The Minimalist Hypothesis: Directions for Research

Gail McKoon
Roger Ratcliff
Northwestern University

According to the minimalist hypothesis (McKoon & Ratcliff, 1992), the only inferences routinely generated during reading (without special goals or strategies), are those based on quickly and easily available information and those required for local coherence of the text being read. The minimalist hypothesis summarizes the past 20 years of text processing research. During that time, little uncontestable evidence has been found to support the notion that readers engage in the constructive processes that would be required to generate a large number and variety of inferences. Most of the data that does show constructive inferences has been collected in situations where readers could plausibly be thought to use special efforts, goals, or strategies directed toward the kind of inference under investigation. For the great majority of experiments, in which there is no reason to think such efforts took place, the minimalist hypothesis is a description of the few kinds of inferences that might be drawn in the absence of special goals or strategies.

Of course, readers often engage in reading for a special purpose—to learn, to criticize, to gain information for decision making, and so on. But in most experiments, they have no such purpose. The data collected in these experiments—the data summarized by the minimalist hypothesis—will hopefully provide the basis from which we can eventually gain an understanding of the kinds of inferences that are added when readers make special efforts toward some particular goal. The minimalist hypothesis describes the initial information provided by the retrieval system to construct an initial representation of a text that in turn could provide a foundation on which constructionist representations could be built. The
hope is to understand which inferences are provided initially and which require additional processing. Of course, the theoretical picture is not likely to be this simple; such complications as continuously available kinds of information, partial information (McKoon & Ratcliff, 1986), and parallel processing are to be expected. But we have hope that such issues as the time course of availability of different kinds of information, the automaticity of some kinds of processes, and the interdependence of various kinds of inferences can be sorted out.

At this writing, a year has gone by since the minimalist hypothesis was proposed and it has become clear that this hypothesis has more to offer than was originally intended. Although we meant the hypothesis to be a summary of the current state of text processing research, we also hoped that it would provide a challenge to investigators to examine inference processes with renewed intensity and increased methodological rigor. We hoped that constructionist theories would begin to specify what inferences should be generated with what kinds of cognitive processes, in counterpoint to the minimalist hypothesis. Instead, constructionist efforts have most often treated the minimalist hypothesis as a target, criticizing the hypothesis on all conceivable grounds. In most cases, the attacks on minimalism offer no constructive impetus to new research.

To give an example, consider the well-known inference about an actress who falls from a 14th-story roof (McKoon & Ratcliff 1986, 1989a, 1989d). McKoon and Ratcliff (1992) claimed that the failure of readers to explicitly encode the inference that the actress died was a contradiction of constructionist theories of reading. Instead of developing an account of this result or providing new empirical information about it, constructionists began an argument among themselves over whether their view, as formulated in the past, should or should not predict the “died” inference (e.g., against: Glenberg & Mathew, 1992; for: Magliano & Graesser, 1991). Such an argument points to the incoherence of the constructionist view.

Constructionist theorists have also become revisionists with respect to the conditions under which constructionist inferences are generated. In the past literature, from Bransford, Barclay, and Franks in 1972 to Glenberg (Glenberg & Mathew, 1992; Glenberg, Meyer, & Lindem, 1987), Graesser (Graesser, 1981; Magliano & Graesser, 1991), Singer (Singer, 1979; Singer, Halldorson, Lear, & Andrusiak, 1992), and Trabasso (Trabasso & Sperry, 1985; Trabasso & van den Broek, 1985) in the 1990s, constructionists have discussed their experimental results as though they reflected inferences generated during encoding, in the absence of special efforts, goals, or strategies on the part of the reader. There has never been any suggestion that special circumstances existed in their experiments, or that such circumstances were required for the encoding of constructionist inferences (except see Johnson-Laird, 1980, 1983). When we labeled their position as postulating automatic encoding of inferences (McKoon & Ratcliff, 1992) and argued that the data could not support such a claim, we find suddenly that Glenberg (Glenberg & Mathew, 1992) “does not think most mental modelers would hold that mental models are constructed automatically (at least not all of
the time),” while Garnham (1992, sec. 1.1) in contradiction implies that it has always been the case that “constructionist processes play an essential role in inferences that are made automatically.”

Equally confusing is the constructionist response to our characterization of their hypothesis as: “the mental representation of a text automatically specifies, in some complete way, the real-life situation described by the text” (McKoon & Ratcliff, 1992, p. 458). We thought this a fair rewording of Bransford, Barclay, and Franks’s original hypothesis that comprehension results in the “construction of a holistic description of the overall situation being communicated” by a text (Bransford, Barclay, & Franks, 1972, p. 202), and because most constructionists would align themselves with Bransford, Barclay, and Franks, we thought our characterization to be a fair rendition of current constructionist positions. Apparently, not all constructionists agree (cf. Garnham, 1992, 1993a, 1993b, 1993c; Glenberg & Mathew, 1992). But, without exact distinctions among which inferences are and are not required to communicate the situation described by a text, their agreement or disagreement does not provide any useful insights.

