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How Emotion Impacts the Brain's Successful Learning and What to Do About It

Stress can reduce attentive focus…and interfere with the construction of memory and emotional self-control

The Amygdala - *The Emotional Filter*

Amygdala: For executive functions to influence intake through the RAS, there must be an open pathway from the PFC to the RAS in the lower brain. The amygdala controls traffic between the upper and lower brain. It is a part of the limbic system found in the temporal lobe of the brain. The amygdala can be thought of as a "fork in the road" or a "switching station" on the way to the "thinking brain" (prefrontal cortex). Stephen Krashen described this as the "affective filter."

- After information passes through the attention filter, it travels to the amygdala. The amygdala then directs the information to one of two places.
- The information can be sent to either the lower REACTIVE brain or to the REFLECTIVE "thinking brain" (prefrontal cortex).
- In the reactive lower brain, information triggers an automatic fight, flight or freeze response.
- In the reflective "thinking brain" (prefrontal cortex) conscious thought, logic, and ***What determines if the amygdala directs information to the reflective "thinking brain" (prefrontal cortex) or to the reactive lower brain?***

When a person is in a state of high or sustained **stress** or **fear** the metabolic activity in the amygdala increases. If this heightened state of activity is high enough or sustained, the amygdala becomes a blockade impeding flow into and out of the PFC.

- New information coming through the RAS cannot pass through the amygdala's filter to gain access to the PFC for memory construction
- Without output from the executive functions in the PFC reaching the RAS to select input for attention, attentive focus is not in voluntary control
- With flow in and out of the PFC blocked, incoming information is conducted to the **lower, reactive brain**.
- The lower, reactive brain has a limited set of behaviour outputs: fight, flight, or freeze in animals – "act out" and "zone out" in students. *Be aware of students who act engaged, but are bored or fearful of failing to achieve highest goals.*

Sources of school-related stress:

- Until the prefrontal cortex (PFC) executive functions mature, students are more reactive than they are reflective, especially when they experience stress.

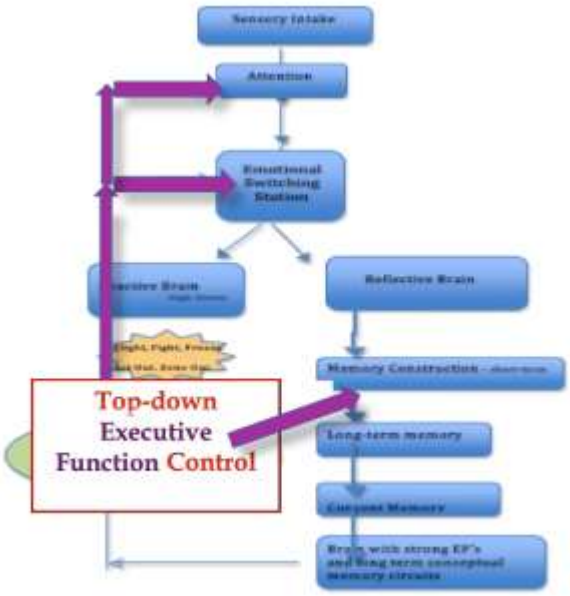
- Stress comes in many forms for students:
    - The boredom of already having mastery of the information
    - No personal relevance and not being sufficiently interested in a topic or aware of how the topic relates to a student's own interests or prior knowledge
    - Frustration from previous failures, being confused, and falling behind. *This is equally stressful for students who get failing grades and for students who repeatedly fail to achieve the goal they (and their parents) set such as #1 in the class or all "A's"*
    - Fear of being wrong if asked to speak in class, answer questions, or present their work orally - especially true for English language learners.

Promoting Transfer of Input through the Emotional Filter

Reducing Stress

Reduced stress promotes a **relaxed and alert state** in which information can pass through the amygdala and on to the **reflective "thinking brain" (prefrontal cortex)** for long-term memory and executive function processing. Students can build skills that allow the prefrontal cortex to over-ride the lower brain's reactive impulses.

- Participating in new learning requires students to take risks that are often beyond their comfort zones. Steps should be taken to reduce stress during these times.
- Students can learn how to become aware of their own stress and invoke strategies for relaxing and refocusing.



Strengthen Executive Function networks in the PFC to influence self-control and send top-down input to calm the stressed amygdalae. Participating in new learning requires students to take risks that are often beyond their comfort zones. Steps should be taken to reduce stress during these times.

