

Neuroplasticity In Action: Cognitive, Clinical, Environmental, And Translational Neuroscience In The Experiential Undergraduate Course At A Canadian University

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Abstract:

We propose a model psychoeducational program which seems to bear some therapeutic potential. We believe that such intervention might be beneficial not only for adolescents, but also for adults in all age groups. Canadian undergraduate students participated in an experimental research course grounded in neuroscience that was offered for credit during the COVID-19 pandemic. The training had an interdisciplinary character and integrated cognitive, clinical, environmental, and translational neuroscience perspectives to study the interplay between brain, behavior and social determinants of health. The course curriculum implemented an experiential learning style and had a neuroscientific focus on brain plasticity. This paper aims to identify the need for this type of action and explains the researchers' role in designing it. It sheds light on the emotional challenges during the traumatic times of lockdowns, university closures, and social isolation, when the experience of uncertainty and extreme loneliness led to mental health deterioration. We aimed to gain experience in creating a neuropsychological perspective on the management of adolescents' emotional and somatic pain, viewed as a subjective, multidimensional, and individual phenomenon. In those trying times, more than ever before, offering a salutogenic intervention under the umbrella of mental health promotion seemed to be an attainable goal with possible benefits to participants. No previous evidence could be found about educational training with potentially therapeutic elements offered in university settings. This underscores the need for innovative and effective health promotion initiatives of this type.

Keywords: Adolescents, Experiential learning, Mental health, Neuroplasticity, Salutogenesis, University students.

INTRODUCTION

FINDING THE RESEARCH NICHE

Research serves as a powerful tool in the implementation of procedures and steps taken toward exploration and critical appraisal

of information; it is the practice of creating knowledge and increasing our understanding of world phenomena (Cresswell, 2012). In 1910, John Dewey complained that "science has been taught too much as an accumulation of ready-made material...[and] not enough as a method of thinking" (Dewey, 1910). Researchers' responsibility in the process of scientific discovery is viewed as significant, especially in qualitative research (Ravitch & Carl, 2021); scientific visions based on their awareness and judgements, beliefs and assumptions, determine their modus operandi and have a great impact on the research outcome (Wiersma & Jurs, 2009). Research activity combines both experience and reasoning; it is seen as "the most successful approach to the discovery of truth" (Borg, 1963).

While conducting literature reviews, we learn that the volume of interesting, creative studies and new, usable and rigorous theories

is viewed as limited (Ramirez et al., 2015), with a low methodological quality being one of the concerns (Ho et al., 2021). Studies inform that in face of new scientific discoveries, rapidly changing environment, and emerging theories, research methodology should promptly adapt to meet new challenges (Saunders et al., 2023). It is well known that equivocal methodology makes studies difficult to be reproduced (Shreffler & Huecker, 2023). Thus, methodological transparency is needed in establishing scientific rigor and ensuring the quality of research findings, which should be verified to be replicated by other researchers (Aguiar, 2024):

Methodological rigor in research refers to the precision of a study in terms of planning, data collection, analysis, and reporting. Rigor in designing and performing scientific research and the ability to reproduce findings are cornerstones of scientific advancement. This is essential as it ensures the credibility and validity of the research (Aguar, 2024, p. 21).

This is where the conceptual framework is created to provide answers to two important questions, with one asking about the

importance of research undertaking and the other about the potential value of new findings and their anticipated contribution to the existing knowledge (Varpio et al., 2020, p. 990). We interpret a conceptual framework as the justification of reasons for which a new study should be conducted (Varpio et al., 2020). The framework a) describes the state of the existing knowledge usually conveyed through a literature review, b) identifies gaps in the comprehensive approach to the presented issue and the need for new scientific inquiry, and c) supports the choice of methodology based on the theoretical foundation and researchers' philosophical assumptions (Varpio et al., 2020). The early stage in our project was dedicated to conducting an initial systematic literature review to detect the need for an

intervention targeting stress and creating resilience. The review was initiated with a predetermined research question on how instructional interventional study in tertiary education could lead to creating resilience in students. It is worth noting that, since literature was identified before the COVID-19 pandemic, this resilience review required several major updates. Due to an overwhelming number of publications concerned with the pandemic, only papers that appeared to be most relevant to the final version of the project were selected. The research conducted during the pandemic shed a new light on the importance of effective therapeutic interventions for Generation Z. The unprecedented, and thankfully, only temporary, "new normal", with the university lockdowns, social distancing and overall uncertainty, became a major challenge for adolescents and young adults.