What has become apparent is that the “constructionist position” is not a position at all. One could have assumed that many of those engaged in research on text processing in recent decades shared an underlying theoretical view, the constructionist view originally put forward by Bransford et al. (1972). The assumption of a shared view was reasonable given that there was little discussion of any alternative view and, indeed, little discussion of any disagreement of any kind. However, instead of a unified view, it now appears that constructionism is a collection of informal views that differ on various dimensions: Each view is apparently molded by data collected from whatever methodology the holder of that view believes to reveal underlying text representations. We do not, of course, expect constructionists to provide a complete and detailed theory of inference generation overnight. Rather, we intended the minimalist hypothesis to prompt new research that would lead to revisions in both the minimalist hypothesis and constructionist views. At the end of this chapter, we point to some intriguing examples of such research (and see Graesser, Singer, & Trabasso, 1993; Graesser & Zwaan, chap. 7 in this vol.). We hope for research that will extend and elaborate the minimalist hypothesis until, perhaps, it will no longer be declared minimalist. But this can happen only through cumulative research, not through argument.

First, however, we need to clarify some of the methodological constraints on empirical research specified by the minimalist hypothesis and define some of the particular problems for study that the hypothesis suggests. In so doing, we show that some criticisms of the hypothesis have been misguided.

METHODOLOGICAL RULES

The minimalist hypothesis describes the kinds of inferences that will be generated during reading when the reader engages in no special efforts, goals, or strategies. Special strategies can be set up for the reader through instructions, payoffs, or
problem-solving kinds of texts (cf. Bransford et al., 1972, Exp. 3; Potts, 1974). In the absence of such strategies, the minimalist hypothesis states that only two kinds of inferences will be generated during reading: those based on easily and quickly available information and those required to establish local coherence. Such a severe limit on inference processes implies an equally severe limit on experimental procedures. The minimalist hypothesis can be tested only by examining the encoding of inferences under conditions in which the experimental procedures allow all processes but those of encoding during reading to be excluded as explanations of the results.

**Online Tests.** These are popular, but unfortunately the logical possibilities for interpretation of their results are not universally understood. When a target item immediately follows a text, responses to the target may be determined by backwards context-checking processes (Forster, 1981) or by processes in which the target and the context interact (Norris, 1986; Ratcliff & McKoon, 1988). Either way, it is important to note that the preceding context can potentially include all preceding information and that context includes not only individual pieces of information but also the meanings that result when those pieces are combined. It is not possible, for example, to test for context checking by comparing whole texts against texts with some sentences deleted (Singer et al., 1992) or against texts with the same words recombined into different meanings (Whitney, Ritchie, & Crane, 1992) because the preceding context has necessarily changed.

Because of the context checking and interactive processing possibilities, online results can rarely tell us whether the information represented by a target item was available during reading before the target was actually presented for test. All they can usually tell us is how quickly the relation between target and context is available when the context and target are both in short-term memory at the same time, which happens when the target is presented. For example, Onifer and Swinney's (1981) results do not necessarily indicate that both meanings of an ambiguous word are available during reading (as suggested by Singer, Graesser, & Trabasso, 1993); logically, all that can be concluded is that the relation between the ambiguous word and a test word is quickly available (see Ratcliff & McKoon, 1988). However, it is theoretically possible to rule out context checking and interactive processing explanations of online results. We know of two occasions on which this has been done (noting that on both occasions the results supported the minimalist hypothesis; Hopkins, Klin, & Myers, 1993; McKoon & Ratcliff, 1992), and we strongly urge that further studies be conducted as tests of the minimalist hypothesis.

**Reading Time.** Another popular measure of comprehension processes is reading time for a word, phrase, or sentence. Sometimes (cf. Huitema, Hopkins, Klin, & Myers, 1993; Myers, O'Brien, Albrecht, & Mason, 1993; Rayner &
Morris, 1991) a slow down in reading rate is used simply to indicate that processing is more difficult for one linguistic unit than another. But when reading time is used to measure comprehension, a serious problem arises: Readers always have the option to trade off speed and accuracy. As the minimalist hypothesis emphasizes, readers can read for speed, sacrificing accurate and complete understanding; or they can read for complete understanding, sacrificing speed; or they can engage in more microscopic tradeoffs. Without some measure of degree of understanding, reading time is uninterpretable except as an indication that the reader has chosen some particular point on a speed/accuracy trade-off function. What is required for many purposes is the combination of reading time and a measure of comprehension. On the basis of reading time data alone, it is not correct to decide that some inference is established in the mental representation of a text during comprehension (as has been done by, for example, Graesser et al., 1993, pp. 20, 39; O'Brien, 1987; O'Brien, Shank, Myers, & Rayner, 1988).

