Moment-to-Moment Emotions during Reading

Arthur C. Graesser
University of Memphis
Sidney D’Mello
University of Notre Dame

The Reading Teacher, Research into Practice

Art Graesser
Department of Psychology & Institute for Intelligent Systems
202 Psychology Building
University of Memphis
Memphis, TN 38152-3230
901-678-4857
901-678-2579 (fax)
a-graesser@memphis.edu

Sidney D’Mello
Department of Computer Science
Department of Psychology
University of Notre Dame
Notre Dame, IN 46556
Phone:(901)-378-0531
http://www.nd.edu/~sdmello
Email: sdmello@nd.edu

Art Graesser is a professor in the Department of Psychology and Institute for Intelligent Systems at the University of Memphis, Memphis, USA; graesser@memphis.edu.

Sidney D’Mello is an assistant professor in the departments of psychology and engineering at Notre Dame University, USA; sdmello@nd.edu.

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Reading failures can be explained by dozens of cognitive, motivational, and social factors. In this article we put the magnifying glass on a factor that has been neglected over the decades of research in reading and the learning sciences: Moment-to-moment emotions. Readers experience a variety of emotions and cognitive-affect states that typically fluctuate dynamically. These moment-to-moment trajectories of emotions have only recently been identified by researchers in reading, cognitive, and learning sciences (Baker et al., 2010; D’Mello, Craig, & Graesser, 2009; D’Mello & Graesser, 2012; Graesser & D’Mello, 2012; Woolf et al., 2009). This article provides some tentative answers to a number of fundamental questions about the links between emotions and reading. What emotions occur during reading? How do the emotions interact with comprehension and learning? How can these emotions be identified? How might a teacher or computer improve reading comprehension by attending to these emotions?

The definition of emotion in this article is purposefully inclusive and broad because there has been precious little empirical research on moment-to-moment (M2M) emotions during reading and other learning tasks. An emotion is defined as an affective state (or hybrid cognitive-affective state) that deviates from a neutral, baseline, set-point of physiological arousal. More nuanced definitions and classifications of psychological states will no doubt emerge as this research area matures. This article does not focus on enduring emotional traits of readers or moods that span several minutes or hours (Meyer & Turner, 2006; Pekrun, 2006). Instead, the concern is with the either the persistence or changes in emotions every few seconds.

Four Scenarios Illustrating Links between Reading and Emotions

Some concrete examples make it quite apparent why it is important to understand the M2M emotions during reading. Consider the following scenarios.
Scenario 1: Boredom. The reader becomes bored when the text is not delivering relevant information to the reader’s needs. The material may be too dense and beyond the reader’s zones of abilities, so the reader gets pie eyed and tunes out. On the flip side, the text may be so easy that the reader’s mind wanders (Smallwood & Schooler, 2007). The reader will obviously not get much out of the reading material when this happens. We can explore what characteristics of the text and reader predict when boredom occurs. Readers rarely read complete articles in newspapers and other media, so one can explore the point in the text when the readers tune out. We can examine the half-life of engagement. When in the text does engagement die and when are there kick-starts of re-engagement?

Scenario 2: Frustration. Readers in some academic contexts do not have the option of disengaging from the text. Forced-fed reading can be frustrating when the material is incoherent, arcane, tedious and irrelevant to the reader’s goals. It is well documented that the reading experience is influenced by text characteristics (Graesser, McNamara, & Kulikowich, 2011) and the relevance of the material to the reader’s goals (McCrudden & Schraw, 2007). Frustration may occur when there is a clash between academic assignments, texts, and reader goals.

Scenario 3: Confusion. Students experience confusion when cognitive disequilibrium arises from obstacles to goals, contradictions, anomalous information, uncertainty, text cohesion gaps, and obvious gaps in knowledge. Interestingly, confusion is a strong positive predictor of learning and comprehension to the extent that it encourages thinking and reasoning (D’Mello, Lehman, Pekrun, & Graesser, in press). However the reader’s attributions matter. Some students attribute the confusion to their poor abilities in mastering the subject matter whereas others take up the challenge and apply thoughtful effort to conquer the confusion (Dweck, 2002; Meyer & Turner, 2006).
**Scenario 4: Flow/engagement.** Csikszentmihalyi’s (1990) flow state occurs when the students are so engaged in the learning material that time and fatigue disappear. The challenge lies in predicting when flow states occur. Perhaps this occurs when the text is at the reader’s zone of optimal challenge: not too easy or too difficult but just right. Perhaps reader characteristics matter. Academic risk takers may push the envelope and accept more challenges than the cautious learner who is afraid of failure (Meyers & Turner, 2006).

