Neuroscience-Inspired, Behavioral Change Program for University Students

James J. Hudziak, MD[a,*], Gesa L. Tiemeier, MD/PhD Program[b]

KEYWORDS

• Health promotion • Behavioral change • Transitional age brain development
• Critical period • Developmental mismatch

KEY POINTS

- Transitional age youth (TAY) with their associated transitional age brains (TAB) are at high risk for negative health outcomes, high rates of psychiatric illness, suicide attempts, and morbidity and mortality.
- In the context of the TAB, the high-risk living environments sometimes found in college combined with little or no external regulatory support are associated in some cases with profoundly negative statistics on alcohol and drug use, emotional behavioral health, and perhaps low 6-year graduation rates.
- These statistics led to the design, development, and implementation of a neuroscience-inspired, incentivized behavioral change program at the University of Vermont called the Wellness Environment (WE).
- WE argues that the prescription of an incentive-based, behavioral change, contingency management program with brain-building activities simply makes good scientific, programmatic, and financial sense for colleges and universities as they attempt to support TAY to graduation.

TRANSITIONAL AGE BRAIN GOES TO COLLEGE: WHY THIS IS A PERFECT STORM

In this issue, Chung and Hudziak describe the process of neurodevelopment during the transitional age brain (TAB) epoch and summarize the argument that because of the neurodevelopmental mismatch of different parts of the brain, TAY are at high risk for engaging in behaviors that can lead to negative outcomes, morbidity, and mortality. As conveyed in the article by Winston W. Chung and James J. Hudziak,

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[a] University of Vermont College of Medicine and Medical Center, FAHC-UHC Campus, Box 364SJ3, Room 3213 St. Joseph, Burlington, VT 05401-3456, USA; [b] Leiden University Medical Center, Albinusdreef 2, Leiden, 2333 ZA, The Netherlands
* Corresponding author.
E-mail address: james.hudziak@uvm.edu

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"The Transitional Age Brain: The Best of Times and the Worst of Times," in this issue, the central hypothesis is that the TAB has fully matured risk-taking hardware (because of early maturation of subcortical brain regions amygdalae, nucleus accumbens, and so forth) but not yet matured regulatory hardware (prefrontal cortical regions). The early years (13–17) of the TAB epoch occur within the context of external structure provided by parents, other family members as well as educational institutions and other social structures. Thus, some of the high-risk behavior of early TAY is moderated by parental rules and expectations. These external controls and expectations do not completely negate the risk for morbidity and mortality associated with suicide, substance use and misuse, psychiatric illness, and accidents in TAY.

In almost every measurable domain, adolescence is a developmental period of strength and resilience. The aim of this article is to draw added attention to the special case of why the student with a TAB at college represents a perfect storm; novelty, risk, stress, pressure, substance use and substance abuse are present at the same time the external regulatory system (parents and others) has been removed. The authors focus on the potential outcome when there is an intersection between the high rates and easy access to alcohol and drugs, high-risk social and living environments, and the lack of supervision and regulatory support at a critical period of neurodevelopment in which the regulatory regions of the brain are going through the critical process of maturation (pruning). The authors end by presenting one possible model solution to this critical problem: the prescription of a neuroscience-inspired, incentivized behavioral change program developed at the University of Vermont (UVM).

TRANSITIONAL AGE BRAIN GOES TO COLLEGE: THE FACTS

The TAB, and the resultant thoughts, actions, and behaviors of the TAY, represents one key to understanding the causal relations to the spike in morbidity and mortality in this age group. Where is the evidence? Recent evidence of the rates and consequences of high-risk alcohol and drug use, accidents, and psychiatric illness is presented in the context of the TAB.

About 1 in 4 college students report academic consequences from drinking, including missing class, falling behind in class, doing poorly on examinations or papers, and receiving lower grades overall. Furthermore, about 20% of college students meet the criteria for an alcohol use disorder (AUD). Drinking often causes inappropriate or impulsive behavior among college students. Approximately 900,000 students are injured simply because of being intoxicated. About 696,000 students between the ages of 18 and 24 are assaulted by another student who has been drinking. About 97,000 students between the ages of 18 and 24 report experiencing alcohol-related sexual assault or date rape.[1] A full 28.5% of female students reported having experienced an attempted or completed sexual assault either before or since entering college.[2] As mentioned earlier, suicide and depression are strongly emerging in adolescence.