Multiple regression analysis of reading times is sometimes suggested as an alternative to more traditional controlled experiments (Graesser & Kreuz, 1993; Magliano & Graesser, 1991). Graesser, Magliano, and Haberlandt (in press, p. 8) say that "it is important to appreciate the broad capabilities of the reading-regression methodology," and point to the valuable contributions of this methodology in demonstrating the robust effects of such variables as number of letters per word, word frequency, imagery, and the serial positions of sentences in texts (p. 9). It has yet to be shown, however, that this methodology will allow investigation of questions of more subtle interest about inference processes (see Kliegl, Olson, & Davidson, 1982).

Facilitative Effects as Opposed to Inhibitory Effects. A frequently encountered mistake in the interpretation of data is the assumption that differences in some measure are due to For example, consider these two texts from experiments by Singer (Singer, in press; Singer et al., 1992):

(1) Wendy aspired to be able to play the grand piano. Her training included doing weights every day. Are pianos heavy?

(2) Peter went to the store for onions for the salad. Peter couldn't keep from crying. Do onions make eyes tear?

Such texts are odd, perhaps incoherent, according to undergraduate judges (and according to Graesser et al., 1993; Magliano & Graesser, 1991; and Singer et al., 1993, have been vehement in their warnings against the use of such texts). In addition, the combinations of the texts with their questions are odd. Any kind of processes (e.g., those measured by reading time or postreading question answering time) might be slowed by the oddness, and therefore any differences in processing times between these texts and less odd texts cannot be attributed to facilitation of processing for the less odd texts.
A similar problem applies to these two texts from Sanford and Garrod (1981):

(3) John was not looking forward to teaching math. The bus trundled slowly along the road. He hoped he could control the class today.

(4) John was on his way to school. The bus trundled slowly along the road. He hoped he could control the class today.

Sanford and Garrod found that the third sentence of the second text was read more slowly than the third sentence of the first text. They and others (Keenan, 1992) attribute this difference to an inference generated during reading of the first sentence of the second text, the inference that John is a school boy. This inference then conflicts with him controlling the class, slowing reading time. But the difference in reading times could equally well have come about because processing in the first text was facilitated by the information that John was a teacher in its first sentence. From the minimalist point of view, one goal for research is to separate out these kinds of confoundings by investigating whether inferences like John being a schoolboy are quickly and easily available from a sentence like John was on his way to school.

Subjects' Intuitions. Many procedures rely on subjects' intuitions, or give subjects the motivation, time, and opportunity to adopt strategies specific to the task they are given. Such procedures include free and cued recall, verbal protocols, story summaries, ratings of various kinds, and question answering under conditions in which there is no speed pressure (Bransford et al., 1972; Glenberg & Mathew, 1992; Graesser et al., 1993; Magliano & Graesser, 1991; Singer et al., 1993). What we know about these procedures from the past 20 years of research and from current theories about memory retrieval processes is that they allow subjects to edit their responses or to construct responses based on information that they otherwise had not encoded and would not have encoded. Corbett and Dosher (1978) and Singer (1978) showed that performance in cued recall is best explained by retrieval processes working to construct a link from the cue back to the to-be-remembered material. McKoon and Ratcliff (1986) showed that free recall responses contained inferences that did not appear in an online test or in a later speeded recognition test. McKoon and Ratcliff (1986, 1989a, 1989d) and Potts, Keenan, and Golding (1988) showed that subjects' ratings of the likelihood of a predictable event did not predict whether the inference would be drawn during reading: For events rated extremely likely, there was no evidence for inference during reading under some retrieval conditions, and two sets of events rated equally likely to occur were not equally strongly inferred during reading. Finally, McKoon (in preparation) showed that subjects' answers to questions about the goals of characters in stories do not accurately predict the occurrence of inferences about those goals during reading. Conversely, there exist inferences that are encoded during reading that would never show up
in question answering, recall, or verbal protocols (cf. Barton & Sanford, 1993; Erickson & Mattson, 1981; Greene, Gerrig, McKoon, & Ratcliff, in press; Greene, McKoon, & Ratcliff, 1992; McKoon, Greene, & Ratcliff, 1993; McKoon, Ratcliff, Ward, & Sproat, 1993; McKoon, Ward, Ratcliff, & Sproat, 1993; Rayner & Frazier, 1987; Taraban & McClelland, 1988; Ward, Sproat, & McKoon, 1991). For those who advocate the use of subjects' intuitions as a research strategy (Glenberg & Mathew, 1992; Graesser et al., 1993; Magliano & Graesser, 1991; Singer et al., 1993; Suh & Trabasso, 1993), the task is to model how such intuitions are constructed, to theoretically relate the intuitions to data obtained from other procedures for investigating comprehension, and to explain how subjects' intuitions will reveal such subtle aspects of comprehension as might be predicted by the minimalist hypothesis—for example, the argument structures of verbs or the combinations of meaning that make the anomaly of surviving dead unnoticeable (Barton & Sanford, 1993).

