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How to Build a Better Neural Highway

Kids' brains learn quicker by using four techniques: Unique experiences, repetition, complexity, and grouping stimuli. And listen-up trainers: It works for adults, too.

Cyndi Rodi

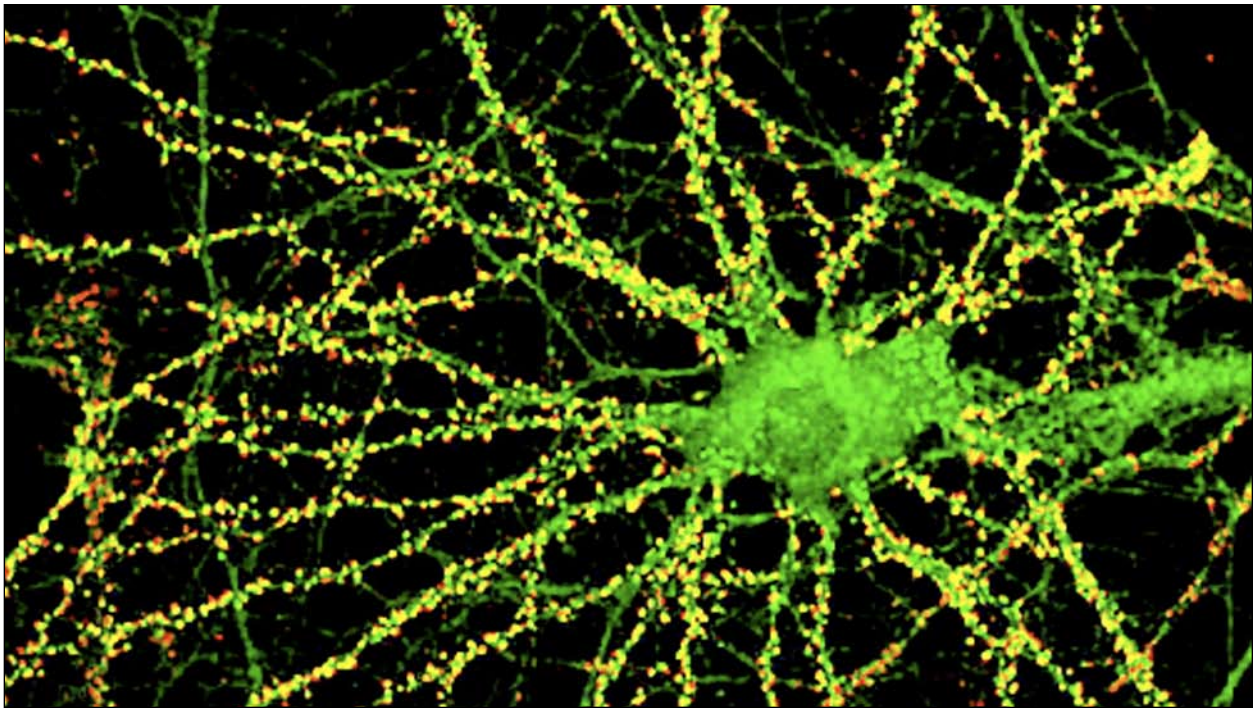

Photo courtesy of The Kennedy Lab at Cal Tech

The brain is somewhat like a powerful computer. It is programmed to record stimuli (the facts, conversations, experiences, behaviors, and feelings of your life), cross-reference that input to previously collected information, and respond according to a reasoned analysis of all available data. However, unlike computers, which require the manipulation of an owner's hand, the human brain and its cells (called neurons) are plastic. Neuroplasticity means the brain not only can sort and react to stimuli, but adapt and change. An advanced, permanent form of this adaptation is called learning.