Based on the continuously conducted review, often called a living literature review, our philosophical assumptions, and our

growing knowledge of human resilience, Antonovsky's model of salutogenesis and the application of constructs belonging to his theory, created the basic conceptual framework of this project (Antonovsky, 1979; 1987; 1996).

"Health professions and disciplines have yet to be powerfully touched by salutogenesis", state Mittelmark and Bauer in 2022 in their chapter on Salutogenesis as a Theory, as an Orientation and as the Sense of Coherence (2022). Salutogenesis has been used in health promotion research and practice since 1979 and 1987; this is when Aaron Antonovsky's books were first published. The theory (or orientation) focuses on the origins and creation of health and components of good health and wellness, as opposed to the development of disease and factors contributing to ill health (Mittelmark and Bauer, 2022; Mjøsund, 2021).

Antonovsky's views were found to be related to Daoism (Sun & Zuo, 2024). The contemporary practice of Daoism (Taoism) that had its rise in ancient China, results from the concept of the Dao (the way; path) which is believed to be the fundamental principle of the existence. It promotes holistic views and focuses on positive aspects of reality (Sun & Zuo, 2024). The philosophy treats inner freedom from suffering as a form of psychological hygiene, being crucial for humans to lead a healthy, fulfilling life (Tang, 2023). Humans should live by pursuing actions which prioritize planning and striving. Daoist philosophy is strongly related to the salutogenic model of health and wellbeing (Antonovsky, 1996), positive psychology (Seligman, 1998), Frankl's logotherapy (1971), and to Csikszentmihalyi's (1991) concept of flow as psychology of optimal experience.

Application of pragmatic philosophy can be helpful in the educational process, especially in experiential learning. Pragmatism holds that people have the potential to shape their views by the power of their intelligence and that human thoughts are intrinsically linked to action (Kaushik & Walsh, 2019). "A major underpinning of pragmatist epistemology is that knowledge is always based on experience" (Kaushik & Walsh, 2019, p. 4). Pragmatism accepts that single and/or multiple realities are open to empirical inquiry (Creswell & Plano Clark, 2011) yet, at the same time, pragmatist scholars represent the view that an objective reality exists apart from human experience (Kaushik & Walsh, 2019, p. 3). However, this reality can only be encountered through human experience since it is grounded in the environment (Morgan 2014; Tashakkori and Teddlie 2010). One of the relevant presumptions formulated for the purpose of successful course delivery was built upon the pragmatic belief that it is impossible for two people to have identical experiences as they result from different worldviews and individual, unique perceptions of reality; yet,

since “worldviews can be both individually unique and socially shared” (Morgan, 2014), there will always be various degrees of shared experiences that lead to shared beliefs (Morgan, 2014 in: Kaushik & Walsh, 2019). We found this interesting and applicable to our teaching experience.

YOUNG ADULTS

By their own self-characterization, and as reflected in their performance on standard delay discounting tasks, adolescents are less

oriented to the future than adults (Steinberg et al., 2009). Among other scholars, van Rijn and colleagues (2024) explored youth’s conscious choice to resist impulses and show willingness to delay a greater reward in place of instant gratification; they concluded that those skills develop with age and can be seen as signs of maturity (van Rijn et al., 2024). Steinberg and colleagues claim that this relatively weaker future orientation in adolescents is apparent across several different areas (Steinberg et al., 2009). This weakness includes a self-reported low probability of planning the future and a minimal tendency to anticipate future consequences of their actions before acting (Steinberg et al., 2009). This indicates that adolescents’ preparedness, planning and overall ability to make future-oriented decisions is mainly regulated by their personal values and individual approach to goal attainment (Do et al., 2025).

Over three decades ago, in one of his first publications on this topic, Jeffrey J. Arnett shared his view about most college students indicating that “they considered themselves to be adults in some respects but not in others”, with a low percentage believing “to have reached adulthood” (Arnett, 1997). The most important criteria for marking the transition to adulthood were indicated to be individualistic and intangible criteria, particularly accepting responsibility for the consequences of one’s actions, deciding on beliefs and values independently of parents’ views or other influences, and establishing a relationship with the grown-ups as equally mature adults (Arnett, 1997).