**Speeded Item Recognition.** One paradigm in which subjects’ intuitions and retrieval strategies can be kept from affecting their responses is speeded item recognition. When a single test word is embedded in a list of other test words, it is very unlikely that subjects can guess the purpose of the experiment, and therefore unlikely that they can adopt strategies specific to the variables under investigation. It is also unlikely that they can engage in retrieval strategies beyond fast automatic ones (automatic as defined by Posner & Snyder, 1975) because their response times are kept well within the automatic range. It might be argued that recognition responses to single words tap only some superficial representation of a text in memory (Graesser & Knez, 1993; Graesser et al., 1993; Magliano & Graesser, 1991; Morrow, Bower, & Greenspan, 1989, 1990; Morrow, Greenspan, & Bower, 1987; Zwaan & Graesser, 1993a, 1993b), but several results show this to be incorrect. Despite claims to the contrary (Graesser et al., 1993, p. 23; Whitney & Waring, 1989), recognition data have shown evidence of schemalike structures in memory for text (Allbritton, McKoon, & Gerrig, 1994; McKoon & Ratcliff, 1980b; McKoon, Ratcliff, & Seifert, 1989; Seifert, McKoon, Abelson, & Ratcliff, 1986), evidence of the encoding of what-happens-next inferences (McKoon & Ratcliff, 1986, 1989a, 1989d), evidence of the encoding of inferences connecting widely separated pieces of text information (Greene et al., in press; McKoon & Ratcliff, 1992), evidence of the encoding of causal connections not explicitly stated by the text (McKoon, Greene, & Ratcliff, 1993), evidence that contextually appropriate aspects of meaning are encoded (McKoon & Ratcliff, 1988), and evidence of inferences related to discourse models (McKoon, Ratcliff, Ward, & Sproat, 1993; McKoon, Ward, Ratcliff, & Sproat, 1993; Ward et al., 1991). It should also be pointed out that constructionist theorists show no hesitation over accepting the results of recognition procedures when those results are consistent with their position (Glenberg et al., 1987; Graesser et al., 1993; Singer et al., 1993; Suh & Trabasso, 1993; Trabasso & Suh, 1993).
"Naturalistic" Texts. It is sometimes argued (Graesser, Magliano, & Haberlandt, in press; Magliano & Graesser, 1991) that the choice of textual materials is a critical methodological issue, that "naturalistic" texts are better in some way than texts written by experimenters. How this argument might be supported empirically is unclear, because Graesser, Person, and Johnston (in press) found no effects of their theoretically interesting variables on reading times for naturalistic texts (on first reading). Empirical support aside, choice of text is not an issue of preference. Instead, it should be the goal of any theory of inference to explain what inferences are generated under what conditions. Constructionist theories must explain why some kinds of inferences (e.g., those studied by Corbett, 1984; Hopkins et al., 1993; Glenberg et al., 1987; Greene et al., in press; Greene et al., 1992; Huitema et al., 1993; McKoon, Greene, & Ratcliffe, 1993; McKoon & Ratcliffe, 1986, 1989a, 1989c, 1989d, 1992; Murray, Klin, & Myers, 1993; Myers et al., 1993; Potts et al., 1988) are generated from experimenter-written texts and other inferences are not. And constructionist theorists must explain why they accept as support for their position some results from experimenter-written texts (e.g., Glenberg et al., 1987; Singer, 1993, in press; Suh & Trabasso, 1993; Trabasso & Suh, 1993) yet reject results from experimenter-written texts that do not support their position.

The argument for rejection of results from nonnatural materials is a general one that appears in many contexts (cf Neisser, 1978). It could form the basis of rejection for much of the research in the areas of visual and auditory perception, memory, decision making, and problem solving. Our reasons against such rejection are the same as those previously put forward by others in other contexts (see Banaji & Crowder, 1991).

