The Cognitive Turn: Constructivism and Schema Theory

Some Background on the 1970s

The political context for developments in the late 60s and early 70s involved major global tensions around civil rights and the war against communism, which persisted in countries like Vietnam and in political events around the world. While we saw the end of the Vietnam War and a peace accord between Egypt and Israel, various countries were still in struggle. The world seemed on the precipice of change, yet it remained embattled within and across nations. In some countries in which the political climate seemed to be in a state of flux, there also appeared to be a shift from social-mindedness to individualism.

- In the U.S., the civil rights movement continued on a path forward despite the assassination of Martin Luther King, Jr. in 1968 and the preponderance of white flight across communities. Civil rights movements spurred development in those of women's rights (e.g., the landmark decision of Roe versus Wade), the change of the voting age to 18 years (via the 26th Amendment), and increased access to education for handicapped students (i.e., the Education for All Handicapped Children Act, passed in 1975). The U.S. also began secret talks to end the war in Vietnam in 1972, finally withdrawing in 1973. Meanwhile, impeachment proceedings against President Nixon began in 1973, which ended with his resignation in 1974.
- In Canada, Prime Minister Pierre Trudeau became involved in the establishment of a bilingual country with the 1969 Official Languages Act, established Canada's relationship with China, and pursued his vision of a "Just Society" with the charter of rights across Canada.
- Australia withdrew from the war in Vietnam in the early 70s and voted in a socially progressive labor government under Gough Whitlam ('72 to '74). (This was dismissed, however, in a form of parliamentary coup d'état—at the hands of conservative interests and with the aid of British-appointed governor general). Aboriginal Australians were given right to vote in Commonwealth elections in 1962, but the struggle for rights persisted.
- In Europe we saw the gradual expansion of the European Union.
- The Middle East experienced the oil crisis and more violence involving Israel.

- In China, the period between 1966 and 1976 marked the Cultural Revolution, which caused an enormous and brutal upheaval to families and society structures in the name of re-establishing a Marxist-influenced doctrine. (The election of Deng Xiaoping in the later seventies represented a shift away from such strong ideologically-driven policies to a new openness to the west and a market economy. In 1972, Nixon visited China; by the end of the decade, relationships between China and the U.S. were restored).
- In South America, the assassination of Allende and the rise of a Junta under Pinochet changed the government in Chile.
- Africa continued on a path of decolonization with independence for Angola and Mozambique and the removal of Ethiopia's long time ruler. Trade union strikes, student-led protests, and participatory socialism were emerging as challenges to South African racism and other inequities.

Universities as Sites for Social Activism and Innovation

In the western world, especially the U.S., universities were sites where an increasing proportion of the population was accessing higher education, including postgraduate education. Universities were meccas for intense debates over social issues (e.g., civil rights) and sites for opposition to the war in Vietnam. They were also sites wherein people and ideas were less segregated, and where major developments offered a diverse set of new frameworks for the mind—including many that challenged the dominance of behaviorism in the social sciences. Ironically, some of the funding for—and productity in enhancing—advances in the social sciences was tied to military funding and interests in improving human performance, such as the U. S. Navy.

Numerous scholars using a range of lenses (e.g., psychological, linguistic, and social) were interested in the nature of learning and readily drawn to studying meaning making in complex learning environments, including reading. They moved beyond solely syntactical accounts of text to more semantic, logical, and pragmatics-focused frameworks to account for meaning making (see: Austin, 1962; Fillmore, 1968; Grice, 1975; Searle, 1969). As research

in cognition emerged, they formed new scholarly areas—including psycholinguistics, cognitive science, and text linguistics (see Pearson & Cervetti, 2015; 2017).

At the same time, a number of scholars became more and more interested in unravelling the mystery of meaning making. On the one hand, this was spurred by the advent of artificial intelligence and technology that began to assume a more prominent role (e.g., Schank, 1982). During this period we saw the beginnings of modern computer systems as advances in hardware and software coupled with attempts to mimic human reasoning. These included:

- The world's first general microprocessor, Intel 4004 (1971);
- Programming language that was simple, flexible, and interfaced with other languages moving forward;
- Storage shifts to floppy disks, mouse held devices, and optic fibers;
- Other major advances in hardware with the introduction of handheld calculators, early personal computers, VCR's video game consuls, mobile phones, the Sony Walkman, and microwave ovens.

Increasingly, scholars were interested in natural language processing and whether they could model text comprehension. And, to this end, researchers were exchanging ideas across their institutions in ways that pull together the thinking of different disciplines. Of relevance to reading, a range of scholars from sociologists to anthropologists to linguists and psychologists to computer science focused upon reading and literacy development. As they did so, major shifts in our understanding and views occurred.

Early Cognitive Developments

The shift away from behaviorism became more and more discernable as the inadequacies of behaviorism to explain complex phenomena became increasing apparent. While the cognitive turn in education did not gain traction till the early 1970s, its antecedents can be traced back to Immanuel Kant, Jean Piaget and Gestaltists (see Side Comment III.1b.1). For example, in his book *Critique of Pure Reason*, Immanuel Kant (1781/1998) discussed innate structures within the mind for perceiving the world. Piaget (1926), in his discussion of young children's thinking, coined the term *schema* and suggested that mental frameworks—constantly under construction by assimilation and accommodation—served as

vehicles for perceiving and interpreting our worlds and building concepts. Gestaltists (around the turn of the 20th century), in terms befitting emerging cognitive thinking, proposed that the mind acted as a global whole with self-organizing principles.

Side Comment III.1b.1.

