



BrainWare® and Mental Performance

The methodology incorporated in Learning Enhancement Corporation's (LEC's) BrainWare products is founded in science and rooted in clinical experience. It is based on a model of brain function derived from work originally published in 1949 by Dr. Donald Hebb at McGill University¹ and confirmed and extended through subsequent research, including both clinical therapeutic efforts and research in cognitive neuroscience and brain imaging, such as fMRI (functional Magnetic Resonance Imaging).²

Model of Mental Processing

The mental processes upon which learning depends are complex. LEC's model of mental processing, presented in Figure 1, integrates research findings from a number of sources dealing with various aspects of brain function (see Bibliography).

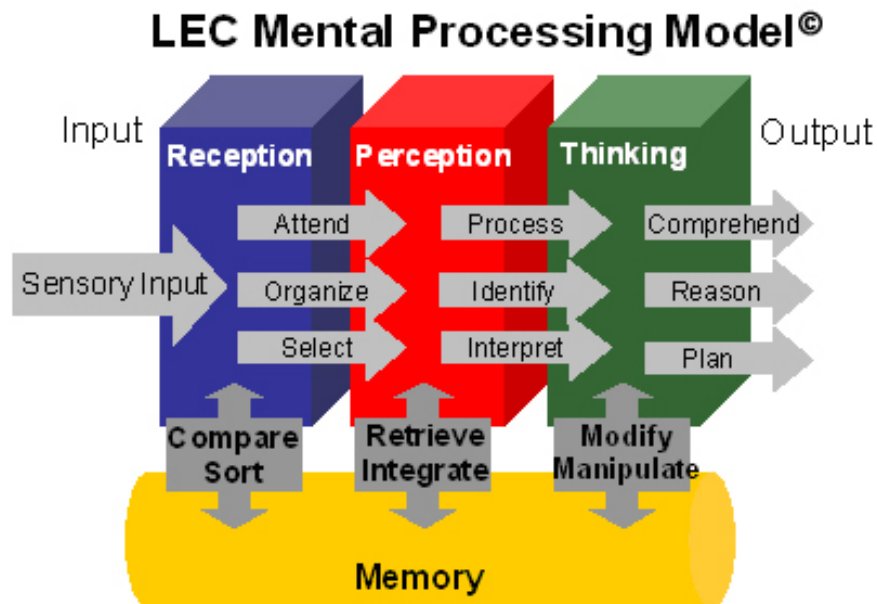


Figure 1. BrainWare Mental Processing Model

The LEC Mental Processing Model displayed in Figure 1 distinguishes four primary categories of mental processes which are part of the learning sequence – Reception, Memory, Perception and Thinking.

Reception

Reception is the initial step in the learning sequence and involves the processing of sensory input. Inputs may be visual, audio, kinesthetic or mediated by other senses. The enormous amount of information available to our senses must be compared, sorted, organized, and then filtered to eliminate irrelevant information and enable relevant information to flow through to

other processes. The skills required to perform these functions subconsciously within fractions of a second include various attention skills (e.g., selective attention) and sensory memory skills.

Memory

Memory is essential in all phases of information processing and is integral to any ability to manipulate information, compare, comprehend, and learn. In fact, if we can't remember something, we can't say that we've learned it; and our experiences, captured in memory, are what make us unique individuals.³ Furthermore, we need memory to actually think anything new. Memory skills range from immediate to long-term depending on the duration of time they are stored, and differ in the degree to which information is maintained in conscious thought.

Perception

At the next stage of the learning sequence, information selected at the Reception stage is further processed to identify and interpret it. This requires retrieving stored information from memory and integrating it with the new information. The skills required to perform these functions are primarily visual and auditory processing skills and memory skills. These processes occur within seconds and are performed subconsciously.

Thinking

The third stage of the learning sequence marks the point at which mental processes become conscious. Meaningful information (that is, filtered inputs which have been processed, identified, and interpreted) is held in the mind and modified and manipulated in order to achieve comprehension. Reasoning and planning skills used in the thinking process include visualization (the ability to create visual images in the mind), working memory, divided and sustained attention, and visual thinking (also called spatial-temporal reasoning – the ability to use visual images to create a new arrangement of elements, to envision future developments and to solve problems).⁴

The functions that enable the processes of reception, memory, perception and thinking – that is, the skills upon which the learning sequence places demands – such as attention, visual and auditory processing, and memory skills – are called cognitive skills. These are the skills that BrainWare is designed to develop. BrainWare is built on 10 key principles – 6 related directly to the development of cognitive skills and 4 related to the critical elements of desire and effort.

