# From *Frustrating* Forgetfulness to *Fabulous* Forethought

*Current research on the adolescent brain may provide insight on how to create a more fruitful learning environment*

**Megan Hall and Georgia Brier**

How many times have you heard a student say, "I totally forgot to do my homework" or "We had a project due today?" Or, on the opposite side of the spectrum, how many times have you seen students so engrossed in the task at hand that they are oblivious to their surroundings? Teens exhibit many of these types of behaviors—of both inattention and intense focus. From an adult's perspective, one cannot help but wonder why this happens. Part of the answer lies in the neural restructuring of the adolescent brain.

This article examines neuroscience research and offers educational strategies for science teachers to facilitate adolescent learning experiences. Our intent is that the information provided will make educators' lives less stressful in dealing with adolescent behaviors.

## Adolescent neural development

During the last decade, research on adolescent brain development has provided insight into adolescent behaviors. Current research has shown that neural transformation takes place during the teen years, and during this period some noteworthy structures of the brain are affected (Casey et al. 2005). The first affected structure is the prefrontal cortex. Located approximately behind our forehead, the prefrontal cortex has been implicated in "Executive Function"—higher cognitive abilities such as alertness, attention, planning, working memory, and regulating appropriate social behavior (i.e., emotional and impulse control) (Strauch 2003; Giedd et al. 1999; Casey et al. 2005).

This may explain why adolescent students find it difficult to keep track of their homework, plan, and organize. We know of a student, for example, who lost his backpack three times during a single trimester. Each time, every piece of schoolwork—notes, lab work, and homework assignments—was completely lost. He continually struggled to focus and stay awake in class. When he heard in class that his frontal lobe would finish developing when he was about 25, he sat up a little bit straighter and his eyes focused. He said, "Wait. So, it'll be easy to plan and organize? I'll look forward to that." Other than providing his class with a humorous experience about his predicament, the student also realized that his cognitive abilities would start maturing, as most adolescents do, at later stages (around the mid-20s) (Strauch 2003).

A second structure that undergoes rapid transformation during adolescence is the cerebellum, which mediates balance and motor coordination. However, the cerebellum recently has also been implicated in recognizing social cues (Strauch 2003). A third structure that changes dramatically during adolescence is the limbic cortex—brain structures involved in emotion, attention, and memory (i.e., hippocampus, cingulate gyrus, amygdala) (Walker 2002). Because structures in the limbic cortex have direct connections to the prefrontal cortex, it is not surprising that the emotional components of the adolescent brain are still a work in progress.

In order for any type of human behavior to be expressed, billions of neurons that compose the brain have to communicate with each other. These cells communicate through electrochemical signaling. A neuron is composed of three main parts—the dendrites, cell body (or soma), and axon. Generally speaking, dendrites receive incoming chemical sig-

**FIGURE 1**

**Example of a daily log and homework list.**

**Biology: Cells and their functions.**

| Day | Date | What did we do in class? | Was there any homework? |
|---|---|---|---|
| M | 2/5 | Activity: Make a plastic bag cell model with gel, glitter, etc.<br>Chapter 6 notes | Chapter 6, p. 144:<br>Review questions 1, 4, 7, 11<br>Critical thinking 2, 5, 6<br>Due Thursday, 2/18 |
| Tu | 2/6 | Cell bonanza lab<br>Cell coloring worksheet | |
| W | 2/7 | Video: Understanding Cells<br>Set up pickle lab | |
| Th | 2/8 | Go over homework<br>Finish pickle lab<br>Cell project: show examples, go over rubric, pick partners, and brainstorm | Cell project due Friday, 2/16 |
| F | 2/9 | Project work day: design and plan to get materials | Prelab: Leaf structure and stomata (7A, on p. 644) |
| M | 2/12 | Leaf structure and stomata lab | |
| Tu | 2/13 | Work on projects: build cells | |
| W | 2/14 | Notes: photosynthesis and cellular respiration<br>Demo: Underwater Leaf Breathing | |
| Th | 2/15 | Project work day: finishing touches | |
| F | 2/16 | Present projects | Chapter 7, p. 162:<br>Review questions 2–3, 7–9<br>Critical thinking 1, 4<br>Due next Tuesday |

nals (via neurotransmitters) to the cell. The cell body processes the incoming information and responds to the information. The axon sends an action potential (an electrochemical signal) from the cell body to synaptic terminals, where the information is converted into chemical signals (through neurotransmitters) and transmitted to other neurons. A fatty cell type, called *myelin,* surrounds the axon to act as an organic insulator. A major wave of myelin production occurs during adolescence. This wave of myelination allows neuronal communication to become efficient, especially around the axons connecting the prefrontal cortex and the limbic system (Walker 2002). This suggests that teens are still developing appropriate efficient connections to modulate their emotions.

Given the current understanding of adolescent neural development, we describe some educational strategies that may enhance adolescent learning experiences.

## What educators can do

Science educators can benefit from a deeper understanding of brain development and apply neuroscience findings pedagogically. Providing visible and invisible structures can scaffold planning strategies and teach organizational skills. Providing welcoming and emotionally neutral environments can help adolescents leave their emotional whirlwind at the classroom door. Learning to support students' frontal lobe development is an enormous challenge. The following strategies help all adolescents; the strategies can be particularly helpful for students with pronounced learning issues involving attention and organization.