FALSIFICATION

The minimalist hypothesis applies to several different kinds of inferences and it is important to separate them in discussing whether the hypothesis can be falsified by empirical data. In the following sections, we separate inferences based on easily available information from those triggered by local incoherence, and we separate inferences based on knowledge given explicitly in the text from inferences based on general knowledge not stated in the text. Throughout these sections, we discuss situations in which the reader has no special goals or strategies.

Locally Coherent Text

1. Suppose that some inference is encoded during reading into the mental representation of a text and that the text contains no coherence break that could have triggered the inference. Then, according to the minimalist hypothesis, the inference could only be generated from information that is quickly and easily
available. To be quickly available, the information could be in short-term memory, it could be in long-term memory for previously encoded parts of the text, or it could be well-known general knowledge. Consider the case where the information is general knowledge. In this case, it is possible to show that the minimalist hypothesis is wrong, and in fact, we have already done so in experiments presented in McKoon and Ratcliff (1989d).

In those experiments, we first showed that an inference about someone being hurt was encoded, to some degree, during reading of a sentence about that person diving into an empty swimming pool and hitting concrete. The evidence that the inference was encoded was obtained from a delayed memory test, so that the problems of interpretation of online tests were avoided, and the test required speeded responses in a situation where subjects could not guess the goals of the experimenter, thus avoiding strategic retrieval processes that could have constructed the inference at the time of the test. Given evidence from the delayed memory test that the inference was encoded and retrievable in certain retrieval contexts, then the minimalist hypothesis must predict that the relation between the inferred information (getting hurt) and the information in the text (diving into concrete) should be available immediately during reading (i.e., within say 250 ms of reading the information on which the inference was based; this would be defined as automatic availability in the Posner & Snyder, 1975, sense of automaticity). Our data showed that it was not (see also Murray et al., 1993). Thus, we ourselves have falsified one prediction of the minimalist hypothesis (noting that, because evidence for encoding of the inference depends on the retrieval context at test time, constructionist predictions are also contradicted). In discussing this finding previously (McKoon & Ratcliff, 1992), we pointed out that it might be accommodated by Kintsch's construction-integration model (Kintsch, 1988), illustrating how the minimalist hypothesis can be modified by the addition of explicit processing mechanisms.

The kind of evidence that cannot, by itself, falsify the minimalist hypothesis is evidence that some relation is (or is not) available immediately online. For example, the relation between bug and insect appears to be available immediately even when the sentence context indicates that the other meaning of bug is intended (Onifer & Swinney, 1981). Because there is no evidence that the wrong meaning supports an inference encoded into the text representation, there is no contradiction of the minimalist hypothesis. Similar reasoning applies to online results discussed by Singer et al. (1993) and to results from experiments by Swinney and Osterhout (1990); Till, Mross, and Kintsch (1988); and Dell, McKoon, and Ratcliff (1983) (but not McKoon & Ratcliff, 1980a).

2. Easily available information can come not only from general knowledge but also from the text being read. Text information can reside in long-term memory like general knowledge, if it was read far back in the text, or it can reside in short-term memory, if it has just been read or if it has been brought back into short-term memory for some reason (cf. Fletcher, 1986; Fletcher, Arthur,
& Skeete, chap. 11 in this vol.; Fletcher & Bloom, 1988; Kintsch & van Dijk, 1978; van den Broek, 1988, 1990a, 1990b). For short-term memory, the minimalist hypothesis explicitly (McKoon & Ratcliff, 1992) assumes that information is processed in cycles, as described by Kintsch (Kintsch & van Dijk, 1978; also Fletcher & Bloom, 1988), such that the propositions residing in short-term memory on any given cycle are a function of both recency and topicality or salience (contra claims by Singer et al., 1993). Clearly, the encoding of inferences based on text information residing in short-term memory cannot contradict the minimalist hypothesis because short-term memory information is assumed by definition to be easily available, although the degree of availability of a concept in short-term memory may vary (see discussion later).

For text information in long-term memory (information that has not been reinstated into short-term memory), empirical evidence about its use in inference generation is only suggestive (Huitema et al., 1993; McKoon & Ratcliff, 1992; Murray et al., 1993; Myers et al., 1993) and it is discussed later in the context of new directions for research.

Locally Incoherent Text

1. Inferences that are not based on easily available information must be triggered, according to the minimalist hypothesis, by local incoherence. For example, our data (McKoon & Ratcliff, 1992) suggest that readers try to understand the relation between Sentences 5 and 6.

(5) The engine of their old car blew up, and Karen and Felix had to buy a new car.

(6) Karen decided fix up the basement.