Principles for the Development of Cognitive Skills

Principle 1: An individual's learning ability is not genetically predetermined in the way that physical attributes like red hair or blue eyes are determined. While learning ability is guided by an individual's genetic code, it arises in significant part through the process of development.⁵ Many studies suggest that individual variation seems to be accounted for about equally by nature and nurture.⁶

This principle supports the very notion of a program like BrainWare designed to help develop mental skills and improve learning ability.

Principle 2: The plasticity of the brain is greater in children, but the brain exhibits the ability to change and develop throughout life.⁷

The significance of this principle is that learning ability can be improved at any age. While individuals will show differences in their ability to develop mental skills at different ages, virtually any individual can improve his or her mental skills at any age. This suggests that the BrainWare methodology will have benefit for a wide range of ages.

Principle 3: Human learning is hierarchical and starts with the simplest of neurological processes. Skills build in a learning pyramid, in which basic skills provide an underpinning for more advanced skills. If any fundamental skills are missing or are deficient, higher level skills cannot develop.⁸ Higher order thinking skills cannot be developed in individuals who lack the fundamental mental operations for learning and performing them.⁹

This is the reason that BrainWare was designed to address basic cognitive skills. Improvement in basic mental processing has a powerful multiplier effect by making the processes of taking in, sorting, filtering, interpreting and applying information more efficient. Efficient fundamental skills pave the way for individuals to engage in knowledge acquisition and thinking.

Principle 4: Processing skills are highly integrated in effective brain functioning.¹⁰ If they didn't integrate, we wouldn't understand the information we are exposed to and wouldn't be able to manipulate or apply it.

The exercises in BrainWare are purposefully designed to integrate skills across and within multiple exercises. BrainWare Safari, LEC's first product, for example, is designed to develop 41 cognitive skills which are integrated throughout the program's 20 exercises and 168 levels. Furthermore, the exercises are mutually reinforcing and supportive so that when a user gets to a level in one exercise that is extremely difficult for them, they can move to other exercises which will help build those same skills. Frequently, upon returning to the troubling level within the previous exercise, it will be passed with much less difficulty.

Principle 5: The brain can only perform one skill consciously at a time. When multiple cognitive skills are required, as in most learning situations, all but one have to be performed automatically, at the subconscious level.¹¹

This is why the exercises in BrainWare require the use of multiple cognitive skills at the same time. Repeating a single skill over and over can lead to improvement in that skill, but the integration of multiple skills is what pushes critical skills more quickly to the subconscious. This approach of putting demands on multiple skills at the same time is also referred to as "cognitive loading." Cognitive loading is a key attribute of the exercises in BrainWare.

Principle 6: Researchers estimate that 80% of what we learn involves our visual system. The ability to transform thoughts into images is what drives new concepts, new ideas, new feelings, and ultimately new behaviors. It is said that Albert Einstein processed information primarily in images, and Beethoven was deaf, but could picture music in his mind.¹² Thus visual

processing, visualization and visual thinking (spatial-temporal reasoning) are vital in learning and thinking.

The combination of cognitive skills exercises within BrainWare has been carefully designed to develop the skills that are the most important for learning. Cognitive skills are addressed comprehensively and strategically. Thus, BrainWare puts particular emphasis on visual processing skills (including visual thinking) – developing the capabilities of the “mind’s eye” – and memory. BrainWare also addresses attention, auditory skills, sensori-motor integration and reasoning and logic skills.

The Role of Desire and Effort

While we have described some key principles for cognitive skill development, desire and effort also play a major role in the pace and degree of change experienced by each individual. BrainWare is designed to address key components that drive desire and effort, as captured in Principles 7 through 10.

Principle 7: Stimulation is an important factor in motivating attention and meaningful participation in a learning activity.¹³

BrainWare incorporates multimedia video-gaming technology with entertaining themes, characters, animation, and interactive elements to stimulate interest. The inherently interesting features of the program help provide intrinsic motivation to persist and overcome more difficult levels.

Principle 8: Immediate feedback is necessary to enable error correction and faster, more accurate learning.

BrainWare provides immediate feedback to the user. There is no waiting to have a challenge or level scored; the computer response is instantaneous.

Principle 9: Sequenced challenges that address the range of each individual’s strengths and weaknesses are required to provide the appropriate levels of challenge and intensity. If a task is too far above an individual’s learning ability, he or she will become frustrated and may not persist. If tasks are too easy, he or she will become bored.

BrainWare’s exercises are designed to build, from relatively easy levels through more difficult exercises. The sequencing of levels according to difficulty within an exercise makes the exercises intense and challenging. Intensity makes the exercises more fun and entertaining. Sequencing also enables an individual’s experience with BrainWare to be personalized in the sense that a user will spend longer on and be more challenged by exercises and levels that address weaker areas and less time and effort on exercises and levels that address stronger areas.