Some landmark developments in psychology leading to the cognitive revolution in reading:

1932 Frederick Bartlett publishes a landmark book *Remembering*—which resurfaced as foundational to the cognitive turn
1956 George Miller publishes his paper, "The magical number seven, plus or minus two"
1959 Noam Chomsky publishes his review of B. F. Skinner's *Verbal Behavior*"critiquing behaviorism
1959 Laurence Kohlberg completes his study of moral development
1962 Albert Bandura publishes *A Psychology of Being*
1964 Jean Mandler and George Mandler publish *Thinking: From Association to Gestalt*
1965 Herbert Simon publishes *The Shape of Automation for Men and Management*
1967 Marvin Minsky publishes *Computation: Finite and Infinite Machines*
1967 Ulric Neisser founded cognitive psychology
1972 Endel Tulving distinguishes episodic and semantic memory
1972 Vygotsky Circle's scholar Alexander Luria publishes *The Working Brain*
1977 Albert bandura publishes *Social Learning Theory*
1978 The term "cognitive neuroscience" is termed
1977 John Flavell publishes *Cognitive development*
1977 Richard Anderson, Rand Spiro and William Montague publish "*Schooling and the acquisition of knowledge*"
1979 John Bransford publishes *Human Cognition*
1985 Howard Gardner publishes *The Mind's New Science*

In his 1985 readable account of these developments, *The Mind's New Science: A History of the Cognitive Revolution*, Howard Gardner cites George A. Miller in suggesting that the beginning of what he referred as a zeitgeist, or the emergence of cognitive science, began on the second day of the Massachusetts Institute of Technology's Symposium on Information Theory. As Gardner indicates, this day—September 11, 1956—may represent a key date on which the rising tide of interest in alternatives to behaviorism was foreshadowed by three key papers. Specifically, Noam Chomsky presented a landmark paper detailing the shortcomings of previous linguistic attempts and behaviorism to explain the language learning capabilities of young children; Newell and Simon presented their efforts to simulate

complex processing on a computer; and Miller presented his work on memory organization and processing, in which he postulated that memory could only cope with 7 plus or minus 2 chunks. These papers foreshadowed the mounting multidisciplinary interests in new views of knowledge structures and processes—precursors to the burgeoning field of informational processing, which became known as cognitive science. This was a change of epic proportion, especially for theoretical notions of reading and approaches to research (i.e., what, why, and how research was conducted) as well as theories and developments in reading practice (i.e., what was taught, and how).

As Gardner's description suggests, this shift gathered momentum in the 1950s and 1960s due to the confluence of work by a range of scholars (including computer scientists, linguists, communication theorists, psychologists, and psycholinguists). First separately and later together they were motivated to go beyond behaviorism to understand the complex meaning making processes occurring across different contexts as readers encountered paragraphs and texts. In summary:

- Computer scientists were interested in modeling meaning making for purposes of computer simulation and developing applications ranging from playing chess to summarizing news stories.
- Linguists were keen to extend their analyses of language to complex texts and extended everyday discourse by enlisting semantic and logical frameworks, such as case grammar.
- Communication theorists complemented this work with pragmatic analyses, including speech act theory (e.g., Austin, 1962; Searle, 1969).
- Psychologists were interested in the role of meaning making and nature of memory, especially in terms of schema theoretic notions. Originally spurred by Frederick Bartlett (1932/1995), this interest was also advanced by influential cognitive psychologist Ulric Neisser (1967; 1976) via his discussions of the workings of reepisodic memory in recalling events (e.g., the Challenger explosion) as well as by David Ausubel's views on and approaches to meaningful learning. Ausubel (1968) stated that "if [he] had to reduce all of educational psychology to just one principle, [he] would say this: The most important single factor influencing learning is what the learner already knows. Ascertain this and teach him accordingly" (p. vi).
- The advent of psycholinguistic perspectives (e.g. Miller, 1963; 1975) linked language and cognition especially in terms of how language was used and understood and its

> indeterminant nature. Such pursuits were foundational to applications of artificial intelligence to language processing, but also a shift to enlisting a linguistic lens especially in terms of language development. In turn, it spurred psycholinguistic models of reading and gave credence to notions of hypothesis testing, risk taking, predicting, and child-directed learning—displacing mastery and rote routines as models for learning. Kenneth Goodman's (1967) study of oral reading—using semantic and syntactic miscue analyses of oral reading to undercover meaning making—challenged notions of strict reading accuracy. Goodman's notion of reading as a psycholinguistic guessing game was complemented by the writings of Frank Smith (1973; 2012); and James Britton (1970); together, their psycholinguistic notions constituted key bridges to reader-centered views of meaning making that aligned with transactional notions of meaning making touted by Rosenblatt (1978). Indeed, their views both foreshadowed and became foundational in the shift toward a view of the learner as actively engaged in figuring out their world—that is, a view of the learner as more productive than receptive, and more purposeful and self-determined than directed and rote.

Accordingly, the cognitive revolution in reading was linked to a series of developments in the field in the early 1970s—especially in those interdisciplinary gatherings of scholars on the state of the field. In part, these gatherings were sponsored by the U.S. National Institute of Education, which provided much of the leadership and funding for learning research during this period. Two such serious attempts funded by NIE led directly to the funding of the Center for the Study of Reading at the University of Illinois and the Institute for Research on Teaching at Michigan State University.

Among most reading educators, the adoption of a cognitive perspective for reading comprehension seemed to have a somewhat fitful history. Arguably, early traces of a cognitive perspective were apparent in the analyses of paragraph reading by E. L Thorndike in 1917, and the discussion of memory for text by Edmund Burke Huey in 1908. But while Thorndike and even Huey acknowledged the nature of the reader's meaning making, they tended to extoll the importance of a close authorial reading of the text. They seemed to espouse the belief that the reader needed to arrive at some kind of literal understanding of the text before beginning to infer, interpret or evaluate. The modeling of comprehension in the first half of the 1900s also emanated from the psychometric work tied to correlational analyses and factor analyses (see Frederick Davis, 1971;1972). The factor analytic model

building of reading comprehension and related measures, though impactful (for instance, by contributing to the teaching of vocabulary as a key factor in comprehension development), tended to be tied to models of reading that were more reductionistic than synergistic.

By the 1960s and 70s, interest in reading comprehension among reading educators had gained momentum as a result of increased interest in teacher questioning and scaffolding of reading comprehension. This interest was evident in Frank Guszak's 1967 study of teacher questioning in reading, Harold Herber's work in 1970 on teaching reading in the content areas, Russell Stauffer's (1969) directed reading-thinking teaching approach, and other discussions of process-oriented comprehension as problem solving that appeared in articles by Herbert Simon (1971), Jill Olshavsky (1976),and Roberta Golinkoff (1975).