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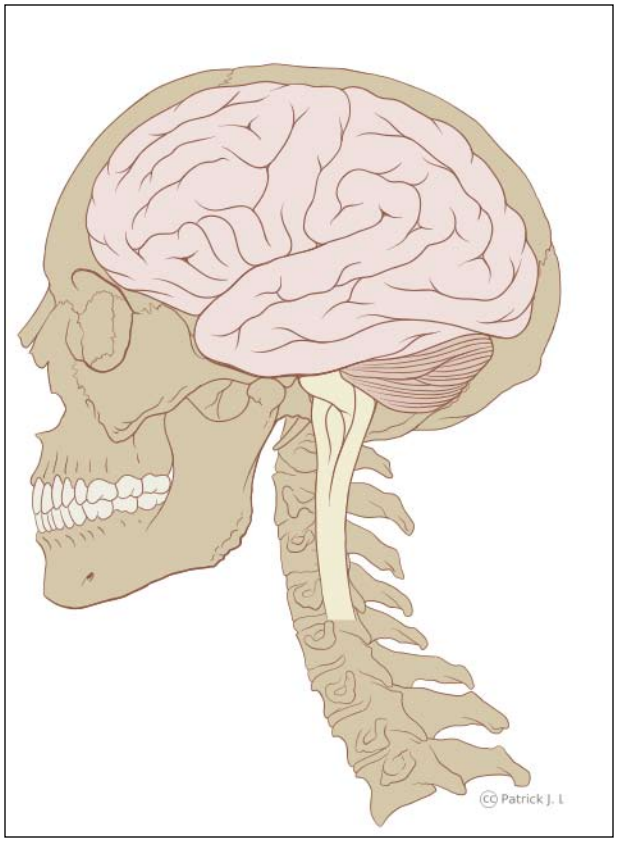
If you cut open a brain, you can literally "see" the learning. Permanent, learned information appears in the form of millions of tiny wire-like connections, known as synapses, that crisscross between neurons. A human brain includes 50 to 100 billion neurons, a number that can change over time based on how the brain is stimulated. Each neuron may use hundreds of synapses to communicate with its neighbors.

New synapses can be created and old synapses can deteriorate. Creation occurs when the body, sensing a stimulus, sends a message in the form of an electrical impulse, which then jumps the microscopic space from neuron to neuron, activating cells and leaving a connection in its wake. Over time, similar stimuli create highways of synaptic connections known as "neural pathways." Their route and structure can be reinforced or changed by learning and experience.

Not all stimuli make a big impression; they generally have to be intense, clear, memorable, and relevant enough for the brain to deem them worthy enough to rate a connection.

Whether synapses wither like fading memories or live on as bustling neural pathways depends on the importance the brain attaches to the messages. People with active, receptive minds frequently bathed in interesting information and brimming with complex thoughts felt to be important, like Einstein, develop brains densely packed with these synaptic connections. Those with fewer and simpler thoughts who are exposed to limited modalities of stimulation have fewer visible connections.

Bottom line: The brain is choosy. It's not a tape recorder, accurately cataloging every single input thrown at it and turning it into a solid connection. Not all stimuli make a big impression; they generally have to be intense, clear, memorable, and relevant enough for the brain to deem them worthy enough to rate a connection.



What does all this mean for trainers and coaches? It's simple: Presentation is key.

Good information presented poorly may not warrant enough connections to create a strong neural pathway. Therefore, if you want to maximize your students' or clients' learning experiences —or your own—it would be quite useful to understand how the brain recalls information and responds best to stimuli.

At CrossFit Kids HQ, we have identified four types of experiences/input which appear to enable the brain to more effectively record and recall information, thereby maximizing learning. Armed with this knowledge, we carefully craft CrossFit Kids programming in order to create lasting learning experiences for children and teens.

Why should you, an adult CrossFitter, care about this? Well, because lots of you have kids. And because everything you're about to read, without any changes or accommodations, will work exactly the same way for you.

Four Tools That Make Learning Stick

Stimulus #1: Novel Experiences. They prime the cell for new info.

Neurons are wildly curious about stimuli to which they have not been previously exposed, so the brain takes note when we offer it something new. Novel experiences create changes within neurons that reconfigure the structure of the cell. It's like changing the combination of a lock. The new experience changes the "combination" of the cell and prepares it to make learning permanent when the same stimulus is repeated.

