US-China Education Review B, June 2017, Vol. 7, No. 6, 274-283
doi: 10.17265/2161-6248/2017.06.002

Enhancing Cognition: Historical and Contemporary Debates

A. Scott Henderson
Furman University, Greenville, USA

For over 200 years, philosophers, psychologists, and neuro-scientists have tried to discern the fundamental components and functions of the human brain. Their efforts have often focused on the ways to enhance cognition. During much of the 19th century, pedagogues emphasized the concept of "mental discipline," which conceived of the brain as a muscle that could be strengthened by studying certain subjects. Beginning in the late 20th century, investigators evinced renewed interest in cognition. Their work has been used by educators who stress the pedagogical applications of neuro-scientific findings, and by entrepreneurs who have created an ever-expanding "brain-training" industry that underscores the salience of mental exercises and/or games. A comparison of mental discipline and modern brain training initiatives indicates that each approach assumes that specific types of cognitive transfer can occur. Nevertheless, neither approach substantiates this hypothesized benefit. Moreover, the two approaches reveal how shifting scientific frameworks can be utilized not only by researchers to advance knowledge, but also by others to promote dubious and/or specious claims.

Keywords: mental discipline, brain training, cognition, neuro-science

Introduction

On January 4, 2016, the United States (U.S.) Federal Trade Commission (FTC) (2016) determined that Lumos Labs was guilty of deceptive advertising. Lumos Labs are the creators and marketers of the popular suite of software products known as Luminosity. Specifically, the FTC ruled that there was insufficient scientific evidence to support claims that use of Luminosity software would improve everyday tasks, delay age-related cognitive decline, and reduce cognitive impairment associated with health conditions. The U.S. District Court for the Northern District of California administered final judgment on behalf of the FTC by imposing a $2 million fine against Lumos Labs.

Claims that specific mental activities can improve cognition are not new. During the 19th century, American pedagogues touted that the study of particular subjects would enhance intellectual abilities (Kliebard, 2004; Kolesnik, 1958). Though this curricular focus (commonly known as "mental discipline") was abandoned long ago, there are distinct echoes of its claims in today's assurances by various "brain training" companies and educators. Indeed, a comparison of mental discipline with modern advocates of cognitive enhancement illustrates that the latter most closely resembles the former in the belief that mental exercises will lead to heightened performance, sometimes on unrelated tasks. Equally significant, while scientific advances (empirical methods) were used by psychologists to refute the assertions of mental discipline, contemporary educators, and entrepreneurs are attempting to use scientific advances (neuro-imaging) to substantiate similar claims.

A. Scott Henderson, Ph.D., William R. Kenan Jr. professor of education, Department of Education, Furman University.

The Rise of Mental Discipline

Faculty Psychology and Mental Abilities

Although a long line of philosophers from the ancient Greeks to John Locke had speculated about what actually occurs when people think, the individual who exercised the greatest influence on 19th century discussions of cognition was the 18th century mathematician and philosopher Christian Wolff (2010, as cited in Richards, 1980). A rationalist and an important figure in the early German Enlightenment, Wolff built on the work of medieval scholastics by providing an elaborate explanation of the "faculties of the soul," a phrase that typically referred to a wide array of human capabilities (soul was frequently synonymous with mind or consciousness). Wolff (2010) believed that these capabilities, or to use his words—potentiae activae, which translates roughly as "potentialties," obeyed certain laws that could be discerned through systematic investigations. Wolff was initially influential and controversial because of his emphasis on rational inquiry, though that would not prevent later generations from criticizing Wolff's lack of rigorous empiricism (Blackwell, 1961; Hatfield, 1997; Senn, 1997).

The philosophical tradition known as the Scottish school of common sense, which flourished during the late 18th century, also influenced developing conceptions of cognition. Thomas Reid (2002), the main exponent of common sense philosophy, posited the existence of mental faculties along the lines articulated by Wolff, though he believed that they were actual "powers," not just "potentiae," a qualification that imputed a quantifiable dimension to mental abilities. But unlike subsequent advocates of intelligence testing, neither Reid nor other common sense adherents believed that the strength of one's mental faculties was fixed. They argued an individual's cognitive abilities were highly amenable to training and/or schooling, an assumption that would have significant curricular implications (Brooks, 1976; Carson, 2007; Commins, 1933).