Key to what became viewed as the cognitive revolution was research emerging from studies of models of meaning making challenging behaviorism and analyses of meaning rooted in the grammatical deep structure of texts. Notably, David Rumelhart proposed a shift from linear models of comprehension to an Interactional model involving top-down (reader-based) and bottom-up (text-based processes) (Rumelhart, 1983). John Bransford, a graduate student at the University of Minnesota at the time, and his colleagues (see Bransford, 1979; Bransford & Johnson, 1972).did some of the most extraordinary experiments demonstrating the power of schemata. His work highlighted that new meanings are developed as readers enlist their knowledge of the world to formulate meanings with the text—in other words, meanings do not come from the text or author, but from the progressive refinement of meanings suggested by the ideas gleaned or put forward by the reader. It is the reader's knowledge of the world and the relationships between ideas that prompt the reader to predict meanings suggested by the text; thus, schema access, activation, and instantiation by the reader are vital for meaning making.[1] Take the example offered Bransford and Johnson (1972) in which readers were asked to make sense of the following text.

> *If the balloons popped, the sound wouldn't be able to carry since everything would be too far away from the correct floor. A closed window would also prevent the sound from carrying, since most buildings tend to be well insulated. Since the whole operation depends on a steady flow of electricity, a break in the middle of the wire*

[1] The saliency of a reader's background knowledge aligns with the correlational studies of the relationship between vocabulary knowledge and reading comprehension. Indeed, a measure of background knowledge outperforms vocabulary as a predictor of reading comprehension while correlating strongly with the vocabulary measure itself.

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> *would also cause problems. Of course, the fellow could shout, but the human voice is not loud enough to carry that far. An additional problem is that a string could break on the instrument. Then there could be no accompaniment to the message. It is clear that the best situation would involve less distance. Then there would be fewer potential problems. With face-to-face contact, the least number of things could go wrong.* (Bransford & Johnson, 1972, p. 719)

By triggering—or not triggering—a reader's schema (via pictures and topics), Bransford and Johnson were able to demonstrate the importance of a reader's schema in the process of meaning making. Without triggering, the participants (who were not given the picture ahead of reading the passage) could not make sense of the passage, and did not recall it very well. However, when a schema was triggered (via the following picture ahead of time), readers had no problems making sense of the text, and recalled the passage well (see Figure III.1b.1, below).

Figure III.1b.1.

Source: Adapted from Bransford and Johnson, 1972.

In a second study reported in the same article, Bransford and Johnson (1972) similarly demonstrated the importance of schema access and activation prior to reading. Participants were presented with the following passage:

> *The procedure is actually quite simple. First you arrange things into different groups. Of course, one pile may be sufficient depending on how much there is to do. If you have to go somewhere else due to lack of facilities that is the next step, otherwise you are pretty well set. It is important not to overdo things. That is, it is better to do too few things at once than too many. In the short run this may not seem important but complications can easily arise. A mistake can be expensive as well. At first the whole procedure will seem complicated. Soon, however, it will become just another facet of life. It is difficult to foresee any end to the necessity for this task in the immediate future, but then one never can tell, After the procedure is completed one arranges the materials into different groups again. Then they can be put into their appropriate places. Eventually they will be used once more and the whole cycle will then have to*

be repeated. However, that is part of life. (Bransford & Johnson, 1972, p. 722)

This second study again demonstrated the power of schema to facilitate meaning making. Essentially, the topic served to activate the relevant schema—doing laundry. Students given the schema (doing laundry) had a coherent understanding, while those without the schema floundered. Similar demonstrations of the nature and role of schema emerged from other studies. For example, a study by Anderson, Reynolds, Schallert, and Goetz (1977) enlisted an ambiguous text (about wrestling) to illustrate the role of schema in shaping meaning.

The nature of cognitive processes during reading is vividly illustrated by this classic example from Collins, Brown and Larkin (1980); it demonstrates the nature of schema selection and modification,

The text begins:

He plunked down $5 at the window.

As Collins, Brown, and Larkin (1980) detailed, oftentimes readers will be prompted to infer that the text involves an exchange at a ticket office between a female ticket clerk and a purchaser. However, as the text proceeds, the reader's understanding may become confounded when it reads next.

She handed him $2.50 but he refused to take it.

It is not until the reader shifts his schema, which will likely occur when the reader reads remainder of the text, that they settle on an understanding that is coherent and plausible.

So when they went inside she bought him a bag of popcorn.

As Collins, Brown, and Larkin (1980) outlined:

> The theory states that text-understanding proceeds by progressive refinement from an initial model to more and more refined models of the text. …The initial model is a partial model, constructed from schemata triggered by the beginning elements of the text. Successive models incorporate more and more elements from the text. The models are progressively refined by trying to fill the unspecified variable slots in each model as it is constructed. As the questions associated with the unfilled slots in more

> refined models become more and more specific, the search for relevant information is constrained more and more. …people pursue the refinement process until it converges on a solution that satisfies a number of conditions for a plausible model. (pp. 387–388)

Finally, in a study by Reynolds, Taylor, Steffensen, Shirey, and Anderson (1982), Reynolds et al. highlighted the same overriding impact of cross-cultural background knowledge with a comparison of different readings of the following passage by African American and Anglo American eighth grade students. The passage (below) illustrates African American language play in phrases such as "sounding" and "doing the dozens" (pp. 358–359).

> *Dear Joe,*
>
> *I bet you're surprised to be hearing from your old friend Sam. It's been a long time since you moved away so I thought I'd drop you a line to catch you up on what's going on around here. Things haven't changed much. ….. School has been going O.K. but I did get in some trouble last week.*
>
> *It started out as a typical Thursday. Typical that is until lunchtime; at that point things started to get interesting. But don't let me get ahead of myself. I'll start at the beginning. Renee, my sister, and I were almost late for school. ….. We barely caught our ride and made it to school just as the tardy bell rang.*
>
> *Classes went at their usual slow pace through the morning, so at noon I was really ready for lunch. I got in line behind Bubba. As usual the line was moving pretty slow and we were all getting pretty restless. For a little action Bubba turned around and said, "Hey Sam! What you doin' man? You so ugly that when the doctor delivered you he slapped your face!" Everyone laughed, but they laughed even harder when I shot back, "Oh yeah? Well, you so ugly the doctor turned around and slapped your momma!" It got even wilder when Bubba said, "Well man, at least my daddy ain't no girlscout!" …. The next thing we knew we were all in the office. The principal made us stay after school for a week; he's so straight! On top of that, he sent word home that he wanted to talk to our folks in his office Monday afternoon. Boy! Did I get it when I got home. That's the third notice I've gotten this semester. As we were leaving the principal's office, I ran into Bubba again. We decided we'd finish where we left off, but this time we would wait until we were off the school grounds.*
>
> *Well I have to run now. …. Write soon and let me know what's going on with you.*
>
> *Later,*
> *Sam*