These sentences are obviously locally incoherent (simple argument repetition alone does not provide coherence, a point missed by some, Graesser et al., 1993, p. 43; Singer, in press; Suh & Trabasso, 1993; but noted previously by Keenan, Baillet, & Brown, 1984).

What is difficult is defining local coherence for situations beyond the obvious ones. As we pointed out previously (McKoon & Ratcliff 1992), there currently is no definition of local coherence. Arbitrary definitions designed to contradict the minimalist hypothesis provide no real solution to the problem. For example, it is not productive to decide that Sentences 7 and 8 or Sentences 9 and 10 are locally coherent just in order to use data from their texts to falsify the minimalist hypothesis (Graesser et al., 1993; Singer et al., 1993; Suh & Trabasso, 1993; Trabasso & Suh, 1993). These pairs of sentences represent possible coherence breaks, and as such must be carefully considered when attempting to model processing of their texts. These pairs of sentences exemplify the need for empirical
explorations of various bases for coherence, with the goal of arriving at a definition against which minimalism could be tested.

(7) Betty felt sad.

(8) Betty saw her friend knitting.

(9) Jimmy was very sad.

(10) Jimmy's mother told him that he should have his own savings.

2. It has been pointed out that the minimalist hypothesis can be saved from falsification by attributing contradictory findings to "strategies" adopted by subjects especially to produce those findings. Unlike some critics of the hypothesis (Keenan, 1992; Singer et al., 1993; Zwaan & Graesser, 1993a), we do not think this will be so easy. On the one hand, there are experiments where the materials given to subjects might easily be thought to invoke special strategies (Bransford et al., 1972; Potts, 1974), and the instructions and test conditions used in some experiments (e.g., Morrow et al., 1989; see also Wilson, Rinck, McNamara, Bower, & Morrow, 1993) are another instance where special strategies might be used by subjects. But most psycholinguistic experiments cannot be so easily classed as invoking special strategies. How could it be argued, for example, that Glenberg et al.'s (1987) subjects—reading stories about girls picking flowers and other such topics—were engaging in strategies, whereas our subjects (McKoon & Ratcliff, 1992)—reading about CIA agents and cowboy shoot-outs—were not?

More importantly, what any theory must do is to explain the varied and complex sets of results from all those experiments in which subjects most likely did not have special goals, experiments in which the texts constructed by the experimenters were not very interesting and the only strategy subjects engaged in was designed to get themselves out of the experiment as quickly as possible with some minimally acceptable level of performance. Dismissing the varied and complex results from these experiments (as suggested by Graesser, Magliano, & Haberlandt, in press; Magliano & Graesser, 1991) is to miss the power of text comprehension processes. In most experiments, subjects do not necessarily have the "NEED TO KNOW" (Graesser et al., 1993; Singer et al., 1993, p. 34) postulated by some constructionist theorists, yet the complex patterns of data offer the possibility of important theoretical constraints. Even with "puzzling sequence(s) of propositions that satisfy a researcher's counterbalancing constraints" (Graesser et al., 1993, p. 18), there are powerful data to be explained.

Directions for Research

The minimalist hypothesis emphasizes the processes of inference generation. It is this emphasis that in large part determines the methodological rules that must be followed in future research to test or falsify the hypothesis. However, as
mentioned earlier, our original intention was to focus research on the specific kinds of inferences suggested by the minimalist hypothesis. Inference generation is assumed to depend on the ease with which supporting information becomes available or the difficulty of establishing local coherence. Thus the obvious questions for research become what kinds of information are easily available and how easily local coherence is constructed.

Given the evidence available in current research, we have no understanding of why some kinds of information are easily available in support of inferences and others are not. For example, sentences about milking animals on farms are understood as references to cows, information that can be shown to be quickly available (McKoon & Ratcliff, 1989b; Roth & Shoben, 1983), but sentences about stirring coffee are not understood as references to spoons (Corbett & Dosher, 1978; McKoon & Ratcliff, 1981), and information about spoons is not quickly available in the stirring coffee context. The minimalist hypothesis explains this in the processing sense that it predicts the failure of encoding when information is not quickly available. But it does not take the second step of explaining why one kind of information is available and the other not. Constructionist theories do not offer any explanation at all: Either neither piece of information, cows or spoons, would be required in a situation model for the text or both would be required; there is no a priori reason to distinguish between them.

There are a number of intriguing candidate kinds of information that might be easily available and encoded from general knowledge during reading. Instantiations of stereotypical aspects of meaning are one kind of inference suggested by the cow example (see also McKoon & Ratcliff, 1989b). “John rides the bus in the morning” might, through conceptual combinations among John, riding a bus, and morning, quickly evoke the concept school (Sanford & Garrod, 1981). A story about a surgeon might quickly evoke an instantiation of a person of the male sex (Keenan, 1992).