Common sense philosophy crossed the Atlantic in the mid-18th century, and by the early 19th century, it was a mainstay in many American colleges and universities. Although textbooks were quick to incorporate the essential components of "faculty psychology" (the popular phrase denoting Wolffian common sense cognitive theories), there were countless variations on the number of mental faculties that individuals supposedly possessed. Dugald Stewart (1976), one of the original propagators of common sense philosophy, initially identified nine "intellectual powers." Four decades later, Bowdoin philosophy professor Thomas C. Upham (1831) listed seven divisions of the "intellect" in his *Elements of Mental Philosophy*, while his counterpart at Amherst College, Joseph Haven (1857), had condensed that number to four by mid-century. The number continued to vary during the second half of the 19th century, ranging from two to eight intellectual "elements." Most commentators stressed the interrelated nature of perception, reasoning, and introspection, but they nonetheless analyzed and discussed cognitive abilities as if they were independently functioning entities (Beecher, 1969; Hopkins, 1893; Kuklick, 2003; Porter, 1868; Sawyer, 1846; Sloan, 1971; Wayland, 1868).

Equally, confusing was the precise nature of these mental abilities. Putative experts on the subject employed a dizzying array of inconsistently defined and seemingly inter-changeable terms to explain cognition. Even relatively lucid explicators could leave readers perplexed, "The mind has as many distinct faculties as it has distinct powers of action, distinct functions, distinct modes, and spheres of activity." One wrote, concluding with more than a little circular logic that as the mind's capabilities of action and operation differ, so its faculties differ (Haven, 1857, p. 29). Among the abilities most frequently listed were abstraction, analogy, associating, attending (paying attention), classifying, conceiving, explaining, generalizing, imagining, inferring, intuiting,

judging, remembering, methodizing, perceiving, proving, reasoning (deductive and inductive), reflecting, recognizing, synthesizing, and systematizing. These terms and categories established a basic vocabulary for discussing what people did when they exercised their faculties (Rush, 1865).

Classical Curricula and Cognitive Training

The plethora of books devoted to explaining cognition were not self-help manuals explicating how readers could enhance their mental abilities. Contemporaries argued that true intellectual development required the mastery of a particular curriculum. During the Middle Ages, the liberal arts—seven subjects stressed by the ancient Greeks and Romans (grammar, rhetoric, logic, geometry, arithmetic, music, and astronomy)—provided the basis for such a curriculum. The Renaissance and Humanism widened the focus to include the study of classical literature. By the 18th and early 19th century, this curriculum, known as a "classical education," stressed Latin, Greek, and mathematics. The primary purpose of studying these subjects was not to acquire knowledge per se, but to produce a highly trained intellect that would be capable of understanding more specialized fields of study. The Yale report became one of the most influential rallying cries for this educational philosophy. Prompted by a proposal that colleges should make the study of classical languages optional, the report, in rejecting that proposal, noted that the two great points to be gained in intellectual culture are the discipline and the furniture of the mind (Committee of the Yale Corporation & the Academical Faculty, 1828, p. 300). The mind's "furniture" was a body of knowledge handed down over time, while its "discipline" referred to cognitive skills labeled as "powers of the mind." Even though the report deemed the mind's discipline "more important" than its furniture, leading educators would stress a key point over the next several decades. Only a certain kind of furniture—a classical education—would provide the type of discipline that led to mental acuity. As Frederick Barnard, the chancellor of the University of Mississippi and 10th president of Columbia University, observed the subjects which furnish the most beneficial discipline are not necessarily, nor even usually, those which are most immediately related to the ordinary pursuits of men in life (Barnard, 1856, p. 179).

In addition to higher education, grammar schools, and eventually high schools adopted variations of the classical curriculum. As with colleges and universities, the rationale for this course of study was that it "disciplined" and "strengthened" the mind. Indeed, "mental discipline" became one of the many shorthand phrases denoting the cultivation of particular cognitive abilities (Richards, 1856). Pedagogues were quick to note that the primary way to cultivate these abilities was through habitual exercise. The power of the mind to put forth any kind of activity. Emerson White (1886) declared that the brain is trained and developed by occasioning such activity (p. 119). For some educators, the mind was like any other muscle that could be strengthened by training. The "several faculties" of the mind, wrote by James Currie (1884) in *Principles and Practice of Common School Education*, were stimulated just as the organs of the bodily frame were invigorated and developed by physical exercise (p. 6). Other phrases that were used to indicate "mental discipline" were "formal culture" and "formal discipline." The modifier "formal" referred to the form of reasoning or thinking that was being exercised. For example, memorization.