Our course participants were respectfully treated as a unique population of young adults who are highly ambitious but also extremely sensitive and may sometimes struggle to succeed in their transition to adulthood. As educators, we should be aware that, if they report experiencing learning difficulties or prolonged feelings of loneliness and helplessness, this can be caused by their unmet emotional needs, scarcity of mental health resources, and/or by lacking guidance on how to expand their intellectual and emotional potential to live a healthy and happy life.

IDENTIFYING PROBLEMS AND FINDING SOLUTIONS

The 2026 World Happiness Report delivered upsetting news stating that today, in North America and Western Europe, young people are much less happy than they were 15 years ago (<https://www.worldhappiness.report/>). At the same time, the use of social media and screen time by youth have dramatically increased. Studies from around the world provide evidence for an increasing frequency of use of controlled substances (Moran et al., 2015; Tjørmoen et al., 2023). Increases in anxiety, depression, and self-harming behaviors are continuously being reported in today’s youth (Hawton et al., 2012; Twenge, 2019; Mesman et al., 2021; Nearchou, 2022; Adhilah & Setiawati, 2025; Quiroga-Garza et al., 2025). Suicidal ideation is not a single occurrence; it has been reported in high numbers in college student population (Drum et al., 2009; Ong & Thompson, 2019; Mamun et al., 2021). University students are experiencing great psychological distress resulting from personal and environmental challenges. Uncertainty and learned helplessness negatively impact academic motivation and can lead to depression, suicidal ideation, and other mental health problems. A global cross-sectional survey conducted by Varma et al. (2021) showed that youth became even more susceptible to stress, anxiety, and depression amidst the recent COVID-19 pandemic.

Multiple studies focus on developing successful coping strategies to manage stressors that cannot be avoided (de la Fuente et al., 2015, 2017). Stress responses and coping strategies are understood as attitudes, approaches and behaviors developed by a person to overcome the adversity; they are contextual and can be modified depending on the situation (Piemontesi et al., 2012; Lazarus and Folkman, 1984; Folkman and Moskowitz, 2004). It seems imperative to introduce effective coping strategies and explain how to improve stress response so that students can successfully adapt to environmental challenges and demands. Studies show that self-control and resilience developed at an early age can predict good physical and mental health in later adulthood (Laird, 2019).

BRAIN-BASED TEACHING

The brain-based teaching model that serves the transformation of learning paradigm in tertiary education is the focus of many recent publications. Science informs that principles of neuroplasticity can be applied in designing and delivering successful strategies to activate the brain’s power and decrease anxiety, improve adaptability and

perseverance; neurocognitive training has been shown to lead to functional changes in the brain, initiating behavioral and cognitive improvement (Herold, 2019). Sesmiarni (2015) suggests that such model addresses the five needs of the human brain: the need for a sense of comfort (security), the need for human interaction, the desire for knowledge and wisdom, the need for active involvement and finally, the need for self-reflection. All these needs are connected and met when the instructor is willing to adapt the basic features of emotional and social learning and provides an ongoing feedback on students' progress. The learning model promoted by Sesmiarni strongly emphasizes the role of emotions in the learning process as a factor stimulating students' thinking. He quotes Sprenger (2011) who claims that in achieving effectiveness of the teaching/learning process, teacher's compassion is the key component; here we detect an association with the phenomenon of psychotherapeutic alliance (Ardito & Rabellino, 2011). In Sesmiarni's (2015) paper we also find reference to the work of Eric Jensen (2008, 2009), a renowned scholar devoted to neuroscience and education. In his book *Super Teaching: Over 1000 Practical Strategies* (2009), Jensen presents a large variety of instructions for teachers and instructors interested in students' personal and academic success. His professional advice on how to design effective teaching strategies based on neuroscience is invaluable. Jensen also supports the idea of emotional learning as having the greatest impact on students. It is well known that intense emotions during the learning process activate long-term memory encoding (Tully & Bolshakov, 2010). Emotions excite the brain's chemical system, and the released noradrenaline (norepinephrine) enables enhancement of memory through the mechanism of synaptic plasticity (Tully & Bolshakov, 2010).