It is important to understand that, from the minimalist point of view, instantiations will not necessarily represent “correct” interpretations of a text. Because we assume that reading is a collection of processes for which speed and accuracy can be traded off against each other (Greene et al., 1992; McKoon, Greene, & Ratcliff, 1993), information that is quickly available may not be fully checked for accuracy. Such a tradeoff is suggested by the comprehension failures exhibited in the Moses illusion (Bredart & Modolo, 1988; Erickson & Mattson, 1981; van Oostendorp & de Mul, 1990; Reder & Kusbit, 1991) and in Barton and Sanford’s (1993) example about burying the survivors of an airplane crash.

It is also important to understand that information that is quickly and easily available might represent quite complex mixtures. For example, the causal chain that explains how antibiotics combat infection might be quite long, and part of the general knowledge of most readers, but the causal connection between having an infection and curing it with antibiotics that is encoded during reading might be some shorthand like fix, antibiotics, infections (see Keenan et al., 1984). For
another example, the meanings of verbs might include contingencies with respect to the syntactic structures in which they are expressed; *cramming a closet with books* might mean something quite different from *cramming books into a closet* (Levin, 1993; McKoon & Ratcliff, 1989c).

Just as some pieces of information in general knowledge can be quickly and easily accessible from a text being read, so can some pieces of information in long-term memory for the text being read. Salience is the term we have used to describe the accessibility of a concept or event in the discourse model of a text (cf. McKoon & Ratcliff, 1992). During reading, the discourse model is assumed to contain all the concepts and events of the text, though, in general, concepts mentioned recently would be assumed to be more accessible than concepts mentioned farther back in a text. Accessibility is determined by many interacting factors, including syntactic position in a sentence (McKoon, Ratcliff, Ward, & Sproat, 1993; McKoon, Ward, Ratcliff, & Sproat, 1993; Ward et al., 1991); semantic position relative to a verb (McKoon & Ratcliff, 1989c); connections to other concepts via semantic, pragmatic (McKoon & Ratcliff, 1981), associative, argument repetition, and perceived topicality links (McKoon & Ratcliff, 1992; McKoon, Ward, Ratcliff, & Sproat, 1993; Ward et al., 1991); and so on. During reading, all of these factors interact to give text concepts in both short- and long-term memory different degrees of accessibility. In addition, the accessibility of a concept or event depends on the particular cue with which it is referenced (cf. McKoon, Ward, Ratcliff, & Sproat, 1993). For example, *surgeon* might be more accessible relative to the cue *he* than the cue *she*. The retrieval process involved in accessing some discourse concept or event in long-term memory is understood in terms of the current global memory models (the resonance metaphor used in Gillund & Shiffrin, 1984; Hintzman, 1986; Murdock, 1983; Ratcliff, 1978; Ratcliff & McKoon, 1988). (It should be noted that we see the notion of a discourse model as an update of the 1978 Kintsch and van Dijk model; the only difference is that we are attempting to better define the representation constructed during processing, in the same spirit as Fletcher & Bloom, 1988; Kintsch, 1992; van den Broek, 1990b).

As with information from general knowledge, information from the text being read may not be "correctly" interpreted. For example, inferences to instantiate a concept as the referent of a pronoun should succeed just to the extent that the correct referent is sufficiently more salient than other possible referents with respect to the pronoun as a cue. When the referent is not sufficiently more salient, then the speed/accuracy trade-off situation applies; we assume readers can sacrifice accuracy for speed, leaving some references unresolved (Greene et al., 1992; Greene et al., in press; McKoon, Greene, & Ratcliff, 1993).

When is textual information in long-term memory sufficiently salient that it becomes involved in the processing of information currently being read? One possibility is that information about the main characters in a story is always sufficiently salient. McKoon and Ratcliff (1992, see also Murray et al., 1993;
O’Brien & Albrecht, (1992) found evidence that different pieces of information about a main character were connected together even when separated by large distances in surface structure. However, this cannot be assumed to be true quite in general. McKoon and Ratcliff (1992), in a different set of much shorter stories, found that subjects appeared not to encode the inconsistency of two propositions about a main character when the propositions were separated by only a few sentences, and other failures of readers to notice inconsistencies are well documented (cf. Epstein, Glenberg, & Bradley, 1984). Perhaps, a suggestion about how these results might be reconciled is offered in recent experiments by Huitema, Myers, and their colleagues (Huitema et al., 1993; Myers et al., 1993). They used short texts each with a main character, very much like the short stories used by McKoon and Ratcliff (1992), but they found evidence that readers did notice the inconsistency between information given about the character early in the text and information given later in the text. For example, in one story, Dick wants to take a vacation for sun and swimming but later Dick buys a plane ticket for Alaska (Huitema et al., 1993). It may be that the general knowledge that connects vacations, sun, and swimming to plane tickets adds to the accessibility of the proposition about a vacation from the proposition about buying a plane ticket. In other words, Dick, by itself, in the earlier proposition might not be sufficiently accessible from Dick, by itself, in the later proposition. But Dick plus vacation, sun, and swim might be sufficiently accessible from Dick plus plane ticket. In Myers et al. (1993), accessibility of the earlier information was increased in a different way; the information was discussed in several sentences with strong emphasis. Again, readers appeared to notice a later inconsistency. These results are intriguing; they suggest broader explorations of the variables that govern salience and consideration of the possibility that such variables are more powerful than we might have thought.