Most 19th century pedagogues also believed in what would become known as "transfer of training" or "transfer" effects that practicing specific cognitive skills would help a student transfer that ability to other tasks. For instance, learning Latin verb conjugations would make learning conjugations in other languages easier. The reason that a large number of 19th century educators considered classical subjects ideal for this purpose was

mastery of them required a great deal of attention and effort. In contrast to subjects that were more familiar or "practical" and only skills that were attained with such diligence had high transfer potential. Some commentators even argued that improvement in one cognitive skill would heighten an individual's overall intellectual prowess—or that effort devoted to one task would enhance a person's ability in other unrelated activities (Bain, 1889; Cole, 1856).

The Decline of Mental Discipline

Attacks on Classical Curricula

As increasing numbers of public high schools began to emerge in the 1890s, so did concern about their curricula, especially their focus on training the brain though repetition of endless mental pushups. Thus, Burke Hinsdale (1895), a professor of education at the University of Michigan, lamented that mental discipline had placed "knowledge" and "content" in "secondary place" (p. 635). Jacob Schurman (1894), president of Cornell University, struck a similar chord when he admonished that education is not merely a training of mental powers, but also a process of nutrition, one in which the mind grows by what it feeds on (p. 93). Charles De Garmo (1894), a leading educational theorist and president of Swarthmore College, sarcastically charged that mental discipline was an "erroneous theory" (p. 278), while Frank McMurry (1895), an education professor at Illinois State Normal University, called the near-obsession with training mental "judgment" an "unpsychological stand" (p. 163).

An additional, albeit indirect, critique of mental discipline arose from a growing debate whose outcome would have enormous consequences for elementary and secondary education. This debate did not focus on whether certain subjects promoted intellectual skills, but whether a given curriculum prepared students to face the challenges of everyday living and contemporary society. Shortly, after the end of the Civil War, Edward L. Youmans (1867), an Antioch College chemistry professor and founder of *Popular Science* magazine, had denigrated classical curricula for having fallen out of harmony with the intellectual necessities of modern life, a reference to the needs prompted by industrialization and urbanization (p. 2). Charles Francis Adams Jr. (1884) added his trenchant voice to those who saw few benefits from the mindless memorization that played a major role in classical curricula and mental discipline. He told the Phi Beta Kappa Chapter at Harvard University in 1884 that "there is no more mental training in learning the Greek grammar by heart than in learning by heart any other equally difficult, and to a boy, unintelligible work" (pp. 18-19). Although Adams' critique was highly pragmatic, for example, he noted that his great grandfather, John Adams, would have be far better off knowing French instead of Greek and he did not support the "narrow scientific and technological training" that others favored (p. 10). Some educators, however, believed that a utilitarian approach to education not only sanctioned, but also necessitated vocational courses. Oscar D. Robinson (1894), the principal of Albany High School in New York, articulated this view in a letter to Charles W. Eliot, the president of Harvard University, "Such studies, such as stenography and manual training are coming to high school and they are coming 'to stay' … Remembering that more than 90% high school pupils will never go to college, I consider such subjects far more valuable than astronomy, meteorology, or physiography" (p. 368).

The Emergence of Modern Psychology

Other important shifts were occurring in the 1890s that would influence views on mental discipline and how the brain itself was conceptualized. In short, the study of human consciousness and volition had been

initially part of "moral philosophy," a discipline from which "mental philosophy" eventually separated. Although based on logical principles, neither moral nor mental philosophy utilized empirical methods (Fay, 1939; Keen, 2001). This was especially problematic for investigations of cognition. Haven (1857) had concisely expressed this dilemma when he mused on the challenges of creating a mental science. He said dispiritedly that the mind is at once the observer and the object observed (p. 18). Influenced by positivism, European and American scholars began to apply the scientific method to examine social, political, and psychological phenomena during the last half of the 19th century. Political science, sociology, anthropology, and a more quantitatively rigorous discipline of economics resulted from these efforts, as did the modern field of psychology (Haskell, 1977; Ross, 1991).

