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What Makes the Brain "Pay Attention?"

Neuro-logical Teaching

We live in very exciting time as educators. With neuroimaging and measurement of brain chemicals we can literally to see what happens in the brain during the learning process. PET and fMRI specialized brain scans measure glucose or oxygen use and blood flow in identifiable regions of the brain that correlate with of brain cell (neural) activity.

With the new discoveries comes increased responsibility to use evolving knowledge to adapt our teaching practices to use the information from science to best benefit of our students. Understanding the neuroscience and cognitive science of how the brain learns provides educators an extended skill set. This background knowledge is becoming an increasingly valuable asset for the planning of curriculum, design of assessments, and development of instructional strategies to further bridge the achievement gap, recognize and remediate learning disorders, reverse negativity, mitigate socioeconomic inequities, and increase student motivation while promoting knowledge acquisition that extends beyond test success to serve students now and in the future.

Highly effective teachers develop intuition and experience with which they interpret their observations and responses to their interventions to guide subsequent adaptations and expand upon what works well regarding the range of student behaviors to instructional goals. It is not surprising that the strategies that educators have found most successful are now supported by the increasing pool of mind, brain, and education research. Brain imaging and other technological developments allow us to how external and internal factors including teachers' most successful strategies influence brain processing. The more we learn about how successful strategies work, the more we can extend and adapt them.

The research about factors that influence student attention provides an example of the benefits derived from the confluence of neuroscience and best educational practices. We now have neuroscience research tools that literally show the types of sensory information most likely attract and hold student attention and gain entry to the brain's higher neural processing. In this article, combining my background as a neurologist and classroom teacher, I'll describe neuroscience research correlations to strategies that increase the likelihood that the sensory information we want students to acquire is "admitted" for passage through their brains' attention filters to become consolidated into memory.

Children Are Paying Attention

Students are criticized for not paying attention; they may just not paying attention to what their teachers think in important.

The brain evolved with increasing efficiency of structure and functions that promote the survival of the animal and the species. For mammals, the most successful adaptations promoted their abilities to respond quickly and appropriately to changes in their unpredictable environments and store memories of the their successful and unsuccessful responses that then guide subsequent choices.

One such adaptation is the *attention filter*. Every second there are millions of bits of sensory information available from the eyes, ears, internal organs, skin, muscles, and other sensory receptors. This quantity of data would overwhelm the brain if not for an attention filter that determines which two thousand or so bits of data are accepted for entry.

The structure that determines what gets in – what the brain attends to is called the *Reticular Activating System* or RAS. The RAS is a primitive network of cells in the lower brainstem that is essentially the same in structure and function in all mammals including child and adult humans. The RAS is like a fine net through which sensory input must pass if it is to reach any higher regions of the brain. Without admission through this filter, information available from the senses, such as what teachers say, do, or show students has no chance of becoming memory.

Through neuroimaging research we know that the RAS is a virtual editor that grants attention and priority admission to the small fraction of all the available sights, sounds, and tactile sensations available at any moment that contain sensory data about *changes* in the brain owner's environment. What is different, novel, curious, unexpected?

Can It Hurt Me?

With novelty or change being the attention intake priority, highest priority through the attention filter is sensory information about changes in the environment that are perceived as potential threats. When threat is perceived, the RAS automatically selects related sensory input and directs it to the lower brain where the involuntary response is not to think, but to react - fight, flight, or freeze.

The benefit of priority going to possible danger is critical for animals in the wild, but as the RAS system has not changed significantly as man evolved. This intake system's priorities have significant implications for student attention in a classroom.

When students' attention response systems perceive (accurately or inaccurately) that something in the environment could be a threat (physical or emotional), such as an unfamiliar substitute teacher with a stern demeanor or gruff voice, their RAS reacts by selecting sensory input perceived as relevant to that perceived treat. The cost is in the limitation of intake of instructional input while the attention filter is not open to accepting that sensory information. The students then criticized for not paying attention to the lesson are not neurologically inattentive. Their RAS is paying attention to (letting in) its 2000 or so bits of sensory input, just not the sensory input the teacher expects them to select.

Knowing that the RAS admits sensory input that promotes curiosity only *when other survival needs are met* further emphasizes the importance of promoting school communities where students feel safe, where they can count on the adults in charge to enforce the rules that protect their bodies, property, and feelings from classmates or experiences they could perceive as threats to their well being.