Their study generated findings that highlight how differences in understanding are culturally anchored. In particular, Reynolds et al. examined how eighth grade students (white and black) treated the material and interpreted the encounter. They noted of one student in

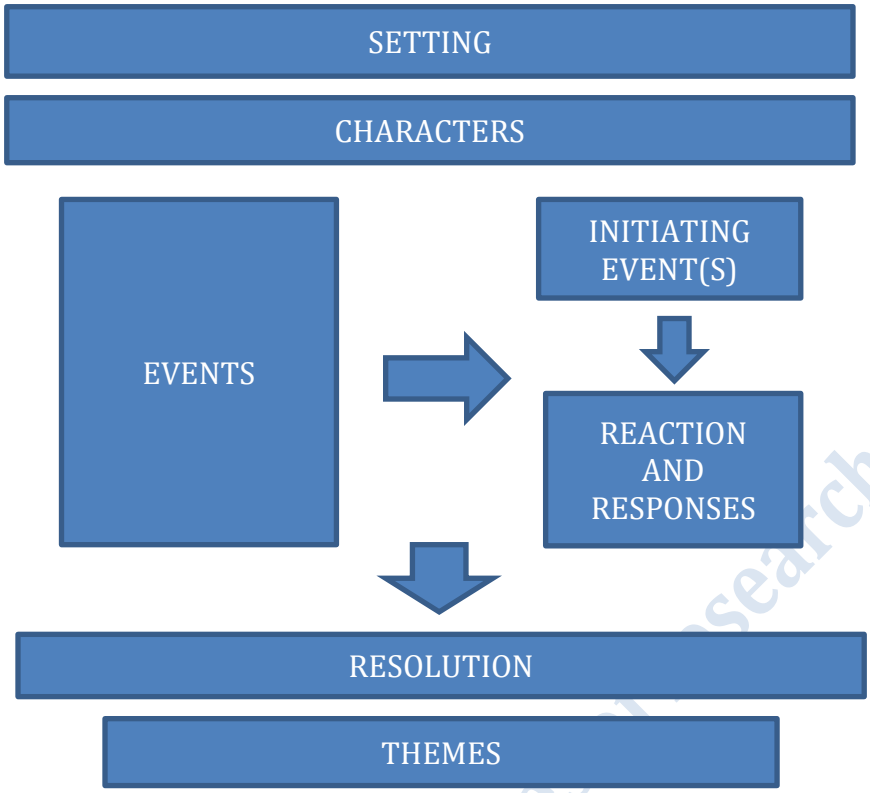
particular, "on being told that white children understood the letter to be about a fight instead of sounding, he looked surprised and said, 'What's the matter? Can't they read?'" (p. 365).

The schema that a reader activates and accesses is not only tied to their background knowledge; there are also other dynamics at play. Some of the dynamics may be quite interpersonal, involving the relationship between the reader and the author or fellow readers, or tied to the reader's embodied relationship with what might be (for the reader) an enlivened plot or narrative elements. As researchers such as Pichert and Anderson (1977) and Jose and Brewer (1984) found, the perspective of the reader had an impact on their focus as well as on the amount and details of their recall (in one of their studies, they compared the recall of readers who were asked to read a text from one character's perspective (e.g., a burglar) with that of readers who were not assigned a particular point of view). This work underscored how perspectives not only heighten recall of the text but also trigger different views and criticisms of the ideas presented—highlighting how a reader's positionality, purposes, identity, and perspective might engineer specific forms of enhanced meaning making. With this in mind, one could create the circumstances that ensured success or failure based on the match or mismatch with the background, experience, and the perspective prompted by the text.[2]

Discussions of background knowledge extended to the propositions represented in the text and how they might be structured (i.e., in terms of genre, rhetorical conventions, and a reader's expectations for and knowledge of the semantic and logical constitutions of text structures).[3] In conjunction with this work, a number of scholars turned to analyzing the structure of both narratives and expository text with the intent to studying the influence of readers' experiences and expectations. In particular, a number of studies examined key elements of narrative structure, such as setting, plot, or event structures (see Figure III.1b.2, below; Stein and Trabasso, 1981; Trabasso, Secco, & Van Den Brock 1984; Whaley, 1981).

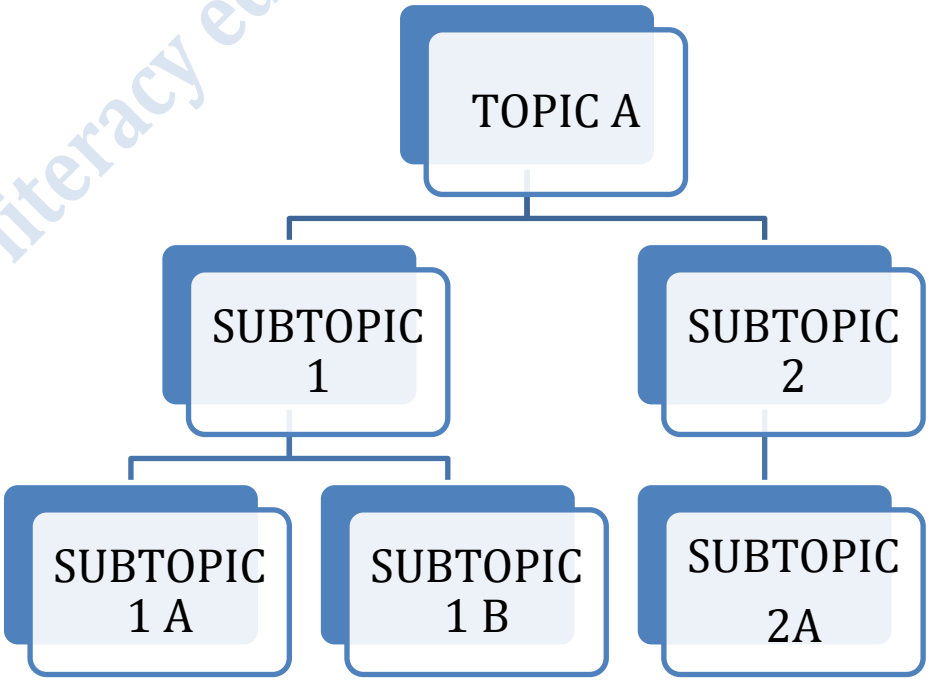
Figure III.1b.2.