The "new psychology" was distinguished by experimental methods employed by Wilhelm Wendt in Germany and by William James in America. This approach to psychology would eventually, if not immediately, banish mushy, ill-defined concepts, such as "mental faculties" and "mental discipline" to the dustbin of metaphysics (De Garmo, 1896; Lagemann, 2000). In his ground-breaking *Principles of Psychology*, James (1890) confirmed that his study of psychology was based on "natural science" and a "strictly positivistic point of view" (p. vi), echoes of which would appear in John B. Watson's (1913) seminal article on behaviorism. Watson proclaimed that psychology as the behaviorist views it is a purely objective experimental branch of natural science (p. 158).

Acknowledgements that experimental evidence was dismantling some of the fundamental assumptions associated with mental discipline became increasingly common during the first decade of the 20th century, though like earlier discussions of cognition, they were plagued by imprecise and inconsistent terminology. F. C. Lewis (1905) of Dartmouth University, while arguing that formal discipline possessed a "core of truth," admitted that "experimental test" had disproven the "vague doctrine of faculties or general powers" (p. 292). Both Alexander Meiklejohn (1909) of Brown University and Patterson Wardlaw (1908) of the University of South Carolina posed the question—Is Mental Training a Myth? and promptly reached similar conclusions. Although he disagreed that "mental training" was an outright "myth," Meiklejohn eschewed the distinction between the form and content of subject matter, as well as the more general applications of mental discipline, noting that professor William James had played a leading part in the melting down of conventional and uncritical dogma (p. 129). Wardlaw (1908) similarly denigrated formal discipline's reliance on "faculty-psychology," labeling the latter a "mere assumption" refuted by the results of exact experiments (p. 32). Finally, illustrating the growing influence of empiricism, James Angell (1908) of the University of Chicago posited that only "specific experiment" could "confirm or disprove" whether certain habits gained in the mastery of one study may be appropriated directly in another (p. 13).

James (1890) and Thorndike and Woodworth (1901) conducted the initial experiments that chipped away at the validity of mental discipline. Thorndike (1906) concisely summarized the significance of their findings in his book entitled *The Principles of Teaching Based on Psychology*. Thorndike (1906) cautioned that the amount of general influence from special training was "much less" than previously supposed (p. 248). An even more damning judgment came from the influential psychologist G. Stanley Hall (1907), president of Clark University and a founder of child psychology. In his magnum opus, *Adolescence*, he excoriated mental discipline, remarking that he could recall no fallacy that so completely evicts content and enthrones form (p. 512). Furthermore, in 1907 and 1909, two comprehensive studies on mental discipline concluded that only very specific transfer effects had been documented by ongoing research (Bennett, 1907; Heck, 1909).

Neuro-Science and Brain Training

Imaging Technology and Passive Strategies for Cognitive Improvement

During the decades that followed the discrediting of mental discipline, interest in cognitive psychology decreased, even though reliance on standardized testing, including intelligence quotient (IQ) tests, increased. Behaviorism, which became the dominant lens through which the discipline of psychology viewed phenomena, emphasized the need to study stimuli and responses, while at the same time stressing that the brain itself was a black box whose functioning was largely unknowable and likely unimportant (Lagemann, 2000). The influence of progressive teaching methods notwithstanding, most teachers still emphasized the need for students to commit specific information to memory, despite the fact that the most basic understanding of human memory remained elusive (Wineburg, 2001). The launch of the Soviet satellite Sputnik in 1957 caused Americans to worry that U.S. students' knowledge in certain subjects lagged behind that of their communist counterparts, which prompted elected officials to increase funding and curricular standards for math and science via passage of the *National Defense Education Act* in 1958 (Henderson, 2009). In essence, lawmakers—acting as the nation's chief pedagogues—showed no concern over what went on inside students' heads as long as those heads were filled with the right information.