Emotional self-management: Recognizing one's own emotional states, and using strategies to avoid the high stress levels that hijack the successful flow of input to and output from the prefrontal cortex, can be achieved with practice.

Guide students to *become aware of their own stress and strategies for relaxing and refocusing. Students can be taught to*

- Monitor emotions
- Reflect before acting on emotions
- Experience control over sensory responsiveness (e.g. attending to a sound for a longer time)
- Self-calm (e.g. visualization, mindful breathing)

Teach Students about Their Brains and Amygdala

- Learning how the brain processes input helps students develop more reflective PFC control over their reactive lower brains.
- "Bad" behaviour doesn't mean they are bad kids
- They can learn to influence their amygdala

Related Articles and Websites:

- ***How to Teach Students about the Brain*** link:

http://www.radteach.com/page1/page8/page44/page44.html

- ***What You Should Know about Your Brain*** link:

http://www.radteach.com/page1/page8/page45/page45.html

- Animated depiction of neuron network with axons, dendrites, and synapses: http://www.youtube.com/watch?v=frFiBNPVRl4&feature=youtu.be
- Neuroscience concepts and activities organized by grade level: www.brainfacts.org/About-Neuroscience/Core-Concepts
- Neuroscience for Kids: activities and interactive learning about the brain: http://faculty.washington.edu/chudler/introb.html#bb

Dopamine-Reward System: *Why prediction is so powerful*

Dopamine is usually thought of as a neurotransmitter. **Neurotransmitters** are chemicals in the brain that transmit signals between neurons (nerve cells). Neurotransmitters allow for information to travel from neuron to neuron throughout the brain.

Power of Dopamine

Dopamine, when released in amounts that exceed what is needed for carrying signals across synapses, travels throughout the brain. The extra dopamine now acts as a neurochemical with more widespread impact. Increased dopamine is associated with (it both increases and is increased by) pleasurable experiences and the anticipation of pleasurable experiences. Its release also increases focus, memory, and executive function.

When dopamine levels go up, the following behaviors are more prominent:

- *Pleasure*
- *Creativity*
- *Motivation*
- *Curiosity*
- *Persistence and perseverance*

The following activities increase dopamine levels:
- *Positive interactions with peers*
- *Enjoying music*
- *Being read to, or told a story or anecdote*
- *Acting kindly*
- *Expressing gratitude*
- *Humor*
- *Optimism*
- *Choice*
- *Movement*
- ***Feeling the intrinsic satisfaction of accurate predictions and challenges achieved***

Big dopamine boosters: *Making predictions and achieving challenges with progress feedback*

At the outset, a player is presented with a goal. The player begins at level one, and through trial and error (*predictions and feedback*) builds enough skills to ultimately pass level one.

The next level challenges and may exceed the player's newly developed skills, but ultimately, through sustained effort, practice, and persistence the player succeeds and continues to progress through the levels.

The player receives ongoing feedback and the dopamine boosting pleasure of ***incremental goal progress*** on route to final goal. Knowing that their effort resulted in the achievements (intrinsic reinforcement) the player is motivated to continue to greater challenge of the next level and continue to experience the pleasure of dopamine reward.

The Video Game Model in the Classroom

Video Game Model Includes:
- Goal buy-in (e.g. prediction)
- Individualized achievable challenges
- Frequent feedback or awareness of incremental goal progress

Goal Buy-in – Curiosity, Prediction, & Personal Relevance
With goals designed to connect with students' interests and authentic performance tasks

they consider relevant, students want the knowledge tools they need to succeed. Students are then in the ideal state for attentive learning because they *want to know what they have to learn*.

Examples of Personal Goal Relevance

- Read aloud something curious that relates to the topic at hand
- Personalize information by connecting the topic to a person or place relevant to students. Before a lesson or unit, tell a *narrative* about the life of the author, scientist, historical figure, or mathematician when he/she was about the age of your students
- Discuss the "So what?" factor. How the topic connects to the "real world" or to their lives. Connect a unit with current events
- Relate how they are going to use the new information after you teach it to them (e.g. project, authentic performance task, teach it to younger students)

Achievable Challenge: *Lower the Barrier, Not the Bar*

An **achievable challenge** is one in which a student has the capacity (or skills to develop the capacity) to meet an ambitious goal. As Goldilocks would say, the challenge is "not too hard, not too easy, but just right!" An achievable challenge exists within Vygotsky's "zone of proximal development".

