Validation in Reading Comprehension

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Abstract
Language comprehension involves analysis at the level of the word, sentence, and message and the integration of message meaning with the prior discourse and world knowledge. Contemporary research converges on another facet of comprehension: the validation of message consistency. Existing evidence already favors several principles in validation of reading and listening. Validation is initiated immediately and is routine rather than requiring intentional strategies. Successful validation is a precondition to updating the situational representation of the message. Validation applies to discourse inferences as well as explicit assertions. Finally, the memory-retrieval processes that enable validation closely resemble those of intentional discourse memory. Competing observations of people’s validation failures are proposed to systematically stem from features of the message, understander, and comprehension task. Therefore, theoretical analysis that accommodates both successful and deficient language validation ought to be attainable.

Keywords
validation, language, comprehension, inference, memory

Many human activities depend on successful spoken or written communication. However, ordinary language messages bear errors of many types. A presidential candidate may be called “Rooney” rather than “Romney,” and a teenager may be characterized as confronting “autopsy” rather than “autism.” Story characters may perform actions ranging from the unsuitable to the impossible, such as going to bed before making an intended air reservation or making a purchase in the absence of money. Such deviations demand the understander to continually monitor message consistency: that is, to validate the message.

Language comprehension depends on people’s analysis of word meaning, grammatical structure, and sentence semantics. Sentence meaning, in turn, must be integrated with prior discourse (coherent message) information and world knowledge, resulting in situation-model representations of the message (van Dijk & Kintsch, 1983). However, there is growing consensus that such integration depends on processes of validation, which can expose message discrepancies (Nieuwland & Kuperberg, 2008; Schroeder, Richter, & Hoever, 2008; Singer, Halldorson, Lear, & Andrusiak, 1992).

Validation research already exhibits considerable theoretical convergence. In brief, this theory states that current message information passively cues the memory retrieval of relevant ideas both from the prior discourse and from world knowledge (O’Brien, Lorch, & Myers, 1998). Validation processes then assess the plausibility of tentative links between current ideas and retrieved information (Schroeder et al., 2008; Singer et al., 1992). Validation with reference to word meaning and sentence semantics does not precede contextual validation; rather, the two proceed in parallel (van Berkum, Zwisterlood, Hagoort, & Brown, 2003). Only upon successful validation is the message situation model accordingly updated (Ferretti, Singer, & Patterson, 2008; Schroeder et al., 2008).

Researchers have evaluated numerous candidate principles of language validation. The current status of several noteworthy principles is considered next. Then, the implications of systematic shortcomings in people’s validation are addressed. The emphasis is on reading comprehension, but many of these effects probably generalize to listeners (van Berkum et al., 2003).

Principles of Reading Validation

Immediacy
Messages are proposed to be interpreted, at all levels of analysis, immediately upon the appearance of each word,
within approximately 0.25 s (Just & Carpenter, 1980). Immediacy apparently extends beyond words and sentences to message validation. Immediacy tends to deny an alternative, two-step model, according to which sentences are fully interpreted syntactically and semantically before they are integrated with the discourse representation (see discussions of Ferreira, Bailey, & Ferraro, 2002 and Nieuwland & Kuperberg, 2008).

The immediate contribution of discourse context and world knowledge to sentence validation was addressed by Matsuki et al. (2011; compare Rayner, Warren, Juhasz, & Liversedge, 2004). They examined people’s comprehension of sentences such as Donna used the hose to wash ber filthy (car [plausible] / bair [implausible]) after returning from the beach. Converging evidence from word-by-word reading and eye fixation methods revealed elevated reading time immediately upon the appearance of the less plausible alternative (i.e., bair). The implausible version was not anomalous (compare wash ber luck), elevated reading times for which would diagnose lower-level semantic processes.

Consider, likewise, people’s processing of Jenny saw/ beard the mountain lion pacing in its cage. Staub, Rayner, Pollatsek, Hyona, and Majewski (2007) noted that Jenny beard the mountain lion . . . is transiently implausible at the word mountain, because one cannot hear a mountain. Processing time was immediately inflated upon people’s eye fixations of mountain in the implausible version but not the plausible (saw) version.