Suicide is the second-leading cause of death among 20 to 24 year olds, and 1 in 12 US college students makes a suicide plan. More teenagers and young adults die from suicide than from all medical illnesses combined. This period is also notable for the high rates of accidents and health problems related to risky sexual behaviors.[3] In addition, adolescence is the peak time of emergence for several types of mental illnesses, including anxiety disorders, bipolar disorder, depression, eating disorders, psychosis, and substance abuse. As reported in the National Comorbidity Survey

Replication Study by Kessler and colleagues,[4] 50% of most mental illnesses people experience emerge by age 14 and 75% start by age 24.[5,6]

Addiction is seen as a developmental disease, starting in adolescence and young adulthood. In fact, addiction is perhaps best conceptualized as epiphenomena of the environment's effect on the TAB. Eighteen to 25 year olds have the highest past month and past year use percentages of *all* substances, except inhalants. Exposure to drugs during pruning leads to heightened susceptibility to abuse and dependence disorders. Several population- and clinical-based studies have documented that drug use during youth contributes to an elevated risk for developing a substance use disorder. The risk of cannabis dependence is the highest in the early to late adolescent age groups (age 12–18 –year old), with the highest rate at around the 14- to 15-year-old range. For teenagers with cannabis onset, the risk of dependence is 4 to 7 times higher than the estimated risk to recent cannabis onset users aged 22 to 26. The risk of AUD with alcohol onset in teenage years is twice the risk compared with recent alcohol onset users aged 22 to 26.[1,7] The older youth who delays drug use for the first time when the brain is more mature may be more resilient to neurobiological processes that contribute to abuse and dependence.[8]

Neuropsychological studies of adults with AUD have consistently revealed visuospatial, executive functioning, psychomotor, and memory impairments. Greater cumulative lifetime alcohol experiences predicted poorer attention.[9] One brain structure that has consistently demonstrated sensitivity to alcohol-related neurotoxicity is the hippocampus—a structure crucial to intact learning and memory formation.

TAB with AUD have reduced left hippocampal volume compared with nonabusing controls.[7] Furthermore, drinking heavily during adolescence showed significantly diminished frontal and parietal functional MRI (fMRI) response as well as less accurate performance during a spatial working memory task relative to demographically similar controls. The toll of reduced hippocampal volume and poor performance on working memory tasks suggests that heavy alcohol involvement during college is associated with cognitive deficits that may worsen as heavy drinking continues.[9]

3,4-Methylenedioxymethamphetamine (MDMA) damages central serotonergic nerve fibers in human primates after 2 weeks of use and significant damage of neurons 7 years later without ongoing use of MDMA. This lack of serotonin activity may lead to depression, anxiety, and movement abnormalities. In addition, MDMA has been shown to produce pathologic changes in nerve cell bodies in the dorsal raphe nucleus, which can cause sleep problems.[10]

In summary, the TAB is exquisitely sensitive to the effects of alcohol and drugs. The vicious cycle that results from a brain that is primed to make impulsive, risk-taking, pleasure-seeking decisions contributes to the potential for highly dangerous alcohol and drug use, increased academic problems, sleep problems, and higher rates of common psychiatric symptoms and suicide. All of these in turn (both directly and indirectly) negatively affect neurodevelopment, during the highly critical period of pruning/cortical organization, of the key regulatory regions of the brain.

WHAT IS THE COST OF IGNORING THE UNIQUE PROBLEMS OF THE TRANSITIONAL AGE BRAIN AT COLLEGE?