[2] Nevertheless, several strands in measurements of reading ignore and override such findings. They tout culture-free tests when they may be excluding cultural variability. For example, the use of latent trait theory to develop tests (which assume reading performance will be one-dimensional) has and could continue to perpetuate an approach to testing which excludes items that do not operate in support of mainstream differences.
[3] See Kintsch & van Dijk, 1978; Pearson, 1978; Tierney & Mosenthal, 1982.



Additionally, they looked at exposition using various forms of structural analyses including hierarchies and flowcharts (see Figure III.1b.3, below; Armbruster & Anderson, 1980; Dansereau, 1979; Geva, 1983; Marshall & Glock, 1978; Meyer, 1975; Meyer, Brandt, & Bluth, 1980).

Figure III.1b.3.



So What?

Together these studies represented major shifts in our understanding of the nature of meaning making—especially with regard to the importance of background knowledge access and activation in encoding meaning. For reading educators, these findings challenged many of the traditional assumptions touted about reading comprehension, including:

- The notion that reading was an act of reception, wherein the reader's task was to decipher the author's meaning;
- The belief that meaning involved translating words into meaning—and that there was a single meaning for the text that was to be unlocked by the reader;
- That meaning involved first the literal then the inferred.

Perhaps the most powerful revelation was the notion that readers create meaning—whether their goals are to learn from text or engage with the images or ideas suggested by authors. In turn, we came to recognize that inferencing was the fuel of meaning making, not a byproduct or re-rendering of what appeared to be explicit meaning presented in the text. Meaning making required activating, accessing, and refining a reader's background knowledge and schemata. This was akin to suggesting that the text was in part generated by the reader—that meanings represented a mix of explicit and inferred cues interlaced with views of what the author was intending. In other words, meanings emerged as a composite of orchestral proportions—often with elastic qualities, but difficult to separate from one another.

The ramifications with regard to testing were also profound. Unfortunately, standardized tests and other large-scale assessments often enlist a form of one-dimensional item response theory, thereby systematically excluding items that might benefit students who might not be performing as well. Indeed, the background knowledge effect has a broad and overriding influence, regardless of how well a reader measures on standardized tests. On culturally diverse material, for instance, otherwise well-performing readers may not do as well—displaying characteristics of normally poor-performing readers and vice versa.

This key shift in views of meaning making in turn prompted additional pursuits. These included exploring in more depth the dynamics of how readers engage background knowledge to not only address a range of problems (especially complex knowledge domains) but also explore the nature of complex knowledge and how it is acquired and built. These shifts in understandings also prompted an interest in cognitive engineering, learning to learn, or what developmental psychologist John Flavell (1977) termed "metacognition."

At the same time, there was increased recognition that we had neglected work on reading comprehension. We were seeing a decline in students' reading performance beyond the third grade, and an orientation to teaching reading comprehension that appeared to geared toward testing rather than understanding the nature of comprehension for extended text or its development.

In reading education, the combination of developments in psycholinguistics and cognition along with various conscious efforts to focus on reading comprehension began occurring in research and the literature as well as in research funding. Simultaneously, a number of new studies and books began to focus on reading comprehension, including *Schooling and the Acquisition of Knowledge* (1977), edited by Richard Anderson, Rand Spiro, and William Montague, and *Teaching Reading Comprehension* (1978) written by P. David Pearson and Dale Johnson.

Another key development involved the creation of a major research center, The Center for the Study of Reading at the University of Illinois. It was there that an interdisciplinary group of scientists (i.e., psychologists, linguists, psycholinguists, literacy education researchers, and artificial intelligence scholars primarily from Bolt, Beranek, and Newman) focused their research on reading comprehension from a cognitive perspective. These scholars—as well as others around the world—quickly energized the field and advanced our understanding of reading comprehension from a cognitive and text linguistic perspective. Among the numerous notable scholars in this group were Allan Collins, Richard Anderson, Thomas Anderson, Bonnie B. Armbruster, Bertram Bruce, Diane Schallert, Dolores Durkin, Debra Genter, Georgia Green, Stella Vosnaidou, and the two of us, Rob and David.

Getting Personal

As reading researchers in this era (actually David is just about a half decade ahead of Rob in terms of age and entry into the field), both of us were keenly interested in probing the nature of meaning making. We became captivated by the burgeoning field of work and the promise it had for challenging our practices and understanding of reading.

Rob's story. Rob was an assistant professor at the University of Arizona with colleagues such as Joseph Vaughan, Wilbur Ames, William Valmont, Patricia Anders, Diane Schallert as well as Ken and Yetta Goodman.

As I began probing the nature of meaning making through a constructivist lens, I was immediate conscious of mismatches with our teaching and testing practices. Immediately,

the ramifications of these notions for assessment. Indeed, constructivist notions of reading comprehension suggest that the normalcy of unstable measures of reading comprehension for a reader or across readers depend on the relevance of the passage to the reader and the nature of the probes. The pertinence of these findings for testing were apparent in the responses of different students to the rich assortment of passages included in the U.S. National Assessment of Educational Progress in the 1970s and early 80s. Student performances were quite varied in accordance with what appeared to be the shifting relevance of different passages for different students.[4]

The difficulty in standardizing forms of reading comprehension also emerged in a study I conducted with colleagues (Peterson, Greenlaw, Tierney, 1978), in which we analyzed the use of the Informal Reading Inventory (widely used by teachers to place students at a reading level for instructional purposes). The Informal Reading Inventory assumed that if a student answered a carefully developed set of questions with 75% accuracy, that student could be handle those materials and could be given other material at that readability level. Given the aforementioned cognitive studies in reading comprehension, a student's "reading level" is in reality prone to fluctuations in topics, texts, and the reader's purposes for reading—as well as the probes enlisted. Accordingly, across three parallel sets of questions to the same reading passage, we found that student performance was incredibly erratic. For one set of questions a student might attain a perfect score and be placed at a certain reading level; for a parallel set of questions for the same passage, that same student might perform quite differently and be placed at a different level. Essentially, the volatility of the assessment was predictable if you adopted a constructionist (or re-constructionist) view of meaning making.

