Literature and event understanding

Heather Bailey and Jeffrey M. Zacks
Washington University, St. Louis

We believe that the scientific study of narrative comprehension will move from using short, laboratory-contrived “textoids” to longer, naturalistic narratives. This move is being driven by technological developments and by theoretical interest in event comprehension mechanisms in reading. One mechanism in which we have been particularly interested is event segmentation, which is the spontaneous organization of incoming information into meaningful discrete events. Behavioral and neurophysiological studies suggest that similar principles govern event segmentation in reading and in the perception of movies and live action. Some of these studies contribute to a growing body of evidence that readers mentally simulate events as they read, including some of their perceptual and motor properties. Based on these trends we look forward to a scientific study of narrative comprehension that is increasingly integrated with broad general theories of perception and memory.

Keywords: textoids, events, comprehension, embodied cognition

Often, researchers who study reading comprehension have used “textoids,” which are text materials contrived in the laboratory to control for various text properties (Graesser, Millis, & Zwaan, 1997). Research using textoids has been immensely valuable, particularly for studying the fine-grained structure of reading at the sentence level and below. But textoids have fundamental limitations when it comes to the scientific study of literature. First and obviously, textoids are short. Researchers are unlikely to compose novel-length texts for experimental materials, and if they did nobody would want to read them! Also, textoids often are criticized for being less interesting, less informative, and less coherent than are naturalistic texts (Graesser, Millis, & Zwaan, 1997; Kreuz & Roberts, 1993). We think cognitive research on reading comprehension will move towards using more extended, naturalistic texts (e.g., Copeland, Radvansky, & Goodwin, 2009; Radvansky, Copeland, & Zwaan, 2005). In other words, we believe the field will move from studying the individual instruments to studying the whole orchestra.
This move is already underway, and is driven in part by three technological developments. First is the creation of large psycholinguistic corpora such as the English Lexicon Project (www.elexicon.org) and WordNet (wordnet.princeton.edu). Second is the development of automated computational linguistics techniques for analyzing text such as hyperspace analogue to language (HAL; Lund & Burgess, 1996) and latent semantic analysis (LSA; Landauer & Dumais, 1997). Third is the emergence of internet-based tools, such as Amazon Mechanical Turk (www.mturk.com), that allow large numbers of people to contribute modest amounts of behavioral data rapidly and cheaply. In some cases these tools allow researchers to characterize extended texts without prohibitively expensive hand coding. In other cases they make coding by humans more tractable and affordable. All three of these advances in methods are exciting and important. But the real energy driving the move from textoids to texts comes from the theoretical questions: If you want to understand how people really read then, at some point, you have to study how people really read. This society and this journal are perhaps the best evidence for the significance and currency of this point.

The trend toward studying how people read extended narratives in more natural settings dovetails with an increase in research on event comprehension in psychology and neuroscience (see, e.g., the papers in the recent volume edited by Shipley & Zacks, 2008). In some sense events are the heart of narrative prose. In our laboratory, interest in the cognitive neuroscience of extended narrative text comprehension grew out of a broader interest in event understanding. Specifically, we study how people process everyday activity that they view (e.g., in real life, movies, television, etc.) or read about (e.g., in novels, in newspapers, etc.). We also are interested in how the perception and organization of this activity is related to how well it is remembered at a later time.

Research using these naturalistic materials led us to propose that people spontaneously segment ongoing activity into discrete events, and to try to account in computational and neurophysiological terms for how they do so. The result, which we call event segmentation theory (EST; Zacks et al, 2007), proposes that segmentation comes about as a side affect of predictive processing during comprehension. When people see or read about an activity, they continuously make predictions about what will happen in the near future. These predictions are guided by working memory representations called event models. (We use the term “event model” to distinguish them from the text-specific properties sometimes intended by the term “situation model,” but the two constructs are similar.) When activity becomes less predictable, people segment the activity and memory is updated. The points at which activity is segmented are important because they help people chunk complex activity into more meaningful events. That is, rather than perceiving an activity (e.g., preparing breakfast) as a continuous stream of input, the activity is
broken down into manageable events (e.g., gathering ingredients, scrambling eggs, making toast). In turn, people who are able to effectively segment activity are better able to remember the activity (Zacks, Speer, Vettel, & Jacoby, 2006).