This changed when it became possible to see—or to at least partially see—what actually occurs inside the human head, a development that resulted from the advent of technology such as functional magnetic resonance imaging (MRI) and positron emission tomography (PET) in the late 1970s and early 1980s, a tremendous boost to modern neuro-science (Mattson & Simon, 1996). This technology provides vastly improved images of the brain regions that are activated during certain locomotor and/or cognitive tasks. The challenge—one that has yet to be fully surmounted—is interpreting brain activation. Does it illustrate causation or correlation? At the core of this question is the ability to distinguish dependent from independent variables, which can be a difficult, sometimes impossible, task (Henderson, 2010; Reinhart et al., 2013). Moreover, even if causation can be confirmed, it remains unclear if or how brain activation is connected to the complex process of learning. When a literal light glows on a computer screen, it may or may not correspond to the figurative light that turns on when a person finally understands something.

These caveats have not prevented commercial enterprises from developing products whose alleged benefits are supposedly substantiated by brain research. Fueling the growth of this industry was an investigation conducted at the Center for the Neuro-Biology of Learning and Memory at the University of California in Irvine (Rauscher, Shaw, & Ky, 1993). This study reported that subjects who listened for 10 minutes to a selection of music written by Wolfgang Amadeus Mozart (sonata for two pianos in D-major) showed improvement in spatial-temporal reasoning on a standardized test administered immediately after the music had been played. Though two meta-analyses have almost entirely refuted, this so-called Mozart Effect, the Internet-Based Mozart Effect Resources Centre, which sells books and CDs, claims that music by Mozart helps clarify time/space perception (n.d.). Similarly, developmental psychologist Brent Logan created the BabyPlus Prenatal Learning System in 1995, which consists of audio tapes that provide a prenatal "curriculum" for a developing fetus. The BabyPlus Website notes that its curriculum (informed by the latest findings in neuro-science) can result in infants and children who have "longer attention spans," "improved school readiness," and "strong learning skills," these phrases are relatively meaningless in empirical terms (n.d.). The Baby Einstein Company, founded in 1996 by a former teacher, sells videos that the company claims will

enhance language acquisition for infants and toddlers who watch them (n.d.). Nevertheless, researchers at the University of California in Riverside determined that such claims could not be verified (Richert, Robb, Fender, & Wartella, 2010). As with the Mozart Effect and BabyPlus products, Baby Einstein materials are based on the general premise that cognitive development can be accelerated or otherwise enriched through passive activities, such as listening to music or watching images.

Brain-Based Pedagogy

Neuro-science research has also provided the basis for active (not just passive) strategies for promoting cognitive development and learning. David Sousa (2011), a former teacher and secondary curriculum coordinator, has been at the forefront of these efforts, focusing his investigations on attention, memory, and the general notion that "teaching and learning will improve dramatically" because of neuro-scientific insights (p. 1). Marsha Tate, a former director of professional development for DeKalb County (Georgia) schools, created her own company in 2008. Developing minds that touts strategies to "grow dendrites" (branchlike projections that assist in conveying signals from one neuron to another) and to increase a child's "brain power." Accordingly, Tate discourages the use of worksheets, because they do not grow dendrites (n.d.). Yet, University of Virginia Daniel Willingham (2006) had outlined a significant problem with translating brain-based research into pedagogy. The challenge for those trying to apply neuro-scientific findings to the classroom is the dramatically different levels of analysis that must be bridged as we transition from looking at a brain to looking at a child in a classroom (n.d.). This does not necessarily invalidate all the efforts of Sousa, Tate, and others, but it suggests some specific limitations to their undertakings, especially when they assert that increases in "brain power" will result from their pedagogical recommendations.

The Brain-Training Industry

Besides permitting researchers to gain a greater understanding of the brain, advances in technology have fostered the creation of popular braining-training games, with some estimates suggesting that consumers will spend over $3 billion on them by 2020 (Yong, 2016). Typically, these games require players to respond as quickly as possible to visual and/or audio stimuli that appear on a computer screen or other electronic device. Improving one's game-playing skills is supposed to have a positive impact on related or even unrelated cognitive skills. One company, BrainHQ, offers testimonials from customers as evidence of the benefits that can be derived from playing the electronic games the company has devised. Customers claim that playing BrainHQ's games has fostered "clearing thinking," better hearing, longer attention spans, the ability "to see both sides of the road," higher batting averages, and increased happiness, to cite just a few examples (n.d.). NeuroNation, another company that markets online brain-training exercises, purports that its games can improve working memory, strengthen your brain at a cellular level, and can make users "smarter" (n.d.).

