culture in his lab is really productive. Everyone felt like they belonged there and felt very productive at the same time. It's a good balance between a good culture while still being highly productive.

If you could pick one notable individual in history who you think has the most tremendous impact on the field, who would that be?

This is going to be controversial, but it's Freud. He's just culturally ubiquitous. He's everywhere, and sure. He's not very scientifically sound, but he gets a lot of people talking about the field. For people who don't really understand psychology or don't know what psychology is today, he's the first step into it. His theories are very 'out-there' and if that gets people talking about PNB, then that's great.

Share something you find interesting or peculiar about the PNB students/Department/your lab.

The greatest thing about PNB is the sense of comradery that you recieve. The psychology lobby is always bustling in the day and that's a really cool thing. Everyone's just there, hanging out, doing work and open to socializing. You can definitely see casual mentorship happening, spontaneously. If I was ever stressed out, an upper year student would reach out and jump into helping me. It's a huge aspect that I miss about PNB. Another great thing is how everyone is into research. I was under the impression that everyone was into research when I graduated but transferring into a different program in my last year was very eye-opening. Research isn't as popular as I thought it would be.

"The psychology lobby is always bustling in the day and that's a really cool thing"

How do you deal with the stresses of classes, work and research? (self care, hobbies, etc)

The biggest challenge for me is that Mac Med is very self driven, and so I'm finding that striking a balance is more difficult that before. My schedule is so widely open, so it's up to me to teach myself everything they want me to know. I've been definitely focusing more on the class aspect of things because a lot of the field is very new to me. I haven't been around it as much as some of the other students might have been, so that's been a primary focus for me this year. I am still involved with my previous lab, with Dr. Schmidt, and right now we are just waiting on some data to get cleaned, polished and processed. I haven't been active with research in the past few months, so I am eager to get back into it and continue that as my career goes on.

What is your typical weekday like? (i.e., morning routine, evening routine)

Everyday is a bit different but that's what makes it interesting. For the past while, I've been changing rotations every other week so it's hard to establish a routine. Once I get into something, it switches up on me, and I have to adapt again. Probably the most consistent thing in my routine are my mornings. I brew some coffee and prepare some oatmeal and that's my ritual. I wake up early to make sure I have time to do that. I'm a big believer in eating breakfast and drinking coffee.

Share a moment in your life that has had lasting impact on you (perhaps even shaped who you are now).

I don't know if I can pinpoint any one particular moment that's really shifted the trajectory of my life—no huge revelations, no traumatic experiences for me for better or for worse. Maybe it's just my personality, but it's the little things every day that you experience, all the daily stuff that you will see that shaped you overtime. I don't think I've ever had one single event have a ginormous impact on me—or not that I can recall at least.