In complex discourse, much evidence for immediate validation stems from event-related potentials (ERPs). In the ERP method, the measurement of electrophysiological scalp signals (electroencephalography) begins with a critical stimulus (the “event”). A negative ERP voltage approximately 400 ms after the event (the N400) diagnoses conspicuous sentence anomalies (Dutch trains are sour; van Berkum et al., 2003). This pattern generalizes to text-based inconsistencies, such as describing a quick brother as being slow (van Berkum et al., 2003). Within 750 ms, extensions of the N400 revealed subtle differences between a character believing a false fact versus actually knowing it, an outright contradiction (Ferretti et al., 2008).

Validation is routine, not strategic

Nonstrategic validation posits that readers are routinely sensitive to discourse consistency. In most relevant studies, subjects read simply to understand stimulus texts or to answer questions about them afterward. Reading is not interrupted—rather, the measures of validation are relatively unobtrusive.

One recent test of nonstrategic validation did impose an unusual task: to judge whether the final word in a sentence appeared in color rather than black (Isbener & Richter, 2013). Stimulus sentence sequences ended with a plausible or implausible word (e.g., Frank had a broken pipe. He called the plumber/doctor, respectively). The researchers reasoned that if validation processes persisted in this Stroop-like task, then “congruity effects” would emerge: that is, faster “yes” than “no” color-change judgments for plausible sentences and vice versa for implausible ones. To minimize strategic opportunities, the message words each appeared for only 300 ms. The results exhibited the predicted congruity effects, indicating that validation processing accompanies even this unusual task.

Nonstrategic validation is also supported by the finding that reading with the intention to validate discourse ideas actually prompts more logical but less contextually sensitive validation than reading for comprehension (Singer, 2006, Experiment 3). Likewise, in Staub et al.’s (2007) aforementioned examination of phrases such as beard the mountain lion, the investigators emphasized that the many plausible sentences interspersed among their stimuli minimized people’s development of unusual strategies for understanding them.

Validation enables representational updating

Comprehension continually augments the discourse-situation model (van Dijk & Kintsch, 1983). Successful validation is widely considered a prerequisite for situational updating (Cook & Myers, 2004; Ferretti et al., 2008). Schroeder et al. (2008) characterized this process as episodic gatekeeping: If the current clause meshes with its antecedents, its contents update the situation model.

Burkhardt (2006) noted that a positive ERP response sometimes follows the N400 by approximately 0.5 s. She proposed that this positivity diagnoses representational updating. In one relevant study, we created texts that induced readers to engage in updating (Ferretti, Singer, & Harwood, 2013). For example, they could read, The boys ate while they cycled to practice . . . . The coach established that it was oranges that the boys ate. The latter sentence permits the discourse representation to be amended to specify what the boys ate. Consistent with Burkhardt’s proposal, the word oranges generated a late positivity relative to conditions in which oranges was clearly consistent or even contradictory, suggesting that the representation was indeed updated.

The relations between validation and updating may be complex. When a previously implied trait of a character (e.g., messiness) is causally refuted by the text (e.g., his apartment is messy because he just moved), the representation tends to be updated to negate the trait. Simple,
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noncausal refutations, in contrast, do not have this impact (Rapp & Kendeou, 2009). In addition, updating does not completely eradicate prior representations. Although a character representation may be updated as no longer vegetarian, reading that she ordered a cheeseburger inflates reading time (O’Brien, Rizzella, Albrecht, & Halleran, 1998).

**Discourse inferences are validated**

Inference pervades discourse comprehension. Successful comprehension ought therefore to require the validation of tentative inferences. Much relevant evidence originates from inferences that bridge the current clause to its antecedents. Consider: Claudia arrived in Dresden after Markus . . . She was awaiting him when he disembarked. Reading time for the inconsistent second sentence was greater than for a comparable consistent one, reflecting the cognitive difficulties of the time-incongruence (Rinck, Hahnel, & Becker, 2001). Myriad comparable results obtain for both blatant and subtle causal, spatial, and logical inferred inconsistencies (Albrecht & Myers, 1995; O’Brien & Albrecht, 1992).