The interventions you employ that reduce the perception of threat, such as creating a supportive classroom community or guiding students to develop positive coping strategies, increase their responsiveness to the valuable strategy of using novelty and curiosity to promote the attentive intake of desired instruction content.

Reduce Perceived Stress and Promote Curiosity With Novelty

Dr. Baez was my professor for at summer physics course at Harvard University. The large, hot amphitheater classroom was filled with about 100 other predominantly premed students who, for a number of reasons, chose to fulfill that medical school requirement in this six-week intensive program rather than take physics for the full year at their colleges. This would not be the dream class for any teacher.

Yet, Dr. Baez captured and held our attention so powerfully that first morning we were hooked for the summer. Instead of walking into the lecture hall, he was pushed in seated a child's red wagon. He held a fire extinguisher, which he suddenly activated, aimed at the wall, and was thus, propelled right across the room. This was his demonstration of Newton's second law, "for every action, there is an equal and opposite reaction. (Clearly he was an inspiration for folk singer daughter Joan Baez.)

Teachers without red wagons can also focus student attention through novelty, utilizing strategies such as music, curious photos, hats, or even silence. In the classroom, as in the wild, the types of change or novelty that alert attention include color, movement, music, curious objects, changes in voice (or animal vocalizations), or alterations in your appearance. You have the key to open up students' attention filters to the sensory information of your instruction by incorporating these novelties.

Curiosity Plus Prediction for Sustained Attention

When students are curious about something novel their brains activate a strong processing system that seeks an explanation for its meaning. This motivates the attention filter to continue giving priority admission to sensory input (what you say, do, and show them) perceived as offering *clues* to the meaning of the stimulus that evoked their curiosity. This is the ideal state for sustaining attentive focus because their brains' intake systems *seek* the information you offer to satisfy their curiosity. Their brains now WANT to know the information you need them to receive.

If you walk *backwards* before a lesson about *negative* numbers, the RAS is primed by curiosity to follow along when a number line is unrolled on the floor for a lesson about negative numbers or you take them "back" in history. Even a suspenseful pause in your speech before saying something particularly important builds anticipation as the students wonder what you will say or do next.

To further increase curiosity, sustain attention, and increase the subsequent memory of new learning, have students make predictions about how the curiosity evoking object or event. Prediction intensifies the brain's investment in needing to know not only what the curiosity means, but if they are correct in their "bets". Their predictions can be written down, shared with a partner, or held up on individual white boards at intervals throughout the lesson. Don't break the participation or curiosity with a "yes" or "no", but maintain the interest by responding with a nod of acknowledgment or a "thank you". The goal is for students to continue to remain attentive, so encourage them to alter or repeat their predictions throughout the class in response to the additional clues provided by the instruction.

Give it a Try

Advertising a coming unit with curiosity provoking posters or adding pieces to a large poster you cut into sections like a puzzle invests curiosity as students use the daily cues to predict what lesson might be coming up. The mounting curiosity and student predictions prime the RAS to "select" the sensory input of that lesson when it is revealed.

Playing a song when students enter the room can also promote curiosity and hold focus if they know that there will be a link between some words in the song and something in the lesson. As they seek the link their attention filter admits the sensory information in the lesson itself.

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Memory Bonus

The information that is linked to novelty or a source of curiosity and intensified by student predictions develops stronger links in memory. The brain is on heightened alert when it makes predictions because there is a neurochemical reward system that increases pleasure when correct predictions are recognized. This in an intrinsic motivation system that results in the increased memory of information when students have made predictions and receive feedback that they are correct.

This prediction-reward system is what promotes animal survival by rewarding good choices so they are remembered and repeated. In response to the pleasure of accurate predictions neural networks are altered to strengthen the prior knowledge used to make correct predictions (choices, answers, behavioral responses). When the prediction is incorrect and there is corrective feedback, the brain will even revise the memory circuits that guided incorrect predictions. This is one reason why frequent and timely corrective feedback is important so faulty circuits can be replaced with accurate information.

It is important to keep yourself motivated, especially when you are teaching in these times of overwhelming curriculum demands. Instead of limiting your self assessments to the results of your students' performance on standardized tests, consider what you achieve each time you stimulate a student's curiosity. Just as students are more motivated when they receive feedback about their accurate predictions, so are you as their teacher, so take the time to acknowledge your own successes as you recognize the increased attention and participation in your students when you use strategies of curiosity and prediction!