OUR BODIES, OUR MINDS, OUR SELVES: SOCIAL NEUROSCIENCE AND ITS APPLICATION TO EDUCATION

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“I've had three friends die of gang violence, and they weren't even from a gang...
I cried for two of them, and then the third one, I was just like, in shock. I was like… I can't believe that just happened again.” (as heard on KPCC Southern California Public Radio, story by F. Stoltze, 5-22-08)

15-year-old Alan’s story is one of fear and sadness, of turning from compassion and embodied, tearful awareness to numbness and “shock”. It is a story of empathy come and gone, of emotion felt and lost, of consciousness altered by engagement changed to disbelief. Alan speaks of his life in Los Angeles, but he could be telling the story of many young people caught in zones of urban violence worldwide.

As many young people do, in talking about his experiences, Alan gives away what social and affective neuroscience is just beginning to understand: that the body and mind are linked, and that our very consciousness, the biological mechanisms that make possible our subjective sense of self, form the sounding board for our understanding of other people. Alan cries for the deaths of his first two friends, innocent bystanders caught in gang violence. He feels the sadness of their loss as an emotion that changes his body, through crying as well as other physiological changes, which typically include a decrease in overall activity level, lowered heart rate, a sad facial expression and posture, and other things. His friends’ deaths and the ensuing emotions he feels also alter his mind in characteristic ways, most likely causing him to dwell on the event and to have trouble concentrating on other things, and perhaps even causing trouble knowing how to relate to the other people he loves without fear that he will lose them.

Beyond the emotions that Alan reports for his first two friends’ deaths, Alan’s experience exemplifies another recent neuroscientific discovery about the relationship
between the mind and body. When his third friend dies, Alan’s reaction breaks past his former extreme sadness, to induce a state which he cogently describes as “shock.” From a neuroscientific perspective, Alan is describing the altered state of consciousness he experienced at such an overwhelming event, and alluding to a disjunct between his previous experiences and this new occurrence by stating that he could not “believe” what had just happened. That is, unable to reconcile the events he knows are true with his knowledge about what ought to be true based on his past experiences, his emotion and sense of self are temporarily dampened. He doesn’t cry for his third friend’s death, because he cannot connect his current knowledge to his past experiences in order to engage his body and mind in an appropriate emotional reaction. Instead, the resulting state is “shock,” or the emotional numbness and disembodiment that many people feel during traumatic events that would otherwise trigger overwhelming emotion.

To sum up the discussion of Alan, what have we learned? The answer forms a conceptual outline for the rest of this chapter, and leads us into a discussion of the neuroscience of emotion, social interaction, and their implications for learning and education. First, Alan’s tearful reaction to his first two friends’ deaths highlights the relationship between the cognitive and emotional aspects of Alan’s experience. Alan’s emotions and thoughts are intertwined, not separate. What he feels influences and is influenced by what he thinks, and in fact his thoughts and emotions are two aspects of the same process (Fischer & Bidell, 2006), a concept that we have previously termed “emotional thought” (Immordino-Yang & Damasio, 2007).

Second, emotions involve an interdependency of the body and brain, and both the body and brain are involved in the induction of an appropriate response to Alan’s tragic
news. Alan learns of his friends’ deaths, a circumstance that automatically triggers the emotional reaction of sadness; this reaction modulates basic physiological life-regulatory processing in the body. Alan manifests bodily changes through crying, and if we measured, we would expect to see changes in heart rate, blood pressure, and breathing pattern as well. In turn, these physiological changes are sensed by the brain, and used to shape the contents of Alan’s mind. In this way, Alan’s “cognitive” knowledge triggers an “emotional” response that involves bodily changes as well as the accommodation of Alan’s thoughts to the feeling of these changes. In this body ↔ brain/mind cycle, emotions and cognition are intertwined, and together influence and are influenced by changes in the state of the body.

Third, Alan’s reaction to his third friend’s death forefronts how the relationship between the body, brain and mind is connected to neuropsychological mechanisms of consciousness. When Alan is unable to assimilate the knowledge of his third friend’s death, he cannot mount an appropriate emotional response in his body and mind. The result is a change in his consciousness level, experienced as “shock,” “disbelief,” and, although Alan does not directly say this, a perceived detachment or disembodiment, as evidenced by a lack of crying or emotional reaction.

