Exercising Critical Reflection: Measuring The Relationship Between Brain Derived Neurotrophic Factor And Transformative Learning Experiences

Daniel J. Glisczinski
University of Minnesota Duluth

Abstract

Exercise boosts brain power, according to neuroscience research. And brain power is responsible for constructing increasingly accurate perspectives through critical reflection on disorienting trigger events. This study analyzes the relationship between exercise and transformative learning among undergraduates, as measured by a learning experiences questionnaire informed by emerging insights into education neuroscience. This project synthesizes findings from brain research (Begley, 2008; Doidge, 2007; Dragansky, 2004; Fisher & Heikkinen, 2010; Medina, 2008; Ratey, 2008; Restak, 2007; Siegel, 2010; Sousa, 2010; Zull, 2011) and transformative learning research (Herbers, 1998; King, 1997; Mezirow, 1978; Mezirow, 2000; Mezirow and Taylor, 2009; Taylor, 2000; Taylor, 2011).

Exercising Academic Excellence

Five years ago, I sat captivated as Harvard’s Ratey (2008) told a room full of teachers the story of a wily Midwestern physical educator who leveraged an uncommonly effective source of boosting his students’ brain power.

As Ratey told it, the teacher invited students to meet up before school and run laps around their school’s track. After completing their laps, these students hit the locker room and then carried on with their normal school days. But their teacher, who tracked the academic performance of this daring dozen, discovered that these volunteers showed evidence of academically outperforming their classmates. School data documented that the volunteers’ reading comprehension scores improved at nearly double the value of their peers.

When the teacher’s school district learned of the success of this action research, it decided to offer before-school (or zero-hour) exercise opportunities for all 19,000 of its students. Thereafter, the eighth grade class produced math and science test scores that soared to first in the world in science and sixth in the world in math (compared to their sedentary American peers who scored 19th and 20th respectively in international tests of Science and Mathematics)—as measured by the Trends in International Mathematics and Science Study (TIMSS) exam (Ratey, 2008).

Ratey explained that exercise generated a protein called brain derived neurotrophic factor (BDNF) that he likened to Miracle Grow for exercisers’ brains. And upon hearing this, my own oft-foggy brain concurred that its clearest thinking was generally accomplished during or after exercise—provided that my iPod remained in the off position.

BDNF Fertilizes Front-Brain Function

How does exercise boost brain power? It does so by generating and distributing BDNF from the brain stem to the pre-frontal cortex. BDNF enriches existing neurons and generates new neurons through processes known as neuroplasticity and neurogenesis in the front brain. These enriched and increased neurons then construct more numerous, varied, and robust neuronal pathways by which critical thinking may be initiated and sustained.

Further research indicates that BDNF production is one of many reasons to exercise in support of academic excellence. For example, Begley (2008), Doidge (2007), Dragansky (2004), Fisher & Heikkinen (2010), Medina (2008), Restak (2007), Siegel (2010), Sousa (2011), and Sylwester (2005) concurred that not only does exercise increase BDNF, but it also has been demonstrated to prompt dramatic increases in neurotransmitters such as serotonin—which modulates impulses and directs calm decision making—but exercise also delivers key supplies of
blood and oxygen, which enrich existing neurons, construct new synaptic pathways, and create brand new neurons that Zull (2011) described as the physical embodiment of thought.

**Exercising Critical Reflection?**

When I returned to campus from listening to Ratey at the Mind, Brain and Education conference at Harvard, I put this research in the hands of my educational psychology students. After reading Ratey (2008), Medina (2008), Restak (2007), and related neuroscientific studies, my students and I concluded that exercising for academic excellence seemed like a smart start for rethinking data-driven 21st century pedagogy and andragogy.

Invigorated by collective discovery with my students, the researcher in me entertained a bundle of related research questions. But the one that felt most synergetic was the question of whether exercise-induced BDNF might perhaps promote transformative learning experiences among college students—as demonstrating academic excellence and exploring perspective transformation both required substantial executive function in the brain’s prefrontal cortex.