**What Emotions Occur during Reading?**

Researchers have tracked the M2M emotions that occur during reading and learning environments, such as intelligent tutoring systems and serious games with agents (Baker et al., 2010; Calvo & D’Mello, 2010; D’Mello & Graesser, 2012, in press; Graesser & D’Mello, in press). A small set of *learning-centered* emotions dominate emotional experiences during learning in a broad array of learning environments: Confusion, flow (engagement), boredom, and frustration, with delight and surprise occasionally occurring but considerably less frequently. These learner-centered emotions are very different than the six “basic” emotions investigated by Ekman (Ekman, 1992) that are readily manifested in facial expressions: sadness, happiness, anger, fear, disgust, and surprise. The learning-centered emotions also include anxiety when the learning involves testing or high stakes assessment.

M2M emotions frequently change over time in response to the text or other learning tasks rather than being persistent and static (D’Mello & Graesser, 2012; Graesser & D’Mello, in press). D’Mello and Graesser (2011) documented the duration of the learner-centered emotions. The durations showed the following trend for the six learner-centered emotions (Delight = Surprise) < (Frustration) < (Confusion = Boredom = Engagement/Flow). We would expect delight and surprise to be short-lived in most contexts, but the other four emotions should depend
on the particular characteristics of the learning environment, hopefully increasing with flow and decreasing with boredom. However, the status of confusion may be more complex. How long should a learner remain confused and thinking before the system triggers an event to move the learner along? Is there a zone of optimal confusion?

Transitions between emotions are important to document because they reflect the emotion trajectories over time and text (D’Mello & Graesser, 2012, in press; Graesser & D’Mello, in press). According to available evidence, the transitions are aligned with a model of emotions that emphasize cognitive disequilibrium in learning. Learners start out experiencing either a neutral state or a state of flow, referred to as cognitive equilibrium. This state exists when their knowledge and cognitive skills can handle the incoming information and tasks delivered by the learning environment (Baumann & Scheffer, 2010; Csikszentmihalyi, 1990). But eventually a text-cohesion gap or impasse occurs, which triggers an emotion of confusion or surprise. The learner engages in effortful problem solving activities in order to resolve the impasse and restore equilibrium. However, confusion transitions into frustration when the impasse cannot be resolved, the student gets stuck, and important goals are blocked. Frustration may transition into boredom, a crucial point at which the learner disengages from the learning process. In contrast, students in the state of flow are periodically challenged within their zones of proximal development and experience two-step episodes alternating between confusion and delight from insight, in route to flow/engagement (Baumann & Scheffer, 2010). In contrast to these beneficial flow-confusion-delight-flow cycles, there are the harmful oscillations between boredom and frustration. The harmful oscillation results in disengagement from the task (Baker et al., 2010).

These findings on the duration and transition between emotions underscore the importance of detecting dynamical changes rather than static features of emotions. Will teachers
be able to reliably identify such emotional dynamics in learners? How do we know what emotions the readers are experiencing?

**How Can Emotions be Identified?**

Research on M2M emotions requires the researcher to track the emotions of readers periodically during the course of reading. The Graesser and D’Mello studies poll the emotions every 20 seconds but invite judgments in-between the 20-sec time points (D’Mello & Graesser, 2010, in press; D’Mello et al., 2009; Graesser & D’Mello, in press). The people or instruments that make the emotion classifications vary:

1. *Trained observers during learning.* Trained observers periodically classify or rate the learner’s emotions during the learning session.

2. *Self-report ratings of affective states during learning.* The learners are stopped periodically during the course of learning and give judgments on their current states of emotions.

3. *Emote aloud protocols by learners during learning.* An emote-aloud procedure collects spoken verbal expressions of emotions while the students complete a task.

4. *Retrospective identification of emotions by learners, peers, trained judges and teachers.* Channels of communication and interaction are recorded, including facial expressions, conversation, computer displays, and interactions between the student and computer. These recordings are used to collect emotion judgments by the original learner, peers of learners, trained judges, and teachers.

5. *Noninvasive automated detection of emotions.* Noninvasive sensing methods do not attach sensing devices to the learner and do not disrupt the normal stream of learning by probing the students with questions about their emotions or learning. The computers detect affective states of the learner by analyzing different communication channels and their interactions, such
as facial expression, speech parameters, body posture, and language and discourse (Calvo & D’Mello, 2010; D’Mello & Graesser, 2010).