As views of reading shifted, we realized the need for approaches that tapped into readers' constructions as they engaged with text. In an effort to tap into what readers do as they engage with extended text for themselves, many of us began using retellings, think-alouds as they read, and other means of revealing windows into their process. At the same time, we had students respond to a range of texts. we also went to great lengths to pin down what arguably was the author's representation of text via detailing the explicit and the

[4] The shift of NAEP to a model driven by a desire to provide a single scale undermined a differential approach to reading assessment that afforded the possibility of illumating socio-cultural considerations. In an effort to counter such developments, I resigned from the NAEP Board overseeing the proposed reading assessment and have represented the approach adopted for NAEP by Educational Testing Service (ETS) as "NAEP's folly". Namely, ETS's enlistment of item response theory based on a uni-dimensional latent response theory precludes the same assortment of passages and various responses in current manifestations of the assessment.

implicit semantic, logical, and pragmatic features. To this end, I was drawn to Carl Frederiksen's (1975) rather comprehensive system for analyzing text en route to understanding a reader's understanding.

Together with two of my colleagues (Connie Bridge, Maty Jane Cera who were pursuing graduate studies at the University of Arizona at the time), I spent countless hours trying to apply semantic and logical analyses in pursuit of what was always somewhat elusive—the author's representation of meaning, In the end, Connie, Mary Jane and I pursued a study of the discourse processing operations of third graders, applying Frederiksen's text analyses to two texts as the bases for examining students recalls. Laboring through this text analysis was educative, and we quickly became aware that texts are suggestive rather than definitive when it comes to delineating their meaning. We came to realize that meanings are always in the eyes of the beholders and could be quite varied. WE would suggest that text analyses require inferences as to what writers are doing—even writers are not fully aware, purposely or otherwise. When you ask for and analyze a student's retelling, you have introduced yourself as an audience to the reader—you are a reader once again. Certainly, we could label text as fitting certain grammatical functions—or in terms of agents, objects, actions, modifiers, etc.—but meanings are only derived when readers apply their knowledge of the world to these elements. And, as a researcher, you realize that your studies of readers are apt to be readings of their readings.

Despite these limitations, the text analysis did provide an important bases for our study. By comparing the retellings of the third graders to our propositonally based author's representation we were able to demonstrate that readers of varying abilities are engaged in a rich mix of inferential operations as they fill out the meanings—and that they do so regardless of ability level. Of relevance to notions of reading comprehension at the time, the findings dispelled the view that inferential comprehension followed from literal comprehension of text—that poorer readers were not ready to engage inferentially until they had addressed the literal. The findings yielded what now may seem obvious:

- All readers (good and poor) recall a mix of explicit and inferred information tied to their rendition or meaning spurred by the text;
- Various factors may contribute to the amount and nature of a reader's recall, including background knowledge and confidence.

Perhaps one of the most notable research studies with which I was involved a study that one of my doctoral advisee at the time, David Hayes, pursued with me. Building upon

discussions of the role of background knowledge as it relates to the sport of cricket, Jack studied the role of analogies as a means of building background knowledge for the reading of unfamiliar text (see Hayes & Tierney, 1982). The study highlighted the types of issues that grew out of schema theoretic views of reading and learning, as well as some key methodological concerns. Specifically, the study presented passage on cricket—resembling a news account that might appear in an Australian newspaper—followed by questions as well as predictions of what might follow. Perhaps predictably, as evidenced in the recall and other measures, the findings confirmed how knowledge of a familiar topic (e.g., baseball) afforded a schema that bridged to an understanding of an unfamiliar topic (e.g., cricket).

For example, the study was able to demonstrate the important role of background knowledge by presenting them with the passage on cricket:

> *Today's cricket*
> *The bowlers placed their men in slips and covers, but to no avail. The batsmen hit one four after another as well as an occasional six. Not once did their ball hit the stumps or get caught.*

With this text the importance of background knowledge was highlighted—and that while answers to questions (e.g., Where did the bowler place their men? What did the batsmen hit?) were not effective measures of understanding, changing the readability by shortening the sentences and vocabulary would not likely help.

These notions resonate with a teacher's search for the means to relate to students. They highlight the extent to which a students' background knowledge (activation and access) is at the center of meaning making and comprises the fuel of readers' schema for developing plausible and coherent meanings. They also highlight the extent to which background knowledge may account for one's reading successes or shortcomings, as well as how curriculum and tests might intensify a student's existing privilege or disadvantage by accommodating only certain reader experiences. Moreover, they underscore the pragmatics of meaning making that inform readers' attempts to make sense of the ideas suggested to them by the text.

Based on these emerging insights, along with my foray into schema theory and speech act theory , I pursued other studies that contributed toa number of papers discussing basic postulates of reading (e.g., Tierney & Spiro, 1979). In papers with Jill LaZansky (e.g., Tierney, LaZansky, Raphael, & Cohen, 1987), I explored the reader-writer relationship and

what might be a reasonable band of allowable interpretation emerging from a transactional view of meaning making. In a study with Taffy Raphael (Raphael & Tierney, 1981), we demonstrated how the meaning making of readers acknowledges and may compensate for inconsistencies, especially in familiar and concrete text forms. They explored the ability of fifth grade readers to detect inconsistencies (or obvious misinformation) purposely placed in parallel texts that we constructed and deemed familiar or unfamiliar, narrative or non-narrative. The approach involved asking readers to respond to requests for free recall and probes directed at inconsistencies to an array of parallel texts (see Table III.1b.1).

Table III.1b.1.

Familiarity

Familiar	Less Familiar
Mary had a problem. This is a story about how she solved it (could not solve it). There were two things that Mary had always wanted. One was a place to be alone and the other was a place that she could use for bird watching. Mary decided there was one way that she could get both of these things. Her family was renting a home in the big city and in the back yard there was a large tree….	The Poly Plastic Bad Company had a problem. This is a story of how they solved it (could not solve it). There were two things that the Poly Plastic Bag Company had always wanted. One was a factory of their own and the other were offices that were out of the city. They decided that they could get both of these things. They were currently renting a factory in a big city. But near a quiet river out of the city, they owned a block of land….