As a researcher, I was also interested in engaging Taylor’s (2000, 2009) encouragements for researchers to study transformative learning experiences through quantitative research designs. So I reviewed the existing literature on measuring TLEs in light of emerging lessons from education neuroscience research.

**Measuring Perceptions of Critical Reflection**


Mezirow’s encouragement was equal measures of thrilling and invaluable in terms of support to explore new lenses through which to study transformative learning. Furthermore the work of Brookfield, (2000), Herbers (1998), King (1997) Mezirow (1978), Mezirow (2000), Mezirow and Taylor (2009), Taylor (2000) and Taylor (2011) were essential in informing my own better understanding and operationalizing transformative learning experiences into questions and categories for analysis. Thanks to their exhaustive research, I have been able to develop a learning experiences questionnaire into four unifying experiences common among rational analyses of TLEs. The first is the sensory cortex-based trigger event. The second is temporal region-based reflective observation. The third is the prefrontal cortex’s critical analysis—and rational rejection—of assumptions often operating below conscious awareness. The fourth is the motor region’s work of engaging in committed action.

Additionally, Zull’s (2002, 2011) biological, pedagogical, and andragogical analysis of brain function—especially in relationship to Kolb’s (1984) existing learning cycle research have suggested extensive integration between the stages, biochemistry, and sequencing of transformative learning theory’s rational tenets within sensory, reflective, analytical, and motor regions in the brain.

Finally, the education neuroscientific research insights proceeding from the work of Begley (2008), Doidge (2007), Immordino-Yang & Faeth (2010), Medina (2008), Posner (2010), Ratey (2008), Sousa (2010), Sousa (2011), Sylwester (2005), and Willis (2010) have enabled increasingly concrete understanding of the neuroscientific function within and between key brain structures.

The synthesis of these bodies of scholarship have shaped the my current understanding of this learning experiences questionnaire in its present form and function toward measuring transformative learning experiences. Early blueprints of this questionnaire appeared in my own work (Glisczinski, 2011; Glisczinski, 2010).
Asking Questions

The research question that drives this study has two dimensions: what, if anything, happens to college students’ (a) academic performance, and (b) perceptions of transformative learning experience when they increase their weekly minutes of aerobic exercise? This specific article focuses on the question of whether exercising improves people’s experiences with the critically reflective dimensions of perspective transformation.

Measuring Moving Reflection

After receiving permission from my university to study students’ academic and potentially transformative learning experiences, a colleague advised me to invite her students to participate in the study. Twenty one college seniors at my university volunteered to serve as this study’s sample. Each was studying to become a licensed classroom teacher, with a median age of 23 years old.

All participants agreed to do the following three things: (1) record their minutes of exercise each week throughout the six week study through participant pseudonyms in password protected, encrypted, secure exercise tracking software; (2) report their course grade for an assessment course common to all participants at the conclusion of the study; and (3) complete a learning experiences questionnaire at the culmination of week six.

Volunteers were randomly assigned to control and experimental groups, so participants did not have the opportunity to self-select into a control or experimental level of exercise. At the outset of the study, 10 control group members were assigned to carry on with their normal amount of weekly exercise. Eleven experimental group participants were assigned to increase their weekly exercise by 30 minutes three days each week at heart rate zone three.

Figures 1 and 2 share learning experiences questionnaire items that all participants responded to at the conclusion of the study.

Drafting And Revising A Questionnaire

In the figures that follow, learning experience questionnaire items one through four are organized around specific brain regions and what appear to be their associated transformative learning experiences: (1) first, the sensory regions of the human brain appear to receive and manage events that may trigger cognitive dissonance; (2) secondly, the temporal region of the brain appears to interpret sensory stimuli through reflective observation; (3) next, the brain’s prefrontal cortex appears to be the site of critical analysis—and rational rejection—of formerly-tacit assumptions that contribute to erroneous logic; (4) fourth is the motor region’s applied work of experimenting with committed, informed action.
Learning Experiences Questionnaire