A particularly appealing outcome of such explorations might be to reduce the importance of the problem of defining local coherence. Our original thought (McKoon & Ratcliff, 1992) was that incoherence in the sense of disconnected pieces of information is a rare occurrence. Discourse (written or spoken) is produced from the message that the writer or speaker wants to convey, and we can assume that the message is usually coherent. It may be made coherent through connections among propositions in short-term memory or through easily accessible pieces of general knowledge, or it may be made coherent through salient connections to earlier parts of the discourse. Perhaps it is rare for all of these mechanisms to fail. If so, the research strategy would be, not to look for instances of incoherence, but instead to investigate how quickly and easily the different kinds of information required to establish coherence become available.

Consider the following paragraph from some recent experiments by Dopkins et al. (1993):

The atmosphere on the luxury liner was getting tense. Several valuable items had disappeared from the cabins. When he heard about the problem, the captain began
an investigation in order to nab the thief. After two days of considering the evidence, the captain had the purser brought to his office.

Dopkins et al. investigated comprehension of the purser. This concept was not mentioned before the last sentence in the text. Although the definite article the might suggest an anaphor, no explicit referent exists in the discourse model. So this might be thought to provide an instance of incoherence. But there are a number of possibilities about how the purser might be connected to the rest of the text. General knowledge might provide a simple connection between luxury liners and the purser as one of the employees on the liner. General linguistic knowledge might provide more information, that is, that people are brought to some location by an authority figure for some purpose. The “purpose” argument of brought is left unfilled, and this gap might function as an anaphor to cue a referent. Dopkins et al.’s data support such a suggestion: thief, a part of the possible referent to nab a thief, is facilitated in an online test following the purser sentence. These several kinds of processing might conspire to provide coherence.

If the paragraph is changed to provide different information about the purser, then the conspiracy of processes also changes:

While strolling the deck with the purser, the captain noticed that the atmosphere on the luxury liner was getting tense. Several valuable items had disappeared from the cabins. When he heard about the problem, the captain began an investigation in order to nab the thief. After two days of considering the evidence, the captain had the purser brought to his office.

Now, when the purser is encountered in the last sentence, anaphoric processes connect it to the most salient (with respect to the purser as cue) earlier mentioned discourse entity, the purser encountered in the first sentence. And apparently, according to Dopkins et al.’s data, there is no further processing of the purser to connect it to thief.

This analysis (following closely that of Dopkins et al.) provides an intriguing example of how coherence can be investigated. The challenge is to find and tease apart other such conspiracies of coherence, and to map out their processes and the structures of information upon which they depend.

We are still left, however, with a different kind of incoherence, the incoherence that arises when readers fail to encode connections given to them explicitly (Noordman & Vonk, 1992; Vonk & Noordman, 1990) or when readers appear to encode contradictory pieces of information, such as the animals entering Moses’s Ark two by two (Erickson & Mattson, 1981; van Oostendorp & de Mul, 1990). The minimalist account of such incoherence is simple: Readers, in trading off speed for accuracy in processing, mistake the quantity of easily available connections between Moses and the Ark for quality. But, as with other inferences, the minimalist account does not specify for what kinds of information or under what textual conditions this quantity/quality tradeoff should apply. Construction-
ist accounts fare even worse. Mental models might be stretched to keep the actress falling off the 14th-story roof alive (Glenberg & Mathew, 1992), but we cannot envision a mental model of the surviving dead from an airplane crash (Barton & Sanford, 1993).

CONCLUSION

This chapter has outlined minimalist hypothesis considerations of comprehension processes and methodologies for testing those processes. We hope to have emphasized our original goal, to promote investigation of inference processes with renewed intensity and increased methodological rigor. The large amount of recent research on inference processes, in journals and in the chapters of this book, leads us to be optimistic that much will be learned about comprehension processes in the next few years.

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