Development of an effective and novel mental health intervention with the application of innovative teaching methods became our educational goal. As the four core elements of our training served cognitive, clinical, environmental, and translational neuroscience. Cognitive neuroscience had the focus on the neural mechanisms underlying mental processes like memory, attention, perception, and decision-making. By the application of clinical neuroscience students explored the pathophysiology of neurological and psychiatric disorders and suggested improvement of diagnostic criteria and patient care. By exploring the field of environmental neuroscience, we investigated how social surroundings shape brain development, enhance or impair neuroplasticity, and impact human physical and mental health over a lifespan. Translational neuroscience was highly visible in our course design, curriculum and all formative and summative assignments. Students had the opportunity to gain the experience in applied health science and see how knowledge translation serves real people in their everyday lives.

BUILDING RESILIENCE

The COVID-19 pandemic affected individuals and changed lifestyles in ways many people never thought they were possible to experience. In a matter of weeks, so many aspects of students' daily routines were altered, having a negative impact on their mental health and overall wellbeing. There were several reasons why life suddenly became unpredictable. As course participants reported, it felt natural to live in fear with the pessimistic predictions of what may happen next; first and foremost, there was a constant fear that their loved ones could pass away. Also, witnessing widespread suffering and repeated setbacks evoked deep emotional distress, experienced as helplessness, hopelessness, emotional exhaustion, or vicarious trauma. In the time when the world felt heavy with hardship, these reactions reflected a natural empathetic response to pain.

Students also experienced a huge shift in academic motivation, resulting from the restrictions, boredom and forced adaptation to the unexpected new lifestyle. They had to live at home with other family members who may have lost jobs thus steady income, or who got ill and became depressed. This took huge toll on adolescents: by shifting priorities, being socially isolated and developing insecurities, phobias, and anxieties, they may have felt that days were very repetitive and monotone; stress and unaddressed fatigue and overwhelming sadness were causing a deep emotional pain; their previously clear vision for a bright future was slowly fading away.

Therefore, we focused on building resilience in our course participants. This is an important factor in improving mental health. Resilience is modifiable and can be developed and increased; its enhancement corresponds with higher levels of cognitive performance (Connor & Davidson, 2003). Thus, we hypothesized that during this educational training students will also develop sense of agency (Kush & Cochran, 1993), boost their self-control and self-discipline (Bonanno, 2001), increase motivation (Van Etten et al., 2008), and improve their executive function (Ruuskanen et al., 2018). Our hypothesis was built on scientific evidence that individuals can transform their lives through goal-oriented learning that generates positive changes in the brain (Buzsaki, 2019). Neuroimaging studies expose multiple facets of plasticity, visible as structural changes induced by environment, learning, behavior, and

emotions (Månsson et al., 2016). The brain's physiological ability to create new neural pathways and synapses, form and strengthen dendritic connections, and produce beneficial morphological changes occurs subconsciously and results in regulating behavior (Kolb, 1995). Unfortunately, in some cases, negative neuroplasticity understood as brain atrophy (impaired neuron connection that may lead to dementia and Alzheimer's Disease if left unaddressed), may already be in action, caused by students' unhealthy lifestyles (poor sleep habits, poor nutrition, substance abuse, etc.), mental distress and life adversity. However, the great news is that this can be reversed through contextual teaching and learning (Johnson, 2002). The secret? The student should find and show the inner desire to acquire novel subject knowledge: "Neuroscience confirms the brain's need to find meaning" (Johnson, 2002, p. 4). Students' personal interest in the exploration of new material that can be linked to the existing knowledge increases attention and creates intrinsic motivation. The whole process translates into the physiology of the brain which creates new neuronal connections and pathways during learners' true engagement and scientific excitement (Diamond & Hopson, 1999).