We believe that the event segmentation process that occurs when people observe an activity is the same process that occurs when people read about an activity. However, it is important to note that the act of reading about an event has unique properties that distinguish it from the act of viewing the actual event take place. One can distinguish between three key mechanisms of narrative reading: Event comprehension mechanisms are domain-general and phylogenetically old. Spoken language mechanisms are evolved but are phylogenetically newer and to some extent specialized (e.g., Pinker & Bloom, 1992; but see Elman et al., 1998). Written language mechanisms emerged quite recently and were invented rather than evolved. Reading a narrative is a hybrid activity that depends on all three of these. Although reading and comprehending written language has some unique properties, we are really interested in the part of text comprehension that is shared with movies and with real-life situations — event comprehension mechanisms.

Written narratives describing events provide us with three key tools for studying event comprehension. First, narratives allow for the experimental control of more conceptual features of everyday experience. When writing experimental texts, researchers can control for a number of variables, such as word frequency, sentence length, and situational changes. Second, they provide us with a well-developed theoretical means for characterizing situations and how they evolve over time. Third, narratives give us a set of experimental methodologies in which we can assess reading time, word recognition, lexical decisions, and “think aloud” protocols. Importantly, narratives give us the opportunity to examine whether people perceive and understand written and observed events in similar ways.

There is good reason to think that — at least under some circumstances — readers simulate the perceptual and motor experiences described by a narrative. Theoretical accounts have been proposed by Barsalou (2005), Glenberg, (2007), and Zwaan (2004). Specifically, Barsalou (2005) has argued that, as we read, previous knowledge and experience with the information in a text invokes situated conceptualizations, which are a combination of multiple simulations related to different modalities. For example, when we read about a blooming tulip, we may mentally experience several characteristics of it: what the tulip smells like, what color it may be, the shape and size of the tulip, and any emotions that are evoked by the flower.

Solomon and Barsalou (2004) have provided direct support for the idea that people simulate the information they read in a narrative. They found that people simulate the shape, size, and position of objects while reading — in particular, larger objects take longer to verify in a property verification task. Using different
methods, Glenberg and Kaschak (2002) found evidence that people simulate the movement of objects as they read. That is, people read sentences about actions that required moving an object either away from (e.g., “close the drawer”) or towards the body (e.g., “open the drawer”). Then, to specify whether or not a sentence was grammatically correct, the readers had to respond by pressing a button that required them to move either away from or towards their own bodies. Response times were faster when the response movement matched the movement in the sentence than when the movements were mismatched. Similarly, research has suggested that people simulate the orientation of objects when they read (Stanfield & Zwaan, 2001). In this study, people read short stories about objects in a specific orientation (e.g., about an eagle flying). Then, they are shown a picture (e.g., of an eagle) and asked to verify whether or not the object was in the story. Importantly, the picture was of an object in one of two orientations (e.g., an eagle with its wings spread or an eagle with its wings tucked in). When the orientation of the object in the picture matched the orientation of the object in the story, verification times were faster, suggesting that people were simulating the movements of the eagle in the story.

Neurophysiological studies have provided converging evidence for simulation during reading. Kable, Lease-Spellmeyer, and Chatterjee (2002) demonstrated that, as compared to reading object words (e.g., flower, mushroom), reading action words (e.g., following, slicing) selectively activated visual motor areas. Most notably, Hauk, Johnsrude, and Pulvermüller (2004) observed that the same pattern of neural activation during the passive reading of action verbs and the corresponding movements. That is, reading about actions activated portions of the motor cortex that overlapped with those portions that were activated when the same actions were actually performed. For instance, inferior-frontal areas were activated when people read about tongue-related movements (e.g., talk, lick) and when they performed these movements. The same overlap in neural activity was observed for finger-related movements (e.g., point, write) in dorsolateral areas and for foot-related movements (e.g., walk, kick) in dorsal areas of the motor cortex.