Few businesses could survive with the statistics surrounding success rates at US colleges. The US Department of Education in their 2016 report[11] reveals that the "6-year graduation rate for first-time, full-time undergraduate students who began their pursuit of a bachelor's degree at a 4-year degree-granting institution in fall 2008 varied according to institutional selectivity," ranging from 36% to 89% with an overall rate of

60%. “That is, 60 percent of first-time, full-time students who began seeking a bachelor’s degree at a 4-year institution in fall 2008 completed the degree at that institution by 2014.” Although it is clear that there are many contributing factors to these data, such as pre-existing emotional behavioral problems, lack of preparation for the college life, socioeconomic obstacles to completing college, and individual differences in resiliency, the data point to the fact that completing a college education is not an easy task.

Although there is no literature on the direct correlation between the dynamic problems of the developmental mismatch of the TAB, with high-risk AUD behaviors and failure to graduate, what is clear is that increased understanding of neurobiology introduces the potential to make a great deal of progress in assisting high-risk students with TABs to safely achieve their goal of a college degree.

WHY UNIVERSITY OF VERMONT WELLNESS ENVIRONMENT?

Taken together, the high-risk epoch of TAB development, the high risk of living in a college environment with limited external regulatory support, the profoundly negative statistics on alcohol, drug, and emotional behavioral health plus the low 6-year graduation rates are concerning. In response, the authors designed, developed, implemented, and tested a neuroscience-inspired, incentivized behavioral change program at the UVM called the Wellness Environment (WE).

UVM WE was designed and developed by one of the authors (J.H.), a child and adolescent psychiatrist, in order to test whether health promotion and illness prevention strategies could be implemented in college settings. The goal was relatively straightforward: design a model college experience based on what is known about TAB development, the negative impact of high-risk behaviors in a high-risk environment (eg, free of parental supervision and guidance), and emerging behavioral change and neuroimaging research. WE is based on the hypothesis that such a program would result in more positive choices regarding health-promoting activities in a university setting. The overarching hypothesis is that TAB students would respond to health-promoting, brain-building activities through lifestyle changes if they were presented in an incentive-based framework.

UVM WE is an incentive-based behavioral change program aimed at developing healthy brains and healthy bodies in a college setting. Students who live in WE residential halls receive incentivized exercise, mindfulness, yoga, nutrition, hydration, mentoring, and community opportunities. They receive all of these free of charge with only one requirement: no alcohol or drugs are allowed in the environment. Students are admitted on a first-come, first-serve basis. Over the first 2 years, the authors have tracked bias pathways and can report that although many of the students who live in WE have come to college without pre-existing alcohol and drug problems and are attracted to the health promotion aspects and the WE code, others have specifically signed up to live in WE because they have pre-existing struggles with alcohol, drugs, and emotional or behavioral problems.

The authors have argued that in the same way daily exercise, working out in the gym, or lifting weights could lead to achieving the goal of building a healthy body, it is now evident that a series of brain-building activities is emerging in the literature that provide evidence that TAY (in fact, all ages) could engage in brain-building activities. From behavioral change research comes the second foundation of WE. Incentive-based behavioral change is at the heart of all health care, and college life is no different. The WE design is based on the argument that moving students with

TABs, from high-risk damaging behaviors into health-promoting brain-building behaviors, would require incentivization.

Based on this template, Hudziak proposed the UVM WE to university leaders (President, Provost, Vice Provost of Student Affairs, Director of Student Health, Residential Life, Admissions, and many other key stakeholders), who unanimously approved an implementation project. The design included a model system based on the creation of a course, *Healthy Brains, Healthy Bodies: Surviving and Thriving in College*, in which students would be taught the impact of specific behaviors on genomic and brain health in a nonjudgmental context. The second feature of UVM WE was a proposed residential community based on 4 pillars of brain-building wellness activities, in which students are incentivized to exercise daily with personal trainers, engage in mindfulness and yoga with certified instructors, and participate in healthy dietary practices with a nutrition coach inspired by recent advances in gut-brain neuroscience.[12] Last, a mentoring program was built (wementor.org) to encourage participating students, TAY, to engage in mentoring programs aimed at advancing personal wellness through teaching younger less fortunate youth. All of these activities would be (and have been) incentivized (and are free of additional cost). A key feature of UVM WE is faculty engagement through coursework, in residence halls and campus-wide programming. Students who live in WE are required to sign a contract that indicates they understand if they have alcohol or drugs, or are grossly intoxicated in the WE, they will be removed from the program (and live elsewhere on campus). UVM leadership enthusiastically accepted the proposal. A leadership team was developed; necessary additional personnel were hired, and UVM WE opened during the 2015 to 2016 school year with 120 students. The program grew to 480 students for the 2016 to 2017 academic year, including new students and returning students, and is anticipated to house 1200 students in the 2017 to 2018 year.