DISCUSSION

Our extensive teaching experience in several countries in Europe and North America inspired us to propose neuropsychological training that would go beyond the traditional curriculum and would be grounded in experiential learning. In neuropsychological treatment, the patient's/client's intrinsic motivation and active collaboration with the therapist/coach/trainer is required for positive neuroplasticity to occur. In school and university settings, the instructor takes on the leadership role together with the responsibility for the outcome. Research demonstrates that thoroughly designed teaching tools and strategies proven as successful, help the students question their preconceptions and motivate them to learn, by putting them into a situation in which they come to see themselves as the authors of answers and the agents taking the responsibility for change (Shirani-Bidabadi et al., 2016). Thus, we approached this research project with a belief that teaching style is not irrelevant to the learning outcome, and particularly, to the development of the 'growth mindsets' (Dweck, 2007; Dweck, 2014). Indeed, it proved to be highly applicable to undergraduates who enrolled in our course with great hopes to learn how to overcome pain and suffering endured during the COVID-19 pandemic. This one-term neurocognitive intervention that we designed was offered as regular undergraduate course to students potentially experiencing emotional problems or wanting to help others. It provided insight into neuroscience, demonstrating that the structure and function of the brain are in a continual state of flux which prevails thorough life and depends on learning experience (Darling-Hammond, 2020). We created a knowledge-rich curriculum that offered instruction and training on how to build coping skills, capacity, and resilience, which can be measured with the application of established and successful pedagogical instruments. The findings from this pilot study provide evidence for the impact of the course content and interactive teaching techniques on improving students' mental health and their outlooks on life. In those painful times of COVID, surrounded by the unknown, our students were able to distance themselves from the environmental burden; as the course progressed, they shared the experience of feeling greatly empowered by taking charge of their learning, sharing their voices, and contributing to science.

This project emerged from our tacit knowledge and from our decades-long observation of university students' behavior and performance. We had encountered some serious situations in various educational contexts where childhood traumas and other painful experiences led to unresolved emotional issues and other factors that hindered students' academic efforts. Psychological distress that some students endure, lacking direction and being unaware of successful coping strategies, might be multifaceted and multidimensional; mostly affected seem to be freshmen/first-year undergraduates. Untreated mental illness may be a rare event among university students; however, the occurrence of poor mental health is quite common in this population (Pedrelli et al., 2015). Despite a "vibrant and ever-changing depression research" (Beck & Alford, 2009), depression is increasingly becoming the leading cause of suffering worldwide; it carries the heaviest burden of disability among mental and behavioral disorders (Patten et al., 2016; Rush & Koegl, 2008; Lim et al., 2008). It has become common to regard this medical condition as a "primary mood disorder" or as an 'affective disorder' due to its striking features signaling the illness; however, there are many symptoms of depression other than mood deviation (Beck & Alford, 2009). Like other diseases, depression comes in different forms and has an episodic pattern which might be difficult to detect. The research claims that "in a significant proportion of the cases, no mood abnormality at all is elicited from the individual" (Beck & Alford, 2009). This is, for example, visible in the high-functioning depression (HFD) where symptoms like fatigue, lack of concentration, anhedonia, feelings of guilt, insomnia, and loss of appetite occur

without clinical correlates of depression (Joseph et al., 2025). For example, a deep, long-lasting sadness, or anxieties and fears reported by students are the characteristic moods and symptoms that should raise concerns, along with disclosed feelings of hopelessness, overwhelming pessimism, guilt, and worthlessness. Many young adults suffer from a sudden or gradual loss of interest in hobbies, persistent fatigue, difficulty concentrating, remembering, or making decisions. What is even more concerning, university students tend to ignore changes in their sleep pattern and appetite, or occurrence of somatic pain, persistent body aches and headaches, and overall psycho-physical discomfort until those symptoms get out of control (Wrobel, 2007). Major depressive disorder known for its severity can interfere with the ability to work, study, and to enjoy once pleasurable activities (anhedonia) and lead to suicidal ideation. Dysthymia is a chronic but less severe and less disabling form of depression, but it is also a condition which makes it difficult to enjoy life, function well, or feel good over the long-term. Individuals with dysthymic disorder may also experience major depressive episodes at some time in their life (Wrobel, 2007). It is very important to learn how to recognize those signs and how to approach an individual who may need help.