The advertisements of companies that sell access to braining-training games are often aimed at older individuals who wish to prevent and and/or reverse cognitive decline. To prove the legitimacy of their products, these companies link their websites to peer-reviewed research in neuro-science. The quality of this research, however, is often highly questionable. In the largest meta-analysis to date, seven psychologists reviewed all 374 research studies adduced by the major brain-training companies (Simons et al., 2016). While they concluded that there was "extensive evidence" to support contentions that brain-training interventions "improve performance on the trained tasks," there was "less evidence" that such interventions improve performance on "closely related tasks," and "little evidence" of improved performance on "distantly related tasks or that

training improves everyday cognitive performance." Furthermore, they concluded that "many" of the studies contained "major shortcomings in design and analysis," and that "none of the cited studies conformed to all the best practices" that are necessary to make assertions about the benefits of brain training for everyday activities (p. 103). In sum, this meta-analysis determined that brain-training companies are relying on research that does little, if anything, to provide scientific verification for the statements made on company websites on in customer testimonials.

Conclusions

The key similarity between the era of mental discipline and the current era of brain training is the variously held belief that the practice of discrete mental efforts can and does have transfer benefits. Phrased differently, both eras have been characterized by the contention that general cognitive improvement can result from enhancing performance on specific mental tasks. In the case of mental discipline, the experimental psychologists eventually determined that this assertion could not be substantiated. To date, the same is true for brain training.

Comparing mental discipline and brain training also reveals broader currents in intellectual history. The invalidation of mental discipline involved a fundamental change in how the brain was studied. Instead of treating the brain as the subject of philosophical debate and deductive logic, the rise of experimental psychology focused on the brain as a topic of empirical analysis and inductive logic. Almost 100 years later, technological advances inaugurated new claims regarding how the brain should be investigated, which have led individuals, such as a neuro-scientist—Henry Mahncke and the chief executive officer (CEO) of Posit Science, to opine that another paradigm shift is occurring, a shift that is replacing a style of psychology that is uncontained by neuro-science (Yong, 2016, p. 3). Whether the expanding field of neuro-science represents an actual paradigm shift, as defined by Thomas Kuhn (1962), remains debatable. What is less debatable is the absence of persuasive evidence to support many of the claims made by the brain-training industry and by educators who believe that neuro-science can spark a pedagogical revolution. To be sure, neuro-science has increased the knowledge about the brain, but it has yet to answer certain long-standing questions about cognition, illustrating the veracity of the maxim that knowledge is not necessarily the same thing as understanding.

References

Adams, C. F., Jr. (1884). *A college fetich*. Boston: Lee and Shepard.

Angell, J. (1908). The doctrine of formal discipline in the light of the principles of general psychology. *Educational Review, 36*(1), 1-15.

Baby Einstein. (n.d.). *Spark a lasting journey of discovery*. Retrieved May 20, 2017, from http://www.kidsii.com/brands/baby-einstein/

BabyPlus. (n.d.). *Give your child a head start*. Retrieved May 15, 2017, from http://www.babyplus.com/

Bain, A. (1889). *Education as a science*. New York, N.Y.: Appleton.

Barnard, F. A. P. (1856). On improvements praticable in American colonies. *American Journal of Education and College Review, 1*, 174-185.

Beecher, C. (1969). *The elements of mental and moral philosophy*. Ann Arbor, M.I.: University Microfilms. (Original work published in 1831)

Bennett, C. (1907). *Formal discipline*. New York, N.Y.: Teachers College Press.

Blackwell, R. J. (1961). Christian Wolff's doctrine of the soul. *Journal of the History of Ideas, 22*(3), 339-354.

BrainHQ. (n.d.). *Rigorous training for better brain health*. Retrieved June 1, 2017, from https://www.brainhq.com/

Brooks, G. P. (1976). The faculty psychology of Thomas Reid. *Journal of the History of the Behavioral Sciences, 12*(1), 65-77.

Carson, J. (2007). *The measure of merit: Talents, intelligence, and inequality in the French and American republics, 1750-1940*. Princeton: Princeton University Press.