(6) Biological detection of emotions by recording events in the brain and physiology. These methods include the recording of heart rate, movements of the muscles, galvanic skin response, and brain activity (Calvo & D’Mello, 2010).

None of these measures are perfect windows into emotional experience and the various measures correlate only modestly when considering individual time points (.3 to .5 reliability indices, see Graesser & D’Mello, in press). However, the reliabilities increase dramatically when the aggregate measures are collected over time stretches.

How Can Reading Comprehension Improve through Emotions?

Given that we can track M2M emotions reasonably accurately, how can we respond to the reader to improve their reading comprehension? Once again, available research and theory gives little guidance. However, there are a number of promising hypotheses and some are backed by a modicum of empirical evidence. More research is needed to test these hypotheses in different tasks, texts, and reader populations. Three of the major learning-centered emotions (boredom, frustration, confusion) need some attention, whereas interventions are not needed for flow and the short-lived emotions of delight and surprise. The readers can be left alone when they experience the latter three emotions. It is also important to acknowledge that teachers, tutors, and computer technologies can implement affect-sensitive interventions, but these will be limited to the extent that the emotion monitoring mechanisms are not valid and reliable.

Boredom. One way to handle boredom is to present materials at a more intelligent level of text difficulty. Some bored students need increasing challenges whereas others need easier materials to build self-efficacy. There needs to be a mesh between the complexity of the texts
and the readers’ abilities. Boredom is expected to be less likely when the reading times of readers for sentences/paragraphs are aligned with the complexity of the sentences/paragraphs. Complexity can be measured in an overall scale (such as Lexiles) or particular components of reading that have been calibrated by Coh-Metrix (Graesser, McNamara, & Kulikowich, 2011) on multiple levels of language and discourse: narrativity, cohesion, syntax, and word concreteness. There are two other approaches to handling boredom. There can be an engaging environment with games, multimedia, or intrinsically interesting texts (Millis et al., in press). The student can be put in a productive mindset that motivates them through choice, importance of the material, or alignment with their interests (Pekrun et al., 2010).

**Frustration.** AutoTutor is a learning environment with conversational agents that help students learning by holding a conversation in natural language (Graesser & D’Mello, in press). One version of AutoTutor is sensitive to the emotions of the learner. For example, AutoTutor gives hints or question prompts to put the student on course when they are frustrated. This is a reasonable approach for handing the reader’s frustration. Frustrated students may be helped by a conversation that addresses the sources of frustration and that scaffolds the students to deeper understanding of the text.

**Confusion.** Confusion is a productive emotion to the extent that it promotes productive thinking and reasoning that resolves the confusion (D’Mello et al., in press). Cohesion gaps in text can stimulate more inferences in readers with greater world knowledge and general comprehension skills, a phenomenon known as the reverse cohesion effect (Ozuru, Dempsey, & McNamara, 2009). D’Mello, Lehman, et al. (in press) have conducted studies that plant contradictions in discourse and thereby created cognitive disequilibrium, confusion, and sometimes better learning gains on transfer tasks. A text or learning environment can be
designed to keep the student in an *optimal zone of confusion* to promote comprehension and learning. However, more research is needed to understand the dynamics of confusion.

**Closing Statement**

It is quite conceivable if not plausible that computer technology could play a central role in integrating emotions with learning. It is somewhat of a paradox that computers could play a humane role in developing a more compassionate reading environment. However, some recent findings lend credence to this possibility. Computers can track M2M emotions reasonably accurately and some systems can adaptively respond to readers’ emotions to promote comprehension and learning (D’Mello & Graesser, 2012; Graesser & D’Mello, in press; Woolf et al., 2009). It is extremely difficult for teachers of 30 students and even a one-on-one tutor to detect reader emotions reliably, let alone to productively respond to their emotional states. For example, many teachers perceive students as being engaged when the students view themselves as bored because boredom is not manifested on the face, but rather the context and dynamics of body posture (D’Mello & Graesser, 2010). In contrast, confusion is very much manifested on the face. The future may require coordination between technology and human instructors in tracking and intelligently responding to readers with different emotion and cognitive profiles. And the students may also need to be part of the equation. As we develop self-regulated learners, the readers will need to be actively involved in understanding the dance between emotions and reading.

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