(Technically, the novel experiences cause a major excitatory neurotransmitter called glutamate to be delivered to the appropriate brain cells. This primes the receiving neurons for creating permanent synapses by causing changes to their receptors, which reconfigure the structure of the cells. This gets it ready to respond to subsequent stimulation of the same synapse(s). Hence, the combination-lock analogy.)

This couldn't be simpler to apply to our training. CrossFit ensures kids will be exposed to novel experiences by prescribing constantly varied movements. This gives a different spin to the term "teachable moments." Every time our children and teens participate in a WOD, their brains are being primed for learning through new visual, auditory, and tactile cues. As our kids work out, they are changing the "combinations" of their brain cells. These changes mean that permanent learning is just another experience away.

Stimulus # 2: Repetition. It makes learning permanent.

Repeated exposure to the same stimulus communicates its importance to the brain. It's like you're sending a signal that says, "Hey! I'm doing this over and over again so you'll remember it."

Having been primed at first exposure (novel experience), the brain is now ready to make the pathway permanent. The more times that specific neural pathway is stimulated, the stronger the attraction between its participating neurons becomes. As the stimulation of these synapses continues, the receiving cell's nucleus begins to contribute materials to the process that further strengthen the connections. In this way, learning is made permanent.

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Every CrossFit Kids Affiliate has been through the CF Kids cert, where we teach them to structure their kids' classes to include a period of focus work. This is when we hammer home mechanics demanding perfection, or that kid's version of it, like no other time during the WOD. Focus work for a specific movement is repeated in each class for a set number of weeks. Then, in the interest of offering something new, we focus on a different aspect of CrossFit, though we never move completely away from any one movement. Each of these is cycled back through the focus work at a later date. The focus work ensures kids get the repetition they require to solidify the learning experience. Repetition allows learning to become permanent for our kids and adults alike.

There is an added benefit to repetition. An oversimplified explanation goes like this: When a new stimulus is presented to the brain, it is processed by the prefrontal cortex where it is recorded in working (short-term) memory, given emotional weight, and compared to and associated with past experiences. Over time and with repeated firing of a particular neural pathway, the learned information becomes second nature. When this occurs, it is delegated to the lower portions of the brain where things are "automatic." This frees up space in the thinking areas of the brain and facilitates more learning. For example, when you mastered bike riding (however many years ago), the brain delegated that activity to the motor areas of the brain, such as the cerebellum. When you get on a bike, these more primitive portions of the brain remind both the motor (movement) and cognitive (thinking) areas of the brain what you should be doing. It also reports back to the vestibular system, which is responsible for balance and spatial orientation. This explains why you can get on a bike and be spinning around the block within minutes after not having ridden for many years.

Stimulus #3: Complexity.
You learn better while moving.

Complexity causes the brain to become more active since more areas of the brain are stimulated. The brain functions as a whole unit, each part reliant on the proper functioning of the other. In learning a new skill or idea, the more areas of the brain you actively engage in any particular activity, the more likely the brain is to remember it. This is particularly potent when you simultaneously engage both the motor and cognitive areas of the brain.

Cognition and movement are inextricably connected. Our bodies were designed to move and think at the same time. Our early ancestors hunted and gathered, constantly moving as they were deciding what to do and where to go next. Multiple thought processes, carried out while in motion, were the key to their survival.

Through modern technology, we are able to solidly determine that the cognitive and motor areas of the brain fire together in response to most stimuli. Every

movement requires input from the cognitive brain to carry it out, and thought relies on input from the motor areas of the brain. For example, try to figure out a geometry problem without spatial awareness. Spatial awareness begins to develop in early childhood through vestibular development that dictates the way in which we move and navigate in a world of gravity. Without spatial references, geometry would be a difficult endeavor. Or try this: Imagine you are building a birdhouse that requires you to use a specific tool. Now, visualize yourself going to the garage to retrieve it. You could not bring this image of movement to mind without input from the motor areas of the brain.

Movement is pivotal to brain function and complexity maximizes these results. Just ask Phil Lawler and Paul Zientarski of Naperville, Illinois, a suburb of Chicago. I traveled to Naperville last fall to meet these forward-thinking gentlemen as a representative of CrossFit Kids.