Cole, D. (1856). Classical education. *American Journal of Education and College Review, 1*(1), 67-85.

Commins, W. B. (1933). What is faculty psychology? *Thought, 8*(1), 48-57.

Committee of the Yale Corporation & the Academical Faculty. (1828). Original papers in relation to a course of liberal education. *American Journal of Science and Arts, 15*, 297-351.

Currie, J. (1884). *The principles and practice of common school education*. Cincinnati, O.H.: Robert Clarke & Company.

De Garmo, C. (1894). The report of the committee of ten. *Educational Review, 7*, 275-280.

De Garmo, C. (1896). *Herbart and the Herbartians*. New York, N.Y.: Scribner's.

Developing Minds Inc. (n.d.). *Brain based learning from Marcia L. Tate*. Retrieved July 3, 2017, from http://www.developingmindsinc.com/

Fay, W. J. (1939). *American psychology before William James*. New Brunswick, N.J.: Rutgers University Press.

Federal Trade Commission (FTC). (2016). *Lumosity to Pay $2 Million to Settle FTC Deceptive Advertising Charges for Its "Brain Training" Program*. Retrieved May 1, 2016, from https://www.ftc.gov/news-events/press-releases/2016/01/lumosity-pay-2-million-settle-ftc-deceptive-advertising-charges

Hall, G. S. (1907). *Adolescence* (Vol. 2). New York, N.Y.: Appleton.

Haskell, T. L. (1977). *The emergence of professional social science: The American social science association and the nineteenth-century crisis of authority*. Baltimore: Johns Hopkins University Press.

Hatfield, G. (1997). The workings of the intellect: Mind and psychology. In P. A. Easton (Ed.), *Logic and the workings of the mind: The logic of ideas and faculty psychology in early modern philosophy* (pp. 21-45). Atascadero, C.A.: Ridgeview.

Haven, J. (1857). *Mental philosophy*. Boston: Gould & Lincoln.

Heck, W. (1909). *Mental discipline and educational values*. New York, N.Y.: John Lane.

Henderson, A. S. (2009). The brain race: Competition, national security, and the rise of federal aid to education. In A. S. Henderson, L. Benson, P. Rasmussen, & W. Worthen (Eds.), *Competition: A multidisciplinary analysis* (pp. 159-168). Rotterdam: Sense.

Henderson, A. S. (2010). The new positivism: Research and education. *National Social Science Journal, 35*(2), 84-89.

Hinsdale, B. (1895). The dogma of formal discipline. In National Education Association, *Journal of proceedings and addresses: Session of the year 1894* (pp. 625-635). St. Paul, M.N.: Pioneer Press.

Hopkins, M. (1893). *An outline study of man*. New York, N.Y.: Scribner's.

James, W. (1890). *The principles of psychology* (Vol. 1). New York, N.Y.: Henry Holt.

Keen, E. (2001). *A history of American ideas in American psychology*. Westport, C.T.: Praeger.

Kliebard, H. M. (2004). *The struggle for the American curriculum* (3rd ed.). New York, N.Y.: Taylor & Francis.

Kolesnik, W. B. (1958). *Mental discipline in modern education*. Madison, W.I.: University of Wisconsin Press.

Kuhn, T. (1962). *The structure of scientific revolutions*. Chicago: University of Chicago Press.

Kuklick, B. (2003). *A history of philosophy in America, 1720-2000*. New York, N.Y.: Oxford University Press.

Lagemann, E. C. (2000). *An elusive science: The troubling history of education research*. Chicago: University of Chicago Press.

Lewis, F. C. (1905). A study in formal discipline. *School Review, 13*(4), 281-292.

Mattson, J., & Simon, M. (1996). *The pioneers of NMR and magnetic resonance in medicine: The story of MRI*. New York, N.Y.: Dean Books.

McMurry, F. (1895). Discussion of history. In National Education Association, *Journal of proceedings and addresses: Session of the year 1894* (pp. 160-165). St. Paul, M.N.: Pioneer Press.

Meiklejohn, A. (1909). Is mental training a myth? *Educational Review, 37*(2), 126-141.

Mozart Effect. (n.d.). *The Mozart Effect Resource Centre*. Retrieved May 15, 2017, from https://www.mozarteffect.com/

NeuroNation. (n.d.). *Scientific brain training*. Retrieved July 1, 2017, from https://www.neuronation.com/

Porter, N. (1868). *The human intellect*. New York, N.Y.: Scribner's.