Discourse Style

Non-dialogue	Dialogue
All over the world children like (hate) different games. In some countries, children enjoy playing a game called "Fly' It gets its name because to play the game you need to be able to leap through the air. The game is easy to learn and play. The only equipment you need is six sticks that are similar in style and about as long as a person's foot and wide as a thumb. After the sticks are found they are. Placed on the ground….	Lisa and Mike were bored. It was Saturday and they did not know what to do until Lisa had an idea. "I know a game we can play that they play in some countries. You know children all over the world like (hate) to play different games" Lisa said. Mike was interested and asked "What is the game/" "It is called Fly because to play the game you need to be able to leap through the air". Lisa said "You only need six …

The study highlighted the reader's own role in meaning making and how the readers were not constrained by authors—especially when the ideas were familiar or presented in the context of everyday interactions, such as written accounts of conversations. For example, the readers in the study, unless dealing with unfamiliar text, maneuvered around inconsistencies in their retellings. When interviewed about their treatment of theses, they indicated a consciousness of the contradictions, which many attributed to authorial oversight.

While these pursuits helped me rethink reading, I was aware there were major loose ends. When I look back at these developments, I believe that cognitive views of reading should more fully explore issues of prediction or forward inferencing, persona, identity, imagery and affect. I was increasingly intrigued with perspective taking (see Neisser, 1976; Pichert & Anderson, 1977; Jose and Brewer,1993), author-reader relationships (see Bruce, 1980; Pratt, 1977) and the extent to which students were engaged in visualizing (Pressley, 1976; 1979; Sadoski, & Paivio, 2001; Schallert, 1980; Tirre, Manelis, & Leicht, 1979; Waltz, 1979) as well as what Michael Benton had described as a kind of secondary world experience (Benton, 1992). I would find myself intrigued with the sparkle in readers' eyes and a sense of magic when readers talked about the images that they formed as they read and the vicarious nature of journey with which they engaged as well as the tug of war type relationship with the author. My interviews of young readers and writers highlighted the primacy and saliency of these experiences. There was a kind of dream-like impressionistic quality to the images that readers formed as they read. Further, they often burrowed into a story or assumed a perch within the story world and usually moved around a story as if they were able to project themselves into the story—as of they were operating with a a homunculus or something akin to an avatar of themselves. With Patricia Enciso, who had overlapping interests, a background in drama education and a wealth of knowledge of children's literature, I pursued this sense of embodied participation with fourth graders across a number of stories. We presented the material at the National Reading Conference, but I regret that we never published this pursuit. Fortunately, Pat Enciso went more deeply into these pursuits with her thesis and some of her subsequent work that included a very innovative procedure (Symbolic Representation Interview) that she developed for students to display their participatory engagements with stories (Enciso, 1990; 1996). I remain convinced that understanding reading is a frontier not fully explored in terms of these dimensions.

David's Story. My (David's) story comes in four short chapters. Grad student days at Minnesota, a study leave at Stanford in 1976, and an unplanned move from Minnesota to the Center for the Study of Reading at the University of Illinois at Urbana-Champaign. In each of these chapters, I had my the theoretical ground.

Chapter 1. In grad school I was never too enamored of all the early reading issues that dominated the culture there (it was, after all the home of the coordinating center for the infamous First Grade Studies of the 1960s and featured among its faculty Guy Bond, Bob Dykstra, John Maanning, Ted Clymer, and Jay Samuels—all bonded by an abiding interest in K-1 reading). Having been a fifth grade teacher, I wanted to know more about comprehension and language. So I traveled across the quad to the Psych Department to take Jim Jenkin's year-long seminar on the newly exploding field of psycholinguistics. There I got immersed in that community and past and current research about hos little (and bigger) humans learn to use their language to enter into the family of humankind. Met three post-docs (John Bransford, Jeffrey Franks, and Bill Brewer. When I read and listened to reports of their paradigm-shifting research, it changed my life. I would never again be able to look at a behaviorally-grounded S-R (stimulus-response) bond with a straight face. Understanding consists of synthesis and integration not analysis and decomposition. I never looked back.

Chapter 2. In the fall of 1969, I defended my dissertation at Minnesota, loaded up our brand new Ford Torino (just like Clint Eastwood's!) with Mary Alyce and whatever we could shove into the back seat and roomy trunk and headed off to take a post doc in psycholinguistics in the Psych Department at UT Austin. Met a lot of famous language researchers (Phil Gough and Donald Foss) and linguists (Emmon Bach, Robert Wall, and visitors like Noam Chomsky, George Lakoff, Charles Fillmore, and James McCawley) whose ideas and approaches to language study and analysis shook not only my behaviorist learning theories but my faith in positivistic searches for truth and unqualified causality. I also met and began a life-long collaboration with Michael Kamil.

Chapter 3. I returned to Minnesota in 1970 to take up a professorship and started to do a number of classic psycholinguistic experiments in which we varied language features and looked at their impacts on understanding and/or word identification. By the fall of 1975, I had earned the right to a single quarter study leave, so on New Year's Day of 1976, my wife Mary Alyce and I stuffed what we could into the back seat and less commodious trunk of our 1974 Fiat Sedan, leaving room for two interim acquisitions (4 year old Matthew and 2 year old Susan),a nd headed for Stanford for three months NOT in the Minnesota winter. Bob

Calfee was the sponsor of this post-doctoral study leave. I found three seminars at once that again changed my world view, not by upsetting it but by deepening it and providing an even richer theoretical underbelly. The first was a course offered by Terry Winograd (he was at both Stanford and Xerox Research Park—the site of ground-breaking work that became the backbone of cognitive science) on the computerized analyses of both the semantic and syntactic foundations of text. The second was Gordon Bower's advanced studies of cognition, and the third was Robert Calfee's course on advanced statistical designs for these burgeoning approaches to the close examination of text and knowledge as the primary determinants of comprehension. I returned to Minnesota in April of 1976 armed with new ideas and methods that would literally change my life and career path.