Although very preliminary, as WE has only completed one pilot year, there is emerging evidence that the program has achieved its central goals, having students engaged in brain-building activities, understanding the implications of decisions on their brain health, and creating and maintaining communities with lower rates of AUD problems. Universities and colleges around the country are currently working on designing similar programs. Hudziak has also been awarded a grant from the Conrad Hilton Foundation to assist him in the development of the UVM WE App, an iOS-based health promotion, illness prevention App built on the goals and pillars of the WE program. In addition, UVM WE has drawn the attention of national print and news outlets as well as in local media stories. Each of these news stories as well as a detailed representation of UVM WE, the App, and plans for the future of WE can be viewed at: https://www.uvm.edu/we.

What follows is a primer on Behavioral Change science and the importance of contingency management (CM) to the TAB. The authors then present the neuroscience evidence for several brain-building activities that are incentivized in the WE program.

WHAT CAN BE DONE? BEHAVIORAL CHANGE GOES TO COLLEGE

It has been argued elsewhere[11] that all health emerges from emotional behavioral health. Why an individual decides to drink alcohol, use drugs, assault another, or commit acts of self-harm is an emotional behavioral decision. In the same way, why an individual chooses not to engage in the above but rather pursues healthy, brain-building activities such as daily fitness, meditation, yoga, music, mentoring, or healthy dietary choices is also a brain-based emotional moment. Similarly, the authors have published elsewhere that health care reform is simply the business of behavioral change,[13] moving an individual from engagement in unhealthy behavioral decisions to healthy ones. The science of behavioral change is perfectly positioned to help TAY negotiate the high-risk neurodevelopmental and environmental task of going to college.

UNDERSTANDING BEHAVIORAL CHANGE SCIENCE

Behavior change refers to a modification of human behavior or a change in public health approaches, which "focus on the individual, community, and environmental influences on behavior." Behavioral change models have been successfully applied as a way to better understand, and treat, addictive disorders such as smoking, and later, alcohol abuse.[14] Over the past 4 decades, the model has been applied to a wide range of health behaviors ranging from substance abuse to overeating and physical inactivity with the goal to help health professionals to design, implement, and evaluate health-promoting interventions.[15] The concept of applying behavior change models as a way to promote healthy brain development during the TAB epoch in college settings is the core of the approach at the UVM WE program.

Incentivized-Based Behavior Change (Contingency Management)

In order to most effectively apply behavioral change models in a college environment, the authors have added the science of CM. CM is most widely used in the field of substance-related disorders and refers to the application of a contingency to influence behavior change. Incentive-based behavior change can simply be understood as paying for behavior change. The payment might come in the form of a valuable re-enforcer (money, privileges, prizes) that a participant ultimately finds more rewarding than the drug or alcohol use. A large body of literature supports the use of CM for health-promoting behavior with participants given rewards for not engaging in negative or high-risk behaviors.[16]

BRAIN-BUILDING ROUTINES/HABITS

Using the methods and strategies of incentive-based behavioral change with CM has shown great value in the treatment of substance-related and addictive disorders. In the UVM WE program, the authors have "teetered the totter" and argued that one can incentivize positive health-promoting brain-building behavior for TABs at a time when TAY need it most. In the service of that goal, the authors present in later discussion some of the neuroscience evidence for 4 of the brain-building activities that are incentivized in the WE program.

PRACTICE MINDFULNESS, BUILD YOUR COLLEGE BRAIN

Mindfulness, as described by Dr Jon Kabat-Zinn,[17] "cultivates present moment awareness" and "involves attending to relevant aspects of experience in a nonjudgmental manner."