The available data strongly suggest that readers use information about prior experience when reading narratives, and that they can construct mental representations of situations that are, in important ways, akin to the representations that are formed during actual experiences. In our view, the exciting questions now are: (1) Just how are these representations akin to perceptual and motor representations? For example, important aspects of visual experience depend on spatiotopic representations that map nearby parts of the visual world using nearby neurons in the brain. When readers process spatial information about a scene is it spatiotopically mapped? Similarly, touch sensation and motor action depend on somatopic (body-based) maps; does reading comprehension depend on these as well? What
about tonotopic (pitch-based) maps in hearing? (2) Under what circumstances do readers simulate various aspects of perceptual and motor experience? If readers can form, say, spatiotopic representations of visual information, do they habitually do so during normal comprehension? Or is this an activity reserved for special kinds of text comprehension with particular kinds of text (or textoid)? The data we have just described supporting a role for simulation in reading come from unusual reading tasks using brief, highly structured stimuli. Will these findings generalize to reading “in the wild?”

Some recent data from our lab give us reason to suspect that the answer may be “yes.” According to the event indexing model, readers track changes along multiple situational dimensions, such as time, space, and goals, and update their situation models following these changes (Zwaan, Langston, & Graesser, 1995; Zwaan & Radavansky, 1998). Speer, Zacks, and Reynolds (2007) tested whether such updating occurs when people read naturalistic narratives for comprehension. The stories came from accounts of the everyday activities of a boy in the Midwest of the United States in the 1940s (Barker & Wright, 1951). Participants read four of these stories (each took about 9 min to read) while brain activity was recorded with functional magnetic resonance imaging (fMRI). As they read parts that were associated with updating a situation model, transient increases in brain activity were observed in a set of brain areas that included the medial and lateral posterior cortex at the juncture of the parietal, temporal and occipital lobes and the lateral frontal cortex. These areas also show increases when movie viewers update based on visually perceived changes (Zacks, Braver, Sheridan, Donaldson, Snyder, & Ollinger, 2001; Zacks, Speer, Swallow, & Maley, 2010). Most relevant to the role of simulation during reading, a subset of areas were selectively activated by one or two types of change, and some of these corresponded to areas selectively involved in aspects of perception and action (Speer, Reynolds, Swallow, & Zacks, 2009). For example, a region in the left lateral frontal cortex that is known to be selectively involved in grasping (Castiello, 2005) responded selectively when reading that a character interacted with a new object (e.g., “He picked up his English workbook”). These data suggest two conclusions: First, the similarity between responses to narrative events and visually depicted events suggests that a common event comprehension mechanism is responsible. Second, the selective involvement of brain areas involved in particular aspects of perceptual and motor experience suggests that readers may be performing simulations during this extended naturalistic reading task. These are early days, however, and much more data are needed to critically evaluate these hypotheses.

In sum, we see the move from textoids to text as exciting and rewarding. Working with long, naturalistic narratives can be painful and messy, but the tools are getting better and we think the opportunities repay the effort. We are also
excited about the addition of neuroimaging methods to the reading comprehension researcher's toolbox. Combining these tools affords a great opportunity to ask about the nature of the event representations that readers construct during comprehension.

References


All rights reserved


Authors’ addresses

Heather Bailey
439 Psychology Building
One Brookings Drive
Campus Box 1125
Washington University
Saint Louis, MO 63130
USA
hroth@artsci.wustl.edu

Jeffrey M. Zacks
Psychology Department
Washington University
Saint Louis, MO 63130
USA
jzacks@wustl.edu