Rauscher, F. H., Shaw, G. L., & Ky, K. N. (1993). Music and spatial task performance. *Nature, 365*, 611.

Reid, T. (2002). *Essays on the intellectual powers of man*. University Park, P.A.: Pennsylvania State University Press. (Original work published in 1785)

Reinhart, A. L., Haring, S. H., Levin, J. R., Patall, E. A., & Robinson, D. H. (2013). Models of not-so-good behavior: Yet another way to squeeze causality and recommendations for practice out of correlational data. *Journal of Educational Psychology, 105*(1), 41-47.

Richards, R. J. (1980). Wolff's prolegomena to empirical and rational psychology: Translation and commentary. *Proceedings of the American Philosophical Society, 124*(3), 227-239.

Richards, Z. W. (1856). Discipline—moral and mental. *Journal of American Education and College Review, 1*(1), 107-119.

Richert, R. A., Robb, M. B., Fender, J. G., & Wartella, E. (2010). Word learning from baby videos. *Archives of Pediatrics and Adolescent Medicine, 164*(5), 432-437.

Robinson, O. D. (1894). The work of the committee of ten. *School Review, 2*(6), 366-372.

Ross, D. (1991). *The origins of American social science.* New York, N.Y.: Cambridge University Press.

Rush, J. (1865). *Brief outline of an analysis of the human intellect* (Vol. 1). Philadelphia: J. P. Lippincott.

Sawyer, L. A. (1846). *Elements of mental philosophy*. New York, N.Y.: Paine & Burgess.

Schurman, J. (1894). The report on secondary school studies. *The School Review, 2*(2), 83-97.

Senn, P. (1997). What is the place of Christian Wolff in the history of the social sciences? *European Journal of Law and Economics, 4*(2-3), 202-20.

Simons, D. J., Boot, W. R., Charness, N., Gathercole, S. E., Chabris, C. F., Hambrick, D. Z., & Stine-Morrow, E. A. L. (2016). Do brain-training programs work? *Psychological Science in the Public Interest, 17*(3), 103-186.

Sloan, D. (1971). *The Scottish enlightenment and the American college ideal*. New York, N.Y.: Teachers College Press.

Sousa, D. (2011). *How the brain learns* (4th ed.). Newbury Park, C.A.: Corwin.

Stewart, D. (1976). *Outlines of moral philosophy*. New York, N.Y.: Garland. (Original work published 1793)

Thorndike, E. L. (1906). *The principles of teaching based on psychology*. New York, N.Y.: A. G. Seiler.

Thorndike, E. L., & Woodworth, R. S. (1901). The influence of improvement in one mental function upon the efficiency of other functions. *Psychological Review, 8*(3), 247-261.

Upham, T. C. (1831). *Elements of mental philosophy*. New York, N.Y.: Harper.

Wardlaw, P. (1908). Is mental training a myth? *Educational Review, 35*(1), 22-32.

Watson, J. B. (1913). Psychology as the behaviorist views it. *Psychological Review, 20*(2), 158-177.

Wayland, F. (1868). *The elements of intellectual philosophy*. New York, N.Y.: Sheldon & Company.

White, E. E. (1886). *The elements of pedagogy*. New York, N.Y.: American Book Company.

Willingham, D. T. (2006). *Brain based learning: More fiction than fact.* Retrieved June 18, 2017, from https://www.aft.org/periodical/american-educator/fall-2006/ask-cognitive-scientist

Wineburg, S. (2001). *Historical thinking and other unnatural acts*. Philadelphia: Temple University Press.

Wolff, C. (2010). *Logic, or rational thoughts on the power of human understanding.* Farmington Hills, M.I.: Gale. (Original work published in 1712)

Yong, E (2016). *The weak evidence behind brain-training games.* Retrieved June 3, 2017, from https://www.theatlantic.com/science/archive/2016/10/the-weak-evidence-behind-brain-training-games/502559/

Youmans, E. L. (1867). On mental discipline in education. In E. L. Youmans (Ed.), *The culture demanded by modern life* (pp. 1-57). New York, N.Y.: Appleton.