Fourth, and perhaps least obvious but most important, all of the reactions that Alan describes involve his own body and mind, and yet they are induced by events that happened to other people. Here, Alan reveals that, from a neuroscientific perspective, the mechanisms involved in the feeling and control of the body form a platform for the social mind; we understand and mount reactions to others’ situations by feeling the response of our own viscera or “gut” as our mind perceives and deliberates on the situation at hand.
Related to the third point above, the feeling of our own “self” appears to involve the organized recruitment of brain networks for feeling and regulating the body, connected to memories for experiences within the social and physical worlds. Overall, social and affective neuroscience is discovering and describing the interrelatedness of the body and mind in processes of emotion, thinking and consciousness. Further, the neuroscientific evidence is becoming increasingly apparent that we understand, evaluate and react to the situations of other people by vicariously imagining them on the substrate of our own self.

**Summary Box**

This chapter is about the cognitive neuroscience of emotion and social interaction, and the implications of a cognitive neuroscientific perspective on these topics for education. Using a quote from an interview with “Alan,” a teenage bystander whose innocent friends are caught in urban gang violence, the section introduces several recent developments in the neuroscientific study of emotion and social interaction. Most importantly:

- Emotion and cognition are intertwined, and actively involve both the body and mind.
- Social processing and learning happen by internalizing subjective interpretations of other people’s beliefs, goals, feelings and actions, and vicariously experiencing these as if they were our own.

**What is emotion?**

As an entry point to the discussion of educationally-relevant advances in affective and social neuroscience, it is useful to lay out a neuroscientific definition of emotion. While lay views of emotion abound, here we understand emotion as a set of cognitive and
physiological processes that constitute a person’s automatic evaluative reaction to a perceived, remembered or imagined circumstance. As such, emotions involve both the body and mind, and utilize brain systems for body regulation (e.g. for blood pressure, heart rate, respiration, digestion) and sensation (e.g. for physical pain or pleasure, for stomach ache; Damasio et al., 2000). Emotions also influence brain systems for cognition, changing thought in characteristic ways—from the desire to seek revenge in anger, to the search for escape in fear, to the receptive openness to others in happiness, to the ruminating on lost people or objects in sadness. In each case, the emotion is played out on the face and body, a process that is felt via neural systems for sensing and regulating the body. And in each case, these feelings of the body interact with other thoughts to change the mind in characteristic ways, and to help people learn from their experiences.

It is important to understand that in this view, emotion and thinking are never truly separated, and learning always involves both emotional evaluation and cognitive processing (see Figure 1, from Immordino-Yang & Damasio, 2007). Even solving the driest academic problem involves emotional as well as cognitive processing. For example, how does a high school student, let us call her “Amy,” solve a mathematics problem? To apply problem-solving skills usefully in math, Amy must first motivate and engage herself sufficiently, must recognize the type of problem that is before her, and must call up information and strategies that will steer her toward a correct solution. Emotion plays a critical role in all of these stages of problem solving, helping Amy to consciously or non-consciously evaluate which knowledge and skills are likely relevant, and which will lead to a correct solution, based on her past learning. As she begins
thinking through the solution, she is emotionally evaluating whether each cognitive step is likely to bring her closer to a useful solution, or whether it seems to be pointing her down the wrong path.

From a neuropsychological perspective, the brain systems for emotion form the “rudder” that steers this student’s thinking toward the development and recruitment of an effective skill (Immordino-Yang & Damasio, 2007), in this case for the solving of math problems. Through regulating and inciting attention (Posner & Rothbart, 2005), motivation, and evaluation of possible outcomes, emotion serves to modulate Amy’s recruitment of brain networks that support the skills she is developing. Here I use the example of solving a hypothetical math problem, but the same mechanisms would be at play in the solving of other sorts of problems too, such as in deciding how to help one’s friend or how to vote in a presidential election.