Chapter 4. In the spring of 1978, right after Dale Johnson and I published our twin books, *Teaching Reading Vocabulary* and *Teaching Reading Comprehension*, I got a call from Jean Osborn from the newly funded Center for the Study of Reading at the University of Illinois, inviting me to come as a visiting scholar for a year to help them carve out an agenda on how to teach reading comprehension. By 1978, two years into their first cycle of funding, CSR had astounded the reading research community with seminal studies, some of which we have already recounted in the early parts of this chapter, but they had not yet done much work on the pedagogical part of their 5 year work plan. I would get to help them craft that agenda. Fresh off the book, how could I turn that down? I didn't. So Mary Alyce and I packed up our two cars (the sole Fiat had been replaced by a classic 1976 Olds Cutlas hard top convertible and Mary Alyce's "king of the road" golden VW Scrirocco sporty sedan) with whatever they could carry besides 7 year old Matthew and 5 year old Susan. Changed my life. Changed our lives—for Mary Alyce, Matthew and Susan as well.

My Minnesota grad student, Taffy Raphael, came with me and we started a line of work that 3 years later had morphed into her now famous QAR (Question-Answer-Relatinoship work. I got to know SO MUCH MORE about schema theory and developed an even more knowledge-centric view of comprehension than I came with. Got hit between the eyes with the emerging work on metacognition by Ann Brown and Joe Campione, the schema work of Dick Anderson and colleagues and Alan Collins, the work on metaphor by Andrew Ortony, the work of Rand Spiro on how schema control and are controlled by the comprehension process, the work on stories by Bill Brewer and Chip Bruce. I twas a never ending list—just went on and on. And a year later Rob came as my partner in moving the pedagogical agenda along. That was the start of another life-long collaboration—the end result of which is the volume you are reading now.

Once Rob arrived, and we began to talk about what a pedagogical research agenda that rivaled the

That's my conversion story from the 1970s. Life changing. Career shaping. Never looked back.

Closing Remarks

The 1970s and the cognitive turn signaled significant shifts in the study of reading comprehension and spurred a large number of studies of reading comprehension processes. Many of these studies connected to and extended previous studies, but did so in ways that challenged past views and approaches (i.e., previously-used frameworks and methodology). The confluence of studies represented a shift of monumental proportions; as many concur, it represented a zeitgeist in thinking that exploded traditional models, including past notions of reading comprehension abilities as fixed reception acts rather than productive, dynamic, and creative transactions with oneself and others (see Side Comment III.1b.2). The studies reflected encounters with texts from the real world by adventurous and creative researchers who were themselves changing—in their views of meaning making as well as in the range of studies that they were pursuing with a new openness for explanatory frames.

Constructivism also reinforced theoretical developments emanating from psycholinguists, who argued that reading involved a transaction between reader and the text in a fashion that befitted the reader's natural language processing abilities. At the same time, it supported a growing corpus of work that examined the role of scripts, schemas, and knowledge processes—including studies by cognitivists and artificial intelligence scholars that aligned readers' recalls and responses with various forms of text analyses. For a large number of reading researchers, constructivism shifted attention away from a code emphasis in the early grades to a meaning orientation across all of the grades.

Side Comment III.1b.2.

Essentially, constructivism marked a shift in the zeitgeist with a confluence of influences, including:

- *A decline in behaviouristic frames for thinking about and studying reading;*
- *Building on studies of language development, an increased interest (by linguists) in nativist views of language learners (i.e., that learners are wired to make sense of their world);*
- *A growing interest in the pragmatics of language (i.e., how language is used, as well as semantic and logical analyses of language) along with an interest in studying the nature of extended text—especially narrative and expository forms;*
- *A rediscovery and reincarnation of schema theoretic notions that dated back to Kant and extended to Bartlett, 1995/1932, Piaget, 1926, and Gestaltist views (e.g., Wertheimer, 1945);*
- *The stimulus of discussions among selected cognitivists, including Jerome Bruner (1986), Ulric Neisser (1967), and a number of young researchers such as John Bransford (1979) and Rand Spiro (1980);*
- *An interest in unravelling the scripts we use to understand our worlds that might be enlisted as a means of building machines that could think (e.g., Schank, 1982).*
- *An interest in the nature and role of teaching and learning, following David Ausubel's (1960) work on advanced organizers, Harold Herber's (1970) work on scaffolds (e.g., structured overviews), Russell Stauffer's (1969; 1970) reading-thinking approaches driven by prediction making, and Anthony Manzo's (1973) work on reciprocal questioning;*
- *Key developments and reconceptions of reading in conjunction with the rise of interest in psycholinguistics in the early 1970s;*
- *Concerns about students' reading comprehension performance.*

As constructivism advanced and the cognitive turn proceeded, attention shifted to previously unheralded past research and theory developments that highlighted the natural learning prowess of readers. This was especially the case for nativist views of readers—that is, that readers are wired to make meaning—as well as developmental views of learners tied to schema theoretic notions (e.g., Immanuel Kant; James Piaget, 1926; and Frederick Bartlett, 1995/1932) and cognitive perspectives offered by Ulric Neisser (1967), Jerome Bruner (1986), and Gestaltists (e.g., Wertheimer, 1945). This past research substantiated learning approaches emanating from the work of pedagogical scholars such as David Ausubel (1960), Harold Herber (1970), and Russell Stauffer (1969; 1970).

The end result was that studies of reading comprehension proliferated. A large number of studies of readers' meaning making with extended text used retellings and oral reading miscues as a basis for examining the hypotheses and inferencing made by readers as they read. Rather than employ syntactic or phonological analyses of words, researchers

shifted to using semantic and pragmatic analyses of readers' transactions with texts. Rather than being overly text-driven, constructivist studies therefore highlighted the agency of the reader and the role of perspective taking.

Despite this proliferation of studies, many elements of meaning making that were mentioned nevertheless remained undeveloped or limited. The roles of visualization and schema development were only partially formulated during this period. In terms of limitations, cognition remained a model of meaning making that was individualized and contained primarily "within the head." Research therefore tended to focus on an individual's meaning making without regard to the influence of social transactions with others; further, the relationship between meaning and one's multiple selves was neglected. The models of meaning making also tended to be quite verbocentric—ignoring the kinds of engagements that are participatory and aesthetic as readers travel vicariously within the animated, "material" world of the text in the company of others (including characters, authors, or fellow readers).

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