Principle 10: Success and self-confidence are vital parts of the feedback loop that increase desire and effort. Positive feedback helps commemorate success and build self-confidence, an important driver of desire to perform.

Positive encouragement is offered continuously as the user progresses through the program. At each challenge, at each level, and upon the completion of exercises, positive and entertaining messages are delivered and the character the user has chosen at the beginning grows, reflecting the development in cognitive skills the user is experiencing.

Translating Cognitive Skills into Learning Performance

Mental performance is not merely a function of cognitive skill development and desire and effort. Although cognitive skills and desire and effort are necessary constituents, there is at least one more variable in the equation – cultural intelligence.

Cultural Intelligence, Desire and Effort

Cultural intelligence, for the purpose of this discussion, is knowledge acquired through instruction, reading and environmental and social experiences. This type of knowledge includes communication skills, social skills, reading, writing and math skills, and verbal, factual and procedural knowledge. Thus, a conceptual equation for Mental Performance can be depicted as in Figure 2.

Mental Performance Equation

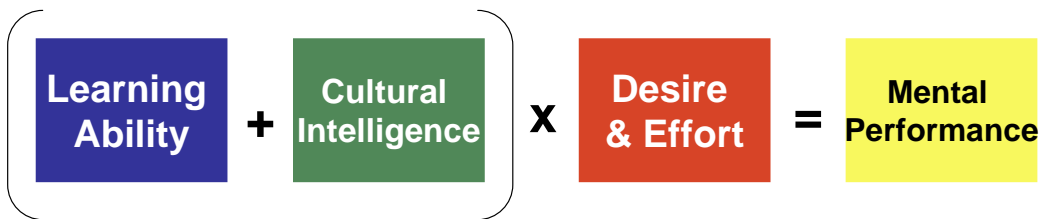


Figure 2. Equation for Mental Performance.

BrainWare does not directly add to cultural intelligence, but contributes indirectly, by making the mental processes of reception, memory, perception and thinking more efficient and by enabling success with mental processing tasks, thereby enhancing desire, effort and self-confidence. As an individual enhances his or her learning ability through BrainWare, he or she is able to acquire knowledge at a faster rate, gradually enriching the newly enhanced learning system with the material it needs to fuel Mental Performance.

The impact of BrainWare on the Mental Performance Equation is conceptualized in the following illustration.

BrainWare Impact on Mental Performance

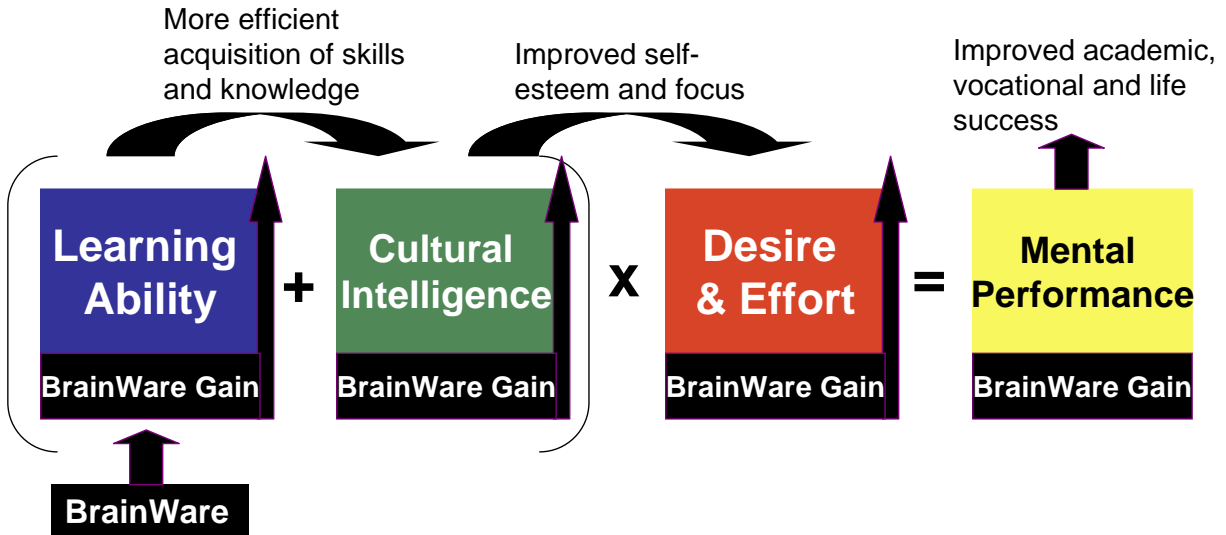


Figure 3. BrainWare Impact on Mental Performance.