Mindfulness meditation, by paying full attention to present-moment experience, results in "disengaging oneself from strong attachment to beliefs, thoughts, or emotions, thereby developing a greater sense of emotional balance and well-being."

Research shows that with mindfulness treatment there are significant reductions in mood disturbance (65%) and symptoms of stress (31%).[18] An 8-week mindfulness program resulted in significant reductions in anxiety and depression scores after treatment according to both self-report and interviewer report.[19] Furthermore, there is some evidence that meditation may also influence recovery from or prevention of disease. A Chinese study showed that after mindfulness intervention students had lower salivary cortisol and higher salivary immunoglobulin A concentration in response to psychological stress compared with control students.[20]

Finally, mindfulness practice has a profound effect on brain function. Neuroimaging studies using fMRI found that mindfulness meditation was associated with activation in attention and emotion-regulating areas, such as prefrontal cortex and anterior cingulate cortex (ACC),[21] whereas the amygdala, an important region for emotion modulation and amplification, showed decreased activation.[22,23]

Mindful individuals are shown to have smaller right amygdala volumes, associated with reduced stress reactivity and lower negative affect in daily life. The amygdala has been shown to contribute significantly to mental and emotional health, with abnormal amygdala function identified in depression, anxiety, posttraumatic stress disorder, phobias, and panic disorders.[24] Moreover, mindful individuals have been shown to have smaller left and right caudate volumes, which are involved in processing negative affect and the neural response to sadness.[25] Mindfulness increases gray matter volume, similar to treatment with selective serotonin reuptake inhibitors, gray matter concentration within the left hippocampus, which also plays a crucial role in the regulation of emotion and cognition.[26]

It has been demonstrated that the effects of mindfulness train the brain to decrease the activation of spontaneous self-generated mental activity; that is, the default mode networks, and downregulation of emotional reactivity.[27–29] Activation in the default mode network is observable in streams of thoughts or episodic memories and mental time traveling.[30,31] Furthermore, the default mode network has been related to monitoring the reliability of internal and external information, often a source of worry and anxiety.[32] A goal of meditation is to train the brain to switch from this default mode network of emotions to test the positive network of cognition. The authors determined that this form of meditation can be used as the basis for an effective behavioral program in self-regulation.[19]

Mindfulness and Wellness Environment

With the above in mind, WE students meditate at the beginning and end of all *Healthy Brain, Healthy Body* classes and have specialized mindfulness and yoga instruction in the WE residential halls. WE Mindfulness Based Health Promotion (MBHP) instructors complete a one-credit-hour training selected from MBHP classes, and the WE App has dozens of guided meditations designed for the TAB college student.

TAKE A (DAILY) HIKE: THE IMPORTANCE OF DAILY PHYSICAL ACTIVITY TO TRANSITIONAL AGE BRAINS

Despite mounting evidence for the importance of physical activity, 74% of adults in the United States do not meet the recommended guideline of at least 30 minutes of moderate-intensity physical activity most days of the week.[33] The economic cost of this sedentary lifestyle is enormous, with estimates indicating that inactivity was associated with $76 billion in medical costs in the year 2000.[34]

Physical activity is not exclusively beneficial for physical health; research has shown profound effects of exercise on mental and emotional health. Animal research has shown that chronic exercise results in antidepressant-like effects and can reduce anxiety-related behavior, similar to responses of antidepressant drug–treated animals.[35]

In human research, exercisers are on average more satisfied with their lives and happier than nonexercisers, demonstrating less anxiety and depression.[36] Cross-sectional research has indicated that reduced levels of exercise are associated with depression among young adults.[37]

A recent meta-analysis determined a positive relation between physical activity and cognitive performance in school-aged children (aged 4–18 years). Time spent in physical activity programs does not hinder academic performance, and it is hypothesized that it could indeed improve performance.[38] The authors' group has published that TAY who exercised more frequently (4–5 days or 6–7 days) had significantly lower odds of sadness, suicidal ideation, or suicide attempt than students who exercised less frequently. Furthermore, these relationships extended to students who were victims of bullying. In particular, these data demonstrate that being physically active on 4 or more days per week was related to an approximate 23% reduction in the odds of both suicidal ideation and suicide attempt in bullied adolescents.[39]