We advanced a formal analysis of the validation of causal bridging inferences for sequences such as Joe poked the balloon with the pin. The balloon burst (Singer et al., 1992). The reader was hypothesized to first construct an idea that, when combined with the antecedent idea, accounts for the outcome. If the constructed idea (e.g., pins are sharp) is compatible with world knowledge, then the inference has been validated. Supporting this analysis, people need less time to answer questions about the hypothetically corroborating knowledge (Are pins sharp?) after reading the former balloon sequence than a control, noncausal sequence (Singer et al., 1992). Comparable results obtain even for complex, unfamiliar causal text such as Some fireworks burn with a crimson flame BECAUSE they contain calcium salts (Singer, Harkness, & Stewart, 1997).

**Validation memory processes resemble those of intentional retrieval**

Having read Ken ate apples on the way to practice, one can readily answer, Did Ken eat oranges? (no). Analogously, if one later reads, The coach knew that Ken ate oranges, full comprehension demands noticing the apples-oranges discrepancy. It is parsimonious to hypothesize that the memory-retrieval processes of comprehension resemble those of intentional retrieval (O’Brien, Lorch, et al., 1998).

In tests of this supposition, researchers have compared measures of reading validation with those stemming from intentional verification paradigms (Carpenter & Just, 1975). As in studies of verification time, an ERP N400 index of validation immediately signals when the verb of a sentence (The gymnast PUNCHES the journalist) mismatches that portrayed in a prior picture viewed by the subject (Knoeferle, Urbach, & Kutas, 2011). In intentional verification, correct response time is often greater for false (mismatching) than true affirmative test items but vice versa for negative ones (Carpenter & Just, 1975). A highly similar reading time pattern emerges for affirmative and negative sentences that match or mismatch their message antecedents (Singer, 2006). This favors the close similarity between passive and intentional retrieval processes in comprehension.

**Conclusions and caveats**

It is noteworthy that in the framework of Kintsch’s (1988) construction-integration theory, comprehension first entails the construction of a tentative network of explicit, implied, and associated discourse ideas. Integration then enhances the activation of the most relevant ideas, effectively discarding irrelevant ones. Ferretti et al. (2013) proposed that the integration stage encompasses both validation and updating. That is, the relevance of an idea is established by validation processes, which in turn may lead to representational updating.

Some qualifications should be offered about the present validation principles. First, some of the principles are closely associated with other features of cognition and might be cast differently. For example, processing immediacy strongly suggests the parallel analysis of multiple levels of language structure. Indeed, immediacy has been explicitly equated with an “incremental,” multilevel analysis rather than a two-step framework, as discussed earlier (Ferreira et al., 2002; Knoeferle et al., 2011). However, the immediacy of validation processing has been particularly addressed (e.g., Matsuki et al., 2011).

Second, yet other candidate principles may receive more scrutiny in the future. In a different domain, Ferguson and Zayas (2009) assessed the automaticity of the validation or evaluation of potentially rewarding and threatening stimuli. Researchers may have disregarded the automaticity of reading validation because of the complexity of applying criteria of automaticity (Bargh, 1994).

**Glass Half-Full or Half-Empty: Systematic Limitations of Validation**

Among people’s comprehension deficiencies are instances of validation failures. For example, readers sometimes overlook the discrepancy of a character making a purchase although he has forgotten his wallet (Cohen, 1979). Some validation shortcomings probably
reflect systematic effects of the message, the reader, and the reading task.

*Message* characteristics can thwart validation in conspicuous and subtle ways. Unsurprisingly, the sheer complexity of message content may stymie validation. Thus, whereas readers validate even the scientific causal inferences underlying *Some fireworks emit crimson flames because they contain calcium salt* (Singer et al., 1997), validation fails for more complex examples (Noordman, Vonk, & Kempff, 1992).