<FIGURE 1 ABOUT HERE>

**Summary Box**

Emotions are packages of behaviors and cognitive strategies that are automatically triggered in certain contexts, either real, imagined or remembered (Damasio, 1994/2005). We use the term “emotional thought” (Immordino-Yang & Damasio, 2007) to describe the mental platform that supports important educational processes like learning, memory, and problem solving, because in real-life learning, emotional and cognitive aspects of mental processing are never separate. In emotional thought, emotion-related changes in the mind and body form feedback loops that steer thought and behavior. In essence,
emotion can be seen as the rudder for learning, as it guides thought and behavior in order to foster the development of effective skills for acting in the social and physical worlds.

**From “self” to “other” and back again**

Many emotions are social, and anyone involved in educating children, from teachers and parents to coaches, counselors and beyond, knows that social learning is a major force in children’s development. Typical children watch and engage with other people, imitate other people’s actions (including mental actions and beliefs), and look to trusted adults and peers for emotional and other feedback on their behavior. They imagine how other people feel and think, and those thoughts in turn influence how they feel and think.

Educators have long known that thinking and learning, as simultaneously cognitive and emotional processes, are not carried out in a vacuum, but in social and cultural contexts (Fischer & Bidell, 2006). A major part of how people make decisions has to do with their past social experiences, reputation and cultural history. For example, returning to Alan and Amy, it is obvious that both of these adolescents are using past experiences to guide their current behavior and learning. In Alan’s case, knowing how it felt to have friends leads him to understand the implications of losing them, and knowing how it feels to get physically and emotionally hurt helps him to understand what his friends must have experienced before they died. In Amy’s case, why does she solve the problem? The reasons may include the desire to please her parents, the intrinsic reward of finding the solution, the avoidance of punishment or the teacher’s disapproval, or the desire to attend a good college. Although we do not usually think of math problems as
emotional, from a neuroscientific perspective, each of these reasons involves an implicit or explicit social or emotional value judgment. As the student imagines how others would react to her behavior, and how it would feel to solve the problem, she engages feedback loops between neural systems supporting memories, sensations, and cultural values, including how she felt in the past in similar situations. Just as for Alan, all of this processing comes together to help steer Amy’s current thinking and behavior, while at the same time giving her a context in which to interpret and learn from her new experiences. As we can see, despite the differences in Alan’s and Amy’s experiences, both adolescents’ behavior is guided at every step by their ability to make social and emotional evaluations and predictions, and by their ability to use their own selves as a platform for decision-making.

**Summary Box**

Many emotions are social. As their name suggests, social emotions involve feelings about other people. Such emotions play an important part in helping to guide students’ and teachers’ behavior and thinking, because they enable people to make predictions about how others will react to their decisions and actions. From a neuroscientific perspective, these predictive processes form a basic mechanism of social learning, as they enable people to learn from others’ behavior, while also guiding their own behavior in directions that will lead to positive outcomes. These processes also underscore the subjective nature of social processing, as predictions and evaluations are made in relation to a person’s own culture, memories, biases, and preferences (Immordino-Yang, 2007).
The neuroscience of self and other

As alluded to above, social neuroscience is revealing some of the basic biological mechanisms by which such social and emotional processing takes place (Frith & Frith, 2007; Mitchell, 2008), although applications to classroom practice are only just beginning (Immordino-Yang, 2009). According to current evidence, social processing and learning generally involve internalizing one’s own subjective interpretations of other people’s feelings and actions (Uddin, Iacoboni, Lange, & Keenan, 2007). We perceive and understand other people’s feelings and actions in relation to our own beliefs and goals, and vicariously experience these feelings and actions as if they were our own (Immordino-Yang, 2008). This processing allows us to empathically experience the emotional and cognitive effects of another person’s circumstances, be they about urban violence or about math problems, and to use these empathic experiences to guide our own behavior and learning.

Notably, empathically experiencing another person’s feelings and actions involves neural systems relating actions with their resulting perceptions. Bringing this discussion to the level of neuroscience explanations, I appeal here to the findings about “mirror neuron” systems (Oberman & Ramachandran, 2007; Rizzolatti, Fogassi, & Gallese, 2001; Umiltà et al., 2001). Although they have not always been described in this way, so-called “mirror systems” are, in essence, networks in the brain where systems for perception and systems for action converge and feed into one another (Antonio R. Damasio & Meyer, 2008). And here is the most important part for educators to consider: in order for these convergence areas to be activated in an observer watching another person, the observer must have some context in which to understand the purpose or goal
of the action being observed. And, in order for an action to be perceived as goal-directed or purposeful, the observer must have some sense of the change in circumstances that the action will produce, i.e. “the goal.” In turn, the change in circumstances that the action produces will be perceived, and then fed back into motor systems, to inform the planning of future actions. (For a more complete treatment of the role of mirror systems in the production of meaningful skills, see Immordino-Yang, 2008.)