Complexity in movement engages the cognitive and motor areas of the brain in tandem. This facilitates more efficient and effective brain function that provides for better information processing and recall.

While there, I witnessed a program they have implemented in Naperville Central High School and Madison Junior High School called Learning Readiness PE (LRPE). LRPE requires kids to participate in special PE courses in which they are asked to vigorously exercise immediately prior to those courses in which they are struggling. Those kids who participate in this program experience jumps in their academic performance well beyond those of the kids in normal PE classes.

To what kinds of activities are these kids exposed? Strenuous activities, aerobic and otherwise, that engage multiple areas of the brain, such as running stairs, swimming, lifting weights, large scale training apparatus that requires opposite arm and leg movements, etc. Complexity in movement engages the cognitive and motor areas of the brain in tandem. This facilitates more efficient and effective brain function that provides for better information processing and recall.

To draw a non-athletic analogy, pretend you are a reporter attempting to gather information about an event that took place in a small Midwestern town. You may ask a local farmer what he witnessed in order to get important portions of the story. If you ask his neighbor, you will gather even more information, some of which will be similar to that of the first farmer and other parts which will be new aspects of the story. Suppose there was a tourist from a big city driving by when the event took place. Ask that person what he saw, and you will get a different version of the truth, one that is told from a different perspective than that of the small town farmers. Continue to search for other witnesses to the event and find that each of them tells a somewhat different version of the story, each colored by their own personal experiences and, sometimes, their agendas. The more witnesses you talk to, the richer the story will become, and the closer you will get to the actual truth of the event.

It is the same with the brain. Recruit more areas, and you will be more likely able to duplicate the "event." Learning occurs because the whole brain is working together to gather, record, and later retrieve the information.

CrossFit Kids has a ready-made arsenal of complexity. Olympic lifts and gymnastics movements tax the brain in a manner that engages multiple areas: motor, cognitive vestibular, etc. Let's face it; the squat is complex if you teach it properly. Like your news story, the varied input creates a richer and fuller account of the original picture, more easily reconstructed by the brain. The act of exercise itself improves brain function, and the complexity ensures learning will become permanent.

Stimulus #4: The Hebb Rule.
Associate learning with other positive stimuli.

The Hebb Rule, formulated by neuropsychology pioneer Dr. Donald Hebb, states (among other things) that those stimuli which are continually paired or grouped together are more likely to become permanently recorded in the brain. Let's draw another analogy:

My mother loves the Christmas season. She decorates every room of the house and hosts numerous parties for family and friends. Every Christmas Eve morning during my youth, I woke to the sound of my mother clanging

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around the kitchen as she baked pies. This was a significant event, since I grew up in a virtually sugarless home. Christmas carols would be loudly playing, threatening to raise the rafters of our home. Opening the door to my room, I was immediately surrounded by the warm, rich smell of cinnamon and apples. As I walked into the kitchen to greet my mother, she would rush across the room, wrap me in her arms and ask me how I slept. It was a pretty amazing way to start the day.

To this day, meaningful and lovely memories of Christmas Eve saturate my mind when I experience those sights, sounds, and scents, right down to the warmth of an oven in a well-used kitchen. In my brain, the smell of cinnamon, sound of Christmas carols, and the sight of Christmas decorations are forever paired with the positive feelings I associate with that time of year. Multiple areas of the brain (motor, cognitive, visual, auditory, olfactory, etc.) work together to stimulate my memories of those Christmas Eve experiences, filled with my mother's love and enthusiasm for the season. These are forever imprinted in my brain, as is the knowledge of how to make a pie (but not nearly as well as she could), through the multiple sensory inputs of those days.

The same is true for CrossFit Kids. Our kids come into a positive family environment. They are excited to see their friends. They have a great time as they go through their classes and receive positive reinforcement from their trainers. They gain a sense of accomplishment from taking on a difficult task and persevering. Their bodies respond favorably to the physical activity. For thirty minutes, the kids are laughing and enjoying themselves, even though they're working hard.