Other Factors

There are some factors that can negatively impact mental performance, by limiting an individual's capacity to develop the skills, desire and effort that contribute to mental performance in the model presented in this discussion. These include factors such as:

- Neurological disorders (ADHD, Dyslexia, Autism, and Brain Damage);
- Language deficiencies;
- Emotional problems;
- Physical visual and auditory impairments;
- Cultural deprivation;
- Poor instruction; and
- Unhealthy lifestyles.

While BrainWare may make a positive contribution to individuals with mild or moderate issues in these areas, more severe problems must be dealt with appropriately before BrainWare can help.

Summary

Mental processing depends on basic cognitive skills. Enhancing the cognitive skills that drive mental processing accelerates and improves the quality of knowledge acquisition and retention. By extension, it improves the ability to perceive relationships, and even creativity. Improving an individual's underlying learning skills can improve not only a person's ability and motivation to

learn, resulting in improved enjoyment of school or work, but can also enhance self-esteem, lower stress, and ameliorate behavior and performance as well.

In fact, this is the conclusion of a long tradition of research. As a report of the Educational Resources Information Center Clearinghouse on Assessment and Evaluation recently summarized the conclusion:

...fine-grained cognitive analyses can be used beneficially to uncover individual differences in the information processing profiles of students (e.g., Carpenter, Just & Shell, 1990). A clear and important implication of this work is that such analyses will eventually lead to dramatic improvement in our ability to assess an individual's current level of intellectual functioning and to prescribe instructional interventions that will maximize each individual's potential.¹⁴

BrainWare has been specifically designed to comprehensively develop the cognitive skills that are the most important for learning ability, as well as to enhance the desire and effort that are so crucial for mental performance. The potential for this approach is perhaps best expressed by neuroscientists summarizing recent research in the following terms:

More recently neuroscientists discovered that the environment – things like stimulating experiences or severe stress – affects the performance of genes in ways that can build a super-functioning brain...¹⁵

Selected Bibliography

Damasio, Antonio R., *The Feeling of What Happens: Body and Emotion in the Making of Consciousness*, (Orlando: Harcourt, Inc., 1999)

Diamond, Marian Cleves, *Enriching Heredity*, (New York: The Free Press, 1988)

Gesell, Arnold, *The Guidance of Mental Growth in Infant and Child*, (New York: MacMillan, 1930)

Getman, G. N., *How to Develop Your Child's Intelligence*, (Luverne, MN: Self-Published Research, 1962)

Hebb, Donald O., *The Organization of Behavior*, (New York: Wiley, 1949)

Horowitz, Mardi J., *Image Formation and Cognition*, (New York: Appleton Century Crofts, 1970)

Pinker, Steven, *The Blank Slate: The Modern Denial of Human Nature*, (New York: Penguin, 2003)

Pribram, Karl, and Joseph King, eds., *Learning As Self-Organization*, (Mahwah, NJ: L. Erlbaum Associates, 1996)

Wolfe, Patricia, *Brain Matters: Translating Research into Classroom Practice*, (Alexandria, VA: Association for Supervision and Curriculum Development, 2001)

¹ Hebb, *The Organization of Behavior*

² e.g. Sally Shaywitz, numerous publications at <http://myprofile.cos.com/shaywitz85>

³ Damasio, *The Feeling of What Happens: Body and Emotion in the Making of Consciousness*

⁴ Horowitz, *Image Formation and Cognition*

⁵ Getman, *How to Develop Your Child's Intelligence*

⁶ Pinker, *The Blank Slate: The Modern Denial of Human Nature*

⁷ Diamond, *Enriching Heredity*

⁸ Hebb, op. cit.

⁹ Pribram, *Learning as Self-Organization*

¹⁰ *ibid.*

¹¹ Gessell, *The Guidance of Mental Growth*

¹² Wolfe, *Brain Matters: Translating Research into Classroom Practice*

¹³ *ibid.*, and Diamond. op. cit.

¹⁴ Apr 94 Current Issues in Research on Intelligence, ERIC/AE Digest, www.parenting-baby.com/intelligence-research.html. Citing Carpenter, P.A., Just M.A., and Shell P. (1990). "What one intelligence test measures: A theoretical account of the processing in the Raven Progressive Matrices test," *Psychological Review*, 97 (3), 404-431

¹⁵ "Women just have something extra in their makeup," Ronald Kotulak, Tribune science reporter, Chicago Tribune, April 17, 2005.



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