### *Addressing adolescent cognitive issues*

During this period of neural development, students often need help with planning and organization. Throughout the school year, teachers can help students plan, but should not do all of the organizational work. Teachers can stress to students that by taking responsibility for noting and completing assignments, they are learning actual skills needed in adulthood. Reliable, repetitive reminders of assignments in various forms provide the structural support that bridges adolescent organizational gaps.

- **Maintain firm due dates.** Adolescents struggle to imagine consequences. A student may need to experience negative consequences before the importance of planning sinks in.
- **Keep a record of daily class activities and assignments in the classroom.** A three-ring binder at the front of the classroom that contains a daily log and homework list for each class can help students keep track of activities and assignments. Students coming back from an absence can check the log sheet (see Figure 1, p. 25, for an example) to find out what they missed. Technology can also help in this area, for example, posting assignments on an electronic course management system like Moodle (Perkins and Pfaffman 2006).

**FIGURE 2**

**Example of a unit check-off list.**

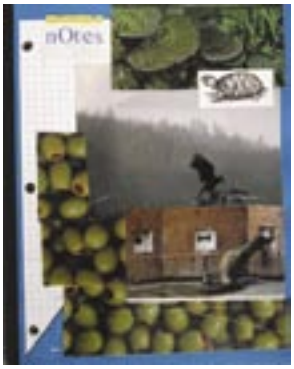
| | | Did you include it? | Grade |
|---|---|---|---|
| **Day-by-day calendar** | | | / |
| **Class notes with chapter questions** | | | |
| Chapter(s) with questions | | | / |
| | | | / |
| | | | / |
| | | | / |
| | | | / |
| **Labs/activities/projects** | | | |
| Description | | | / |
| | | | / |
| | | | / |
| | | | / |
| | | | / |
| **Scrapbook articles** | | | |
| Title | | | / |
| | | | / |
| **Study aide** | | | / |



- **For each unit, provide a unit organizer that delineates types of assignments.** Students can keep track of what has been assigned and what they have completed (Figure 2).
- **Assign specific note-taking and laboratory organization schemes, like a designated lab notebook.** Students can take notes starting on one side of their lab notebooks. Students can then flip their notebooks upside-down and backward and record labs starting on the other side. By using a specific type of notebook (e.g., composition with graph paper), students will be less likely to use the notebook for other classes and will associate that notebook only with your class. Part of a class period can also be used to decorate lab notebooks (Figure 3). Decorating notebooks is a fun way to engage students in the first steps of investing in these academic documents. While students collage appropriate images onto the notebooks, they can also start a table of contents page and number pages. Decorating notebooks also helps develop student ownership. A student is more likely to invest time and energy in a document

**FIGURE 3**

**Examples of decorated lab notebooks.**




that resonates with his or her identity.

- **Use the same format for each assignment handout and color-code when possible.** For example, a homework template using standardized headers and consistently colored paper can help students organize these assignments (Grumbine and Alden 2006).

### *Addressing adolescent emotional issues*

Oftentimes, adolescents' emotions color or distort outside world events. Because affective engagement is so crucial to learning, tools that quiet the storm and redirect students' attention, while still activating the limbic system, can provide powerful assistance. The following tactics can help.

- **Demonstrate emotional neutrality.** Given the turmoil happening in the teenage brain, adults need to project calm, stabilizing behavior.
- **Provide choices.** When a student can create hypotheses and design experiments, curiosity develops. When a student can choose his or her project topic, ownership develops.
- **Break down larger assignments into smaller steps.** On project assignment sheets, try to include a narrative that can coach a student through the steps of the project. Focusing attention on one step at a time helps the bigger picture come together and minimizes students' potential to feel overwhelmed.
- **Vary instruction to provide novel experiences that are emotionally engaging.** Students' emotional associations with learning experiences can strengthen long-term memory.
- **Hold mini-conferences at regular intervals to check in with students.** While the rest of the class watches a science film or works on a project, a teacher can sit down with each student for two to three minutes. Asking students whether they know what assignments they are missing, how many times they have been absent, and so forth, provides a simple but effective check-in. Students can be expected to keep track of their assignments, but it helps if the teacher is ready with a list of missing work. Checking students' notebooks and assignment binders can reinforce good organizational habits and also uncover deficiencies. This simultaneously builds the student-teacher relationship while pulling together loose organizational ends.
- **Focus on the positive and on what can be done to improve every difficult situation.** Because adolescents are learning how to modulate emotions, they benefit enormously from the ability of adults to both guide social interactions and model socially appropriate responses. Demonstrating to students that seemingly insurmountable obstacles can be overcome calmly, logically, and gracefully helps build pathways for self-directed management of future challenges.

In conclusion, neuroscience research can provide some explanations for a plethora of behaviors in teenage students, ranging from emotional outbursts over seemingly trivial matters to disorganization and inability to plan ahead. As adults and science educators, we now have a growing understanding of the underlying neurological changes occurring during adolescence. Current advances in neuroscience can provide teachers with valuable understandings to help students navigate this time of rapid brain development. ■

*Megan Hall* (megan.hall@spps.org) *teaches science at Open School in St. Paul, Minnesota, and Georgia Brier* (brie0062@umn.edu) *is a program specialist with the Department of Neuroscience at the University of Minnesota in Minneapolis, Minnesota.*

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