In their recent systematic review, Barnett and colleagues extensively examined the phenomenon of compromised mental health in

the population of university students with the focus on aspects and conditions of help-seeking and willingness to disclosure suicidal ideation and self-harming behavior (Barnett et al., 2026). In our course, we provided training by simulating real-life occurrences and asking participants to act as both, a) individuals who needed medical assistance and emotional support and b) medical professionals and other concerned individuals (i.e., faculty and campus staff members; classmates, etc.) who rush to provide immediate help. Course participants learned how to react if someone they already know or who they meet in new social situations demonstrates emotional distress or behavioral changes leading to erratic behavior. They were also trained in how to get alerted to own emotional discomfort and recurring worrisome thoughts; and, in case those symptoms become prolonged and severe, how to reach out for help by approaching people who may provide immediate and effective support. Our students acquired extensive knowledge on mental health stigma and how it may stop people, especially young adults, from seeking help with mental health issues.

The discoveries about the great impact of conscious learning (Blackwell et al., 2006) and the theory of growth mindset (Dweck, 2007; Dweck, 2014) are of the greatest importance to this project. Research informs that making students aware of the great impact learning makes on their brains, increases motivation and focus, and leads to a higher academic achievement (Dweck, 2007). Blackwell and colleagues explored the role of implicit theories of intelligence in adolescents' academic achievement. They concluded that "both morale and grade points took a leap when students understood the idea that intelligence is malleable" (Blackwell et al., 2007).

The effectiveness of the growth mindset pedagogy (Dweck, 2007) demonstrated by Rissanen and colleagues (2019) is visible through

the focused learning approach, mastery orientation, persistence, and individualized student support (Rissanen et al., 2019). Goal-oriented and interactive teaching methodology should include elements of intensive practice and hands-on experience when possible. "Repeating an activity, retrieving a memory, and reviewing material in a variety of ways helps build thicker, stronger, more hard-wired connections in the brain" (Blackwell et al., 2007). Two components should be considered by teachers/instructors as fundamental in this process: putting new information in context and letting the students know how the brain works when they embark on a journey of learning.

The concept of motivational learning is supported by Willis (2008) who claims that the learning environment plays a role and students' comfort level can influence information transmission and storage in the brain. When students are truly engaged and motivated, feeling only a minimal, positive stress, information flows freely through the affective filter in the amygdala; they achieve higher levels of cognition, can make associations, and get the experience of the eureka effect, felt as those "aha" moments of satisfaction (Willis, 2008). Such learning effectiveness results from the "atmosphere of exuberant discovery" (Kohn, 2004). By making the classroom friendly to malleable brains, the instructor is inviting a creation of the 'growth mindset' (Dweck, 2007; Dweck, 2014) and increased intrinsic motivation (Limeri et al., 2020; Rhew et al., 2018; Ng, 2018). Limeri and colleagues find that "the extent to which students view their intelligence as improvable (i.e., their "mindset") influences students' thoughts, behaviors, and ultimately their academic success" (Limeri et al., 2020). Willis notes, that especially "for students who believe they are 'not smart,' the realization that they can literally change their brains through study and review" is very empowering (Willis, 2008).

CONCLUSION

This type of course curriculum implements the experiential learning cycle using a four-stage framework based on David Kolb's model where students meet educational goals by intensifying their efforts in the process of knowledge acquisition leading. This occurs by making the scientific theories applicable to the learning context and reflecting on the action, trying new approaches in real-world scenarios. Those real-world scenarios were in our case major course assignments where students worked in small groups with randomly assigned peers. As future medical professionals they were confronted with various case studies introduced by the instructor. Their role was to design and perform a simulation of a real-life patient-physician interaction that involved report of symptoms indicating ill health, diagnosis and recommendation of treatment. All cases revolved around mental health issues, brain injury and somatic pain. Conclusions were drawn by indicating the probability of full or partial recovery in patients in each case and supporting it with scientific findings. We found that this learning approach can be viewed as an example of knowledge translation - students were motivated to learn how to make connections between neuroscientific laboratory discoveries and real-world clinical applications proposed as public health solutions.

Application of principles of neuroplasticity works best when the training relies on core elements such as knowledge acquisition (scientifically documented concepts and facts), development of skills (practical application of theoretical knowledge), experience (hands-on practice), and positive attitude (mindset and engagement). Together, these fundamentals form an experiential learning journey that transforms classroom into an authentic performance space. The cognitive framework is created by participants full attention, active engagement, and ongoing instructor's feedback which make the consolidation of acquired knowledge easy and natural. These pillars ensure learners do not just absorb facts but gradually change their actual work habits and improve overall performance. And this can be described as neuroplasticity in action.

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