If a challenge is too easy, a student will become bored, which leads to stress, and ultimate disengagement from learning. If a challenge is too difficult a student will experience frustration and hopelessness, which, if sustained or frequent, also leads to excessive stress. However, when facing an achievable challenge that is just within their reach, students avoid the detrimental states of stress, and the amygdala is able to pass information to and from the prefrontal cortex.

Achievable challenges promote growth mindsets

Repeated experiences achieving challenges sustain growth mindset or move student from fixed to growth mindsets to sustain motivation, perseverance, and effort.

People with a ***fixed mindset*** believe they are born with a certain amount of intelligence and skill, and that is all they will ever have. They believe that once they fail, there is no point in trying again, because they have reached their limit.

Those with a ***growth mindset*** believe that people are given a certain amount of intelligence and skill, just as they have a certain body type, but that people have the potential to grow their intelligence and skill with hard work, just like a muscle. (Carol Dweck)

Achievable challenges reduce stress from boredom & frustration

One way of helping students to develop a growth mindset is to provide them with achievable challenges and alert them to their progress

Students are most motivated by the *expectation* of a dopamine reward when they learn at their individualized levels of achievable challenge. Providing students with achievable challenges reduces the reactive states resulting from the stress of boredom or frustration and promotes the intrinsic motivation of the video game *model*.

In the ideal video game *model* all students would be learning in their personal zone of achievable challenge at all times. Frequent and ongoing assessments would guide the setting and resetting of instruction and skill practice throughout learning with the individual support needed to sustain the student's efforts to overcome setbacks and obstacles.

What can teachers do to enable students to work within *their* achievable challenge level?

Lower the barriers, not the bar:
Communicate high expectations for all students and provide differentiation and support so students can achieve their goals. At the start of a unit clearly define the learning goals, success criteria, and types of assessments. Take time to provide examples of how students' interests will be incorporated into their learning and how their strengths will be included in the assessments.

- Use pre-assessments
- Activate prior knowledge
- Choice of levels of challenge on route to mastery e.g. Udio, Kahn, flexible groups, levels at work stations, websites, videos, Newsela.com (Archive of more than 500 articles each at five reading levels, organized by category and reading standard)
- Options for scaffolding and enrichment

Increase reading comprehension of challenging texts with the following strategies:

1) "Talking Back to the Text" is an interactive reading strategy that helps students become personally engaged with what they read. Students begin by writing questions and prompts on post-it notes or other small papers that they can insert into their text. Some questions are prediction questions the student will answer before reading while others require response while the student is reading.

- **Before reading** the students writes and answers prediction questions:
  - I think you'll be telling me…
  - I already know things about YOU so I predict.....

- **During reading** students can complete the following questions or prompts:
  - You are similar to what I have learned before, because you remind me of...

- I would have preferred a picture of...(or sketch/download their own)
- I didn't know that and I find it interesting because …
- I disagree because…
- This is not what I expected which was…
- This gives me an idea for …
- I want to know more about this than you have to offer. I'll find out by…
- I have a different way of interpreting *this* information, which is…
- I won't let you get away with this statement, so I'll check your source by ……
- This could be a clue to help me answer the "Big Question" because…
- I think this will be on the test because…

2) "Highlighting with Three Colours"
Highlighting helps students understand complex texts with the use of a *three-colour system*. They'll need a book they can write in, an on-line book/article, or if they can't write in it, a copy of the pages you need to read.

With the very complex text, instruct them to highlight the phrases they understand the first time in one colour. They don't need to go back to reread confusing sentences or look anything up. Just highlight the phrases that they understand – and that may be very little the first time. After that, just change marker colours and go through it again just highlighting any additional understood phrases with the new colour. Repeat with the third colour for the third reading.