In a large study of young Dutch children, being active in sports at least once a week was associated with reduced externalizing and internalizing problems.[40] Aerobic fitness training has also been found to induce changes in patterns of functional activation using fMRI. In humans, aerobic fitness training has been correlated with larger volumes of anterior white matter and prefrontal and temporal gray matter[41,42] as well as increased cerebral blood volume in the dentate gyrus of the hippocampus[43] and decreases in activation in the ACC.[44,45] Specifically, children with higher aerobic fitness levels showed less behavioral interference to misleading and irrelevant cues, coupled with a larger dorsal striatum (ie, left caudate nucleus and bilateral putamen).[46–48] In addition, children with higher aerobic fitness levels also have larger hippocampal volumes compared with children with lower-fitness levels. These larger hippocampal volumes were associated with superior relational memory task performance. The results are consistent with animal models that indicate aerobic activity positively impacts hippocampal structure and function.[46–48]

Finally, recent data continue to show a positive relationship between grades and visits to the sports center. Among (https://www.eab.com/daily-briefing/2014/11/13/gym-data-shows-gpa-bump-for-fitness-inclined-students?WT.mc_id=Email%7CDaily+Briefing+Headline%7CDBA%7CDB%7CAug-19-2016%7CArchive%7C%7C%7C%7C&elq_cid=2240438&x_id=003C0000021F87sIAC) all undergraduates of Purdue University, students who visited the gym on average 16 times per month averaged a 3.2 GPA, compared with a 3.1 GPA for nonusers. It is unclear if these data are statistically significant. Among new students in the fall of 2013, students who visited the gym at least 15 times that semester averaged a 3.08 GPA, compared with 2.81 for nonusers.[49] Earlier this year, Michigan State University (MSU) conducted a similar study and found that gym visits correlated not only with higher grades but also with better retention. The group of students with gym memberships had a 3.5% higher 2-year retention rate (a difference of about 1575 students on MSU's campus) and held GPAs that were 0.13 points higher. The study saw 74% sophomore retention compared with 60% for those without gym memberships.

Fitness and Wellness Environment

With the above in mind, WE students are invited to voluntarily complete a fitness evaluation and have access individually to a personalized fitness coach. WE residence halls all have state-of-the-art workout facilities to incentivize daily workouts. In the WE halls, they also have "Fitness on Demand," allowing the students 24/7 access to world class individual and group fitness instructors. Daily fitness is incentivized by earning WE points toward rewards such as WE hoodies, hats, and other positive contingencies. There is also a one-credit WE-Les Mills–accredited Fitness Training laboratory in which graduates are certified to become WE fitness trainers. On the WE App is a fitness pillar that includes instructions and incentives to engage in exercise 7 days a week.

THE GUT-BRAIN AXIS AT COLLEGE: WHY NUTRITION MATTERS

Research on both animal and human models strongly suggests an important role of nutrition and the microbiota in the regulation of the brain and behavior.[12] The microbiota-gut-brain axis represents a bidirectional network of communication between the intestinal microbiota and the brain. The gut microbiota is required for development of the hypothalamic-pituitary-adrenal (HPA) axis, optimal stress responsivity, and social cognition. Dysregulation of the microbiota-gut-brain axis may contribute to the development of psychiatric and gastrointestinal diseases, a link supported by the comorbidity found between anxiety disorders and irritable bowel syndrome[50] as well as the abnormal composition of gut microbiota in patients with autism.[51]

Animal research shows that mice lacking a gut microbiota have enlarged amygdala and hippocampus, without a difference in total brain volume between germ-free (GF) and control mice, ruling out the possibility that these enlargements were due to whole-brain expansion. The absence of a gut microbiota in mice induced dendritic atrophy, with 32% fewer synaptic connections on the hippocampal pyramidal neurons. Changes in amygdala and hippocampal size have also been documented in rodents subjected to stressors. Furthermore, GF mice exhibit exaggerated HPA axis responses to acute stressors and deficits in social cognition.[52] Similar results were found in rats after chronic antibiotic treatment. The depletion of the gut microbiota of rats during adulthood resulted in deficits in spatial memory, increased visceral sensitivity, and a greater display of depressive-like behaviors. In addition to these clear behavioral alterations, the authors found changes in altered central nervous system serotonin concentration along with changes in the messenger RNA levels of corticotrophin-releasing hormone receptor 1 and glucocorticoid receptor.[53]