To understand how this process is invoked in empathically assessing other people’s actions, think, for example, of the last time you were in a quiet meeting, when suddenly someone began frantically groping for his ringing cell phone. Everyone in the room instantly knew why this person was searching his pockets, as well as the result he was aiming to bring about. Further, everyone in the room likely felt some of the accompanying emotions this hapless person felt as he searched. Why? Because everyone in that room shared a common cultural understanding of the appropriate use of technology in a meeting, and of the embarrassment that results from a breach of conduct. Lastly, what did several people in the room do after watching this unpleasant predicament? Of course, they turned off their own cell phones!

To understand what this means for education, think about a typical classroom, with students engaged in problem-solving activities while the teacher demonstrates and explains the concepts. Beyond the obvious linguistic and visual necessities, what is required for a student to understand and learn from a teacher? And, conversely, what can the teacher do to facilitate students grasping what she is trying to teach? From a neuroscientific perspective, for students to accurately perceive the information the teacher is trying to get across, the student and teacher must implicitly understand each
other’s goals. This is because, to perceive another person’s actions as meaningful, a process which involves empathic activation of motor planning systems (via sectors of these systems known as “mirror neuron” areas) and many other neural systems for various aspects of emotional thought, requires that the perceiver have some background, some prior experience with the topic at hand, some reason to engage. Despite the teacher’s best efforts, if the students are not in tune with the purposes of the lesson, if they are not able to empathically internalize the aim of the teacher’s actions and words, they may not even perceive the features of the lesson that the teacher meant to convey. To them, the teacher’s words and gestures may seem irrelevant, meaningless, or pointless. Alternatively, the students may impute the wrong goal to the teacher’s actions, thinking, for example, that the teacher is only interested in boring them, or in making them feel unintelligent, or in making them learn something that is entirely different from what she actually intends.

**Summary Box**

Just as affective neuroscientific evidence links our bodies and minds in processes of emotion, social neuroscientific evidence links our own selves to the understanding of other people. From a neuroscientific standpoint, understanding other people’s actions, and hence learning from other people, is a process that involves an observer imagining another person’s actions as if they were her own. This process is inherently subjective and biased, as the observer imputes goals to the other person’s actions based on her own experience within that or similar contexts. In educational settings, this suggests that if the students do not understand the teacher’s goals, they may not perceive the teacher’s lesson as it is intended, and the content will be lost. To remedy this, teachers should strive to
learn about the culture and mindset of their students, in relation to school and the relevant
subject matter. Further, teachers should work to make their goals as explicit as possible
for the students, rather than hidden underneath the veil of the subject matter as s/he
understands it.

Schools as social contexts and learning as emotional activity

To conclude, social emotions and their associated thoughts and actions are
biologically built but culturally shaped; they reflect our neuropsychological propensity to
internalize the actions of others, but are interpreted in light of our own social, emotional
and cognitive experiences. These social, emotional, and cognitive experiences, in turn,
can be interrelated under the heading of “emotional thought,” which can originate in the
mind but involves interplay between the body and brain. As we have seen, social and
affective neuroscience, while it cannot directly show teachers how to interact with
students, can inform educators’ knowledge of why and how students learn, especially in
social contexts. Incorporating this new information into traditional models of teaching
and learning may lead to innovative, effective methods for engaging students in
meaningful learning.

References

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Figure Caption

Figure 1. The thought processes that educators care about, among them learning and memory, involve both emotional and cognitive aspects, and the body as well as the mind.

In the diagram, the solid ellipse represents emotion; the dashed ellipse represents cognition. The extensive overlap between the two ellipses represents the domain of “emotional thought.” Emotional thought can be conscious or non-conscious, and is the
means by which bodily sensations influence the mind during learning. High reason is a small section of the diagram, and refers to the most abstract and logical of thought processes, which are nevertheless informed by emotional thought. Reprinted with permission from Immordino-Yang and Damasio (2007).