Another well-known instance of validation failure is that the question *How many animals of each kind did Moses take on the ark?* frequently evokes the answer “two,” even though the ark builder was Noah (Barton & Sanford, 1993). This “Moses illusion” partly results from the fact that the question “presupposes” the truth of *Moses* and focuses on the number of animals (Glenberg, Wilkinson, & Epstein, 1982).

Interrelated message ideas may be too distant to be inferentially validated. Whereas readers may detect the situational inconsistency of Mary going to bed without making an intended air reservation, sufficient intervening text obscures the inconsistency (Albrecht & Myers, 1995). What constitutes excessive text distance, however, is likely to differ among readers. The impact of understander differences on validation is considered next.

Readers’ language-specific working memory resources (“reading span”) are strongly implicated in successful comprehension, even at levels such as relating a pronoun to its antecedent (Daneman & Carpenter, 1980). These observations likewise apply to the validation of causal bridging inferences. As discussed earlier, fully understanding *Joe shoots the balloon with the pins. The balloon burst.* depends on knowing that pins are sharp. Singer and Ritchot (1996) demonstrated that people low both in reading span and reading skill tend not to access such relevant knowledge (see also Knoeferle et al., 2011). Likewise, missing the discrepancy of making sandwiches in the absence of bread increases with age (Cohen, 1979), which probably reflects diminishing working memory resources.

Reminiscent of the Moses illusion, people frequently overlook the anomaly of phrases such as *where to bury the SURVIVING DEAD* (Barton & Sanford, 1993). Hannon and Daneman (2004) showed that this incoherence is particularly overlooked by low-skill readers. They proposed that these people focus on global meaning and therefore miss the discrepancy of *SURVIVING DEAD.*

Finally, *task effects* in reading validation originate in the innumerable purposes of engaging in language comprehension, such as communication, learning, and entertainment. Tasks that highlight message form at the expense of meaning tend to minimize validation. Thus, ordinarily robust signatures of validating causal bridging inferences do not appear in proofreading (Singer & Halldorson, 1996). In the extreme, mind-wandering during reading (Smallwood, McSpadden, & Schooler, 2008) is likely to appreciably stymie language validation.

### Conclusions

The impact of message, understander, and task characteristics on successful validation must be accommodated by theories of language comprehension. Some formulations specifically address comprehension aberrations. The scenario mapping analysis (Sanford & Garrod, 1998) emphasizes that attentional focus at different levels of language analysis may compete with one another. Thus, monitoring a message for global coherence may obscure local anomalies such as *surviving dead.* Likewise, the “good-enough” processing framework posits that partial or erroneous representations may result from comprehension (Ferreira et al., 2002). Restricted focus and erroneous representations result in validation failures at lower or higher levels of language analysis.

The scenario mapping and good-enough processing formulations attribute comprehension failures to regularities of cognition. Thus, immediate interpretation is favored by the rapid forgetting of verbatim message form but increases the risk of inaccuracies (Ferreira et al., 2002). Deriving all candidate interpretations of each phrase would overwhelm cognitive resources, but disregarding some alternatives might result in overlooking anomaly (Sanford & Graesser, 2006). These analyses challenge some tenets of widely held comprehension theories (e.g., Kintsch, 1988) but share enough assumptions with them that reconciliation is likely achievable.

### Cognitive Generality of Validation

Routine and immediate validation in language processing may reveal a more pervasive role of validation in human cognition. It is striking that theoretical analyses of both elementary and complex information processing allude to this role. Memory performance has been proposed to comprise both the retrieval of a candidate stimulus and its subsequent, validating comparison with the memory cue (Tulving, 1983). Change blindness may reflect failed (validating) comparisons between earlier and later visual stimuli (Mitroff, Simons, & Levin, 2004). Formal reasoning has been proposed to entail a validating search for counterexamples to tentative mental models of a problem solution (Schroyens, Schaeken, & d’Ydevalle, 2001). Concerning social understanding, Wyer and Radavansky (1999) presented evidence that the validation of person and event information precedes situational updating. Ahead lies the task of determining whether principles of language validation generalize to these diverse domains.
Recommended Reading


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