Nutrition and Wellness Environment: Eat Well, Study Well, Sleep Well, Live Well

With the above in mind, WE partnered with the Nutrition Department at UVM as well as leading gut-brain scientists around the world and developed WE dietary programs. All students are offered one-on-one dietary consultations with master level dietetics graduate students at UVM. In addition, colleagues at UVM Dining provide tours to all WE students to connect their education in healthy nutrition to real-time direction on how and where to get the food they want. Students are incentivized to engage in probiotic education and healthy dietary planning and eating. On the WE app, there is a scanning pillar that allows WE students to design their dietary goals and then scan their dietary choices to track their ability to meet their own goals. In addition, there is a one-credit laboratory in WE Nutrition Training in which graduates become WE Nutrition trainers.

Music and Wellness Environment: play, practice, and regulate

Research has shown that practicing a musical instrument was associated with higher performance on tests of reasoning, processing speed, attentional and working memory networks, as well as mathematics.[54] After 2 years of group music training, the speech-in-noise perception has been shown to improve, resulting in better school performance and attention. Furthermore, music training was associated with a reduction in the word gap of children raised in poverty.[55] The rich overlap between neural systems devoted to language and music is hypothesized to underlie the benefits music training confers on reading and its neural correlates across multiple timescales of auditory processing.[56–58] In addition, musical intervention is shown to reduce pediatric pain, anxiety, and distress and has an especially large effect on cognitive skills and social behavior in autistic children.[59]

Music training has been shown to affect the anatomy of the brain, with greater gray matter volumes observed in motor-related areas,[60–62] auditory discrimination areas, corpus callosum,[62,63] as well as greater white matter volumes in motor tracts.[64] In addition, the behavioral and functionality improvements after music training were correlated with the structural brain changes of the specific areas.[62]

Research with children and adolescents who play musical instruments showed brain changes in motor areas, the corpus callosum, and the right primary auditory region, all areas important for music performance and auditory processing. In addition, unexpected areas increased in volume compared with those of the controls; these included various frontal areas, the left posterior pericingulate, and the left middle occipital region. Music training is associated with the rate of cortical thickness maturation in several brain areas distributed throughout the right premotor and primary cortices, namely the left primary and supplementary motor cortices, bilateral parietal cortices, bilateral orbitofrontal cortices, as well as bilateral parahippocampal gyri.[65]

Thus, music training may accelerate cortical development. Music training leads to greater gains in auditory and motor function when begun in young childhood. Nevertheless, the results establish that music training impacts the auditory system even when it is begun in adolescence, suggesting the possibility that a modest amount of training begun later in life can affect neural function.[56–58]

Music Training and Wellness Environment

In addition to the core education described above, WE students are invited to participate in sponsored music training programs. WE offers violins and violin instruction to students who live in the resident halls. These programs are highly subscribed. In addition, WE students participate in campus-wide activities such as “WE has Talent” in which they are able to perform their musical and singing skills. The WE music program is being further developed with a goal of offering lessons in a variety of instruments.

SUMMARY

TAY with their associated TABs are at high risk for negative health outcomes, high rates of psychiatric illness, suicide attempts, and morbidity and mortality. In the context of the TAB, the high-risk living environments sometimes found in college combined with little or no external regulatory support are associated in some cases with profoundly negative statistics on alcohol and drug use emotional behavioral health, and perhaps low 6-year graduation rates. These statistics led to the design, development, and implementation of a neuroscience-inspired, incentivized behavioral change program at the UVM called the Wellness Environment.

WE argues that the prescription of an incentive-based, behavioral change, CM program with brain-building activities simply makes good scientific, programmatic, and financial sense for colleges and universities as they attempt to support TAY to graduation.

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