The highlighters can be any three colours, as long as you keep track of which order you use them in, such as:

- First reading: yellow
- Second reading: blue
- Third reading: green

Online Learning Games for Scaffolding and Enrichment: These can be used for skill practice and feedback at the student's individual level of readiness

- **Edutopia links** to my blogs about *On-Line Learning Games* for foundational knowledge and practice: http://www.edutopia.org/technology-integration-research-evidence-based-programs
- **Online Learning Game Resources:**
- **Graphite is a free service from Common Sense Media.** They list many apps, games, websites, and digital curricula. http://www.graphite.org.
- **EdSurge Product Reviews** https://www.edsurge.com/p

Frequent Formative Assessment, Ongoing Feedback, & Awareness of *Incremental Progress*

Students will experience the ***intrinsic pleasure of incremental progress*** if provided opportunities for ongoing formative assessments with feedback, re-teaching, opportunities

for self-corrections, and metacognition. With this exposure students can build understanding and progress at achievable challenge levels of success. In general we experience an intrinsic reward when we realize that we are making progress due to our practice and effort. Even noticing small changes can be helpful. For example, having students keep a graph of how their reading fluency improves based on how much they practice can be very motivating.

Developing Awareness that Effort Increases Goal Progress in Video Game Model

- Conferences
- Portfolios
- Metacognition/class discussion
- Analytic Rubrics with examples of different levels (e.g. benchmark examples)
- Effort=Progress to Goal Graphs

Analytic Rubrics for Incremental Progress Awareness

Analytic rubrics follow the amygdala positive benefits of the video game model of achievable challenge and incremental progress. Rubrics allow all students to:

- Understand what is expected and how they can achieve steps of incremental progress along the way toward overall goal
- Experience the choice (a dopamine booster) of achievable challenge – where they will focus effort
- Develop metacognitive awareness so they can self-motivate (dopamine from intrinsic gratification)

(REFERENCE: Nancy Pickett and Bernie Dodge. *"Rubrics for Web Lessons."* October 2001)

Rubric Generator Websites

http://www.teachervision.fen.com/teaching-methods-and-management/rubrics/4524.html#ixzz1d2xZeJck
http://www.teach-nology.com/web_tools/rubrics/
http://rubistar.4teachers.org/index.php
http://myt4l.com/index.php?v=pl&page_ac=view&type=tools&tool=rubricmaker

Effort=Progress to Goal Graphs

Help your students use graphs to see the connection between their work, practice, effort, and their progress. Goals can range from time spent preparing for tests, number of answers correct on spelling tests, to progressing up rubric levels of proficiency in any subject. Help students build their own goal-directed behaviour patterns by selecting the progress points they want to achieve on route to the final goal. Use small post-its or write in pencil when they believe they can reach each goal subdivision. As they progress they examine the accuracy of their projections and revise subsequent goal achievement dates and strategies accordingly.
Sample graphs: www.onlinecharttool.com

Summary: Positive Emotional State to Engage and Sustain Attention (and memory)

1. Emotions influence where new information is processed in the brain. For learning to become memory it must be directed through the amygdala to the prefrontal cortex.
2. High stress reduces information flow through the amygdala (emotional filter) to and from the cognitive/reflective brain (PFC).
3. During high stress, the survival instinct takes reactive control and responses are directed by the involuntary "lower" brain with output limited to fight/flight/freeze responses (act out/zone out).
4. The mammalian brain is wired to withhold effort when experience predicts a low probability of success.
5. The human brain can be "rewired" to reverse effort withholding when instruction follows the video game ***model*****:** buy-in for attention, achievable challenge, and frequent feedback of *incremental* goal progress.
6. The power behind the video game "model's" impact on motivation and perseverance is the intrinsic reinforcement of the *dopamine*-reward response to accurate predictions and feedback of challenges achieved.
7. Goals that are clear, personally relevant, and believed to be achievable challenges are needed to promote attention "buy-in" and sustained effort when previous efforts have not yielded goal success.

To promote a positive attitude so that information gets to the prefrontal cortex (PFC):

- Use attention boosters for buy-in e.g. curiosity promoting questions/demonstrations and personal relevance
- Have students work in their zone of "achievable challenge"
- Teach students how to recognize their progress towards a goal

Questions to Consider in Planning Units How will students have attention buy in "hooks" to connect them from the beginning and sustain their interest in learning and understanding (curiosity, predictions, personal relevance)

- How will I provide individualized achievable challenge (different routes to mastery)
- How will I provide incremental progress feedback for students?

Your Challenges and Opportunities Start with One Student

- Teaching isn't brain surgery – It's harder
- Start with your achievable challenge – you need the validation of success to keep your dopamine-effort up
- Select one student where your efforts to "individualize" will have evident impact on attentive focus and sustained engagement
- Be alert for improvements: ambient classroom noise, less tardiness, more participants in discussions, perceptive questions, less disruptive classroom behaviour

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