1a. As a college student, I found myself questioning and then rejecting some of my former views or attitudes, values, or beliefs
   □ yes (please continue to the next question)
   □ no (please proceed to question 5a)

1b. I trace my awareness of this questioning and rejecting back to (please check all that apply)
   □ coursework
   □ campus life
   □ life beyond campus

1c. As I recall it, I came to question my views as a result of (please check all that apply)
   □ sight(s)
   □ sound(s)
   □ touch(es)
   □ taste(s)
   □ smell(s)
   □ other

1d. An example of one such experience includes (please briefly describe below)
   ____________________________________________________________
   ____________________________________________________________
   ____________________________________________________________
   ____________________________________________________________
   ____________________________________________________________

2a. Upon reflection, I recognize that I responded to this experience by (please check all that apply)
   □ fighting it
   □ taking flight from it
   □ enduring it
   □ engaging it
   □ other (please describe below)
   ____________________________________________________________
   ____________________________________________________________
   ____________________________________________________________

3a. As a result of this experience, I decided to analyze the merits of alternative attitudes, values, or beliefs
   □ yes (please continue to the next question)
   □ no (please proceed to question 5a)

3b. My analysis led me to realize that certain attitudes, values, and beliefs I’d formerly had were inaccurate and in need of revision
   □ yes (please continue to the next question)
   □ no (please proceed to question 5a)

3c. In order to construct more accurate thoughts and perspectives, I dialogue with (please check all that apply)
   □ my own reflective self
   □ more experienced others
   □ similarly experienced others
   □ less experienced others
   □ other (please describe below)
   ____________________________________________________________
   ____________________________________________________________
   ____________________________________________________________

Questions? Please contact dglisert@d.umn.edu. Thanks.
**Learning Experiences Questionnaire**

4a. In addition to more accurate attitudes, values, and beliefs, I began trying to translate these into more informed behaviors or actions

- [x] yes (please continue to the next question)
- [ ] no (please proceed to question 5a)

4b. My more informed behaviors or actions took the form of (please check all that apply)

- [ ] words spoken privately
- [ ] words spoken publicly
- [ ] deeds done in private
- [ ] deeds done in public
- [ ] other

4c. Examples of my more informed actions include (please briefly describe below)

- [ ]
- [ ]
- [ ]
- [ ]

4d. As a college student, I generally tended to involve myself with people and activities that (please check all that apply)

- [ ] affirmed my existing views
- [ ] challenged my existing views
- [ ] avoided such examination of views
- [ ] other (please explain)

5b. My academic major is/was

- [ ]
- [ ]
- [ ]

5c. My academic minor or licensure is/was

- [ ]
- [ ]
- [ ]

5d. I participated in the *Exercising Academic Excellence* study’s

- [ ] control group
- [ ] experimental group

5e. I’m submitting these responses

- [ ] before participating in the study
- [ ] after participating in the study

5f. My study pseudonym is/was

- [ ]
- [ ]
- [ ]

5g. May the researcher contact you to discuss the information you’ve shared?

- [ ] yes; (here is how I prefer to be contacted)
- [ ] no

---

Questions? Please contact dalisci@sl.umn.edu. Thanks.
Findings And Discussion

At the time of this submission, this study was still in progress. Findings and discussion will be forthcoming at the conclusion of the study.

Working Conclusion

Five years ago, I sat captivated as Ratey (2008) told a room full of teachers the story of a wily Midwestern physical educator who leveraged an exercise as an uncommonly effective source of boosting his students’ brain power. Today I look forward to five years from now when we as transformative learning theory researchers have the resources and the expertise to comparatively study—through magnetic resonance imaging or related instrumentation—the similarities and differences between sedentary brains and exercising brains as they respond to dissonant stimuli. I’ll be fascinated to learn more about the relationship between exercising, BDNF, and critical reflection. For now, my best understanding is that TLEs sequentially engage sensory, temporal, prefrontal, and motor region brain work. For now, I’ll continue to study the role that BDNF may have in triggering cognitive dissonance to reach fruition in experiences of perspective transformation.
References