This grouping of stimuli is invaluable to learning. Multiple inputs create activity throughout many areas of the brain, which ensures that learning becomes permanent more quickly. Like my memories of Christmas Eve, our children and teens acutely recall their CrossFit Kids experiences. Technical aspects of movement become a permanent part of their cognitive and motor functioning. Engaging the cognitive and motor areas of the brain (among others) through vigorous, complex activities facilitates permanent learning and a readiness of recall like no other learning modality.

The Hebb Rule also highlights an important perk to CrossFit Kids training: Just like a song or a scent from my past conjures up strong memories and feelings for me, the fun and affirmation that define their CrossFit

Kids experiences mean that exercise will always bring to mind powerfully positive thoughts and feelings, even physiological reactions, for them. The thought and act of exercise will forever be something they view favorably and desire.

Conclusion

CrossFit Kids training takes advantage of the mind's power to record and recall information by catering to its inherent learning patterns. We are teaching our kids in a manner that maximizes their natural learning potential and creates lasting memories, principles which are applicable to all ages. Studying brain function allows us to offer our children and teens opportunities to learn in a positive and permanent manner. By offering novel experiences, creating repetition, incorporating complex movements and effectively grouping stimuli, we help our kids to learn better, remember more and experience permanence in skill development.

And, of course, it works for adults, too.

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Sources:

Allen, Greg, Ph.D and Eric Courchesne, Ph.D. *"Differential Effects of Cerebellar Abnormality on Cognitive and Motor Functions in the Cerebellum: An fMRI Study of Autism."* American Journal of Psychiatry 160:2, Feb 2003.;

Courchesne, Eric Ph.D. et al. *"Evidence of Brain Overgrowth in the First Year of Life in Autism."* JAMA 2003; 290(3):337-344.;

Dahmela, Makeshwar, et al. *"Measurements of brain activity complexity for varying mental loads."* Physical Review E, Volume 65, 041917, 2002. ;

Jensen, Eric. Enriching the Brain: How to Maximize Every Learner's Potential. Jossey-Bass: A Wiley Imprint, San Francisco, CA, 2006.; Johns Hopkins Medical Institutes. *"Study helps identify key step in simple motor learning,"* 2001.;

McClelland, James L. *"Explorations in Parallel Distributed Processing: A Handbook of Models, Programs, and Exercises, Chapter 4 Learning in PDP Models: The Pattern Associator."* ;

Medina, John. *Brain Rules*. Pear Press, Seattle, WA, 2008.;

Naie, Katja and Denise Manahan-Vaughan. *"Regulation by Metabotrophic Glutamate Receptor 5 of LTP in the Dentate Gyrus of Freely Moving Rats: Relevance for Learning and Memory Formation,"* Cerebral Cortex, February 2004; 14:189-198. cercor.oxfordjournals.org/cgi/content/full/14/2/189.;

Ratey, John J., M.D. *A User's Guide to the Brain: Perception, Attention, and the Four Theaters of the Brain*. Vintage Books, New York, 2002.;

Ratey, John J., M.D. *Spark: The Revolutionary New Science of Exercise and the Brain*. Little, Brown and Company, New York, 2008.;

MIT, 6.892 Lecture #9. *"Hebb's Rule: Modification of Brain Activity."*;

Shukla, K., et al. J. Biol. Chem., Vol. 282, Issue 25, 18100-18107, June 22, 2007. *"Learning-induced Glutamate Receptor Phosphorylation Resembles That Induced by Long Term Potentiation."*.

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Cyndi Rodi is a Level II certified CrossFit Trainer, CrossFit Kids Programmer and Trainer, a member of CrossFit Kids HQ, and part of the team that administers the CrossFit Kids Certification Seminars. She has a B.A. in psychology. Her background includes working with the UCLA-Camarillo Neuropsychiatric Institute Research Program and as a Behavioral Therapist, designing and implementing behavioral change programs for children with disabilities. She has spent recent years immersed in brain research with a particular emphasis on its correlation to physical movement and its applicability to CrossFit training and the specific developmental needs of children and teens. Cyndi has been previously published in the CrossFit Journal, has been a guest on CrossFit Radio, and is a contributing writer and editor for the CrossFit Kids Magazine.