

Accessibility in Text and Discourse Processing

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Accessibility is one of the most important challenges at the intersection of linguistic and psycholinguistic studies of text and discourse processing. Linguists have shown how linguistic indicators of referential coherence show a systematic pattern: Longer linguistic forms (like full lexical NPs) tend to be used when referents are relatively low accessible, shorter forms (pronouns and zero anaphora) are used when referents are highly accessible. This linguistic theory fits in nicely with a dynamic view of text and discourse processing: When a reader proceeds through a text, the activation of concepts as part of the reader's representation fluctuates constantly. Hypotheses considering activation patterns can be tested with on-line research methods like reading time or eye-movement recording. The articles in this special issue show how accessibility phenomena need to be studied from a linguistic and a psycholinguistic angle, and in the latter case from interpretation as well as production.

What happens when people read a text or participate in a discourse? Text and discourse processing are dynamic processes during which the reader or listener constructs a cognitive representation of the information in the text or discourse. Even though readers' and listeners' representations are not identical to the information they read and hear, texts and discourses contain many linguistic signals that guide comprehension. These assertions are among the most important results of research on text and discourse processing during the last decades (see, among others,

Gernsbacher & Givón, 1995; Graesser, Millis, & Zwaan, 1997; Sanders & Spooren, 2001). The main findings can be summarized as follows:

- Text and discourse processing results in a cognitive representation of the information. The crucial characteristic of this representation is that it shows connectedness. This connectedness can be best characterized as *coherence*.
- The cognitive processes of text and discourse production and interpretation can be modeled as dynamic processes in which activation fluctuates. These processes are influenced, or even to a large extent determined, by the linguistic characteristics of the text or discourse.

Before going into more detail on these two findings, we shall first illustrate them with a concrete example (Sanders & Spooren, 2002): that of referential coherence. Referential coherence results from the fact that reference to individuals creates continuity and hence coherence in the text or discourse. The relevant linguistic signals are the references to objects and concepts, and more specifically, the ways in which the reference is realized—through full Noun phrases, pronouns, zero anaphora, and so on.

The following text from Matthews (1994) illustrates how referential coherence structures discourse:

- (1) The heaviest human in medical history was Jon Brower Minnoch (b. 29 Sep 1941) of Bainbridge Island, WA, who had suffered from obesity since childhood. The 6-ft-1-in-tall former taxi driver was 392 lb in 1963, 700 lb in 1966, and 975 lb in September 1976. In March 1978, Minnoch was rushed to University Hospital, Seattle, saturated with fluid and suffering from heart and respiratory failure. It took a dozen firemen and an improvised stretcher to move him from his home to a ferryboat. When he arrived at the hospital he was put in two beds lashed together. It took 13 people just to roll him over. (p. 151)

The text's topic, Jon Brower Minnoch, is identified in the first sentence and is referred to in each sentence throughout this segment of text. Here are the referential forms, with \emptyset standing for zero-anaphor:

Jon Brower Minnoch (b. 29 Sep 1941) of Bainbridge Island, WA
 The 6-ft-1-in-tall former taxi driver
 Minnoch
 \emptyset
 \emptyset
 him
 he
 he
 him.

First of all, this list shows that the linguistic indicators for referential coherence are lexical NPs, pronouns, and other devices for anaphoric reference. Second, it appears that the longest referential forms are used in the beginning of the fragment; once the referent has been identified, the pronominal and zero forms suffice. This is not a coincidence. Many linguists have noted this regularity and related it to the cognitive status of the referents. Ariel (1990, 2001), for instance, has argued that this type of pattern in grammatical coding should be understood to guide processing. She has developed an *accessibility theory* in which high accessibility markers consist of less linguistic material and signal the default choice of continued activation. By contrast, low accessibility markers consist of more linguistic material and signal the terminated activation of the current (topical) referent.

It is not hard to see how a linguistic theory like this fits in with a dynamic view of text and discourse processing. For instance, such a dynamic view leads to the expectation that when a reader proceeds through a text, the activation of concepts, facts, and events as parts of the reader's representation fluctuates constantly. So, hypotheses considering activation patterns can be tested with online research methods like reading time, naming, speeded recognition, or eye-movement recording. Eventually, the fluctuating activation patterns settle into a relatively stable memory representation.

Several discourse comprehension models are based on these insights and empirical findings, such as the Structure Building Framework (Gernsbacher, 1990), the Landscape Model of Reading (Gaddy, van den Broek, & Sung, 2001; van den Broek, Young, Tzeng, & Linderholm, 1998), and the Construction-Integration model (Kintsch, 1998). Questions of how exactly this activation fluctuates and how the activation is influenced by the linguistic characteristics of the text or discourse are currently major research questions, which are partly addressed in contributions to this issue.

Now that we have illustrated the principles of referential coherence and accessibility in text linguistics and discourse processing, we can move on by specifying some major ideas of accessibility.

LINGUISTICS: THE SYSTEM AND USE OF REFERENTIAL SIGNALS

As explained earlier, Mira Ariel has developed an Accessibility marking scale (Ariel, 1990), from low to high accessibility markers:

- (2) Full name > long definite description > short definite description > last name > first name > distal demonstrative > proximate demonstrative > NP > stressed pronoun > unstressed pronoun > cliticized pronoun > zero.

For cases such as our text (1), Ariel convincingly showed that zero anaphora and unstressed pronouns co-occur with high accessibility of referents, whereas stressed pronouns and full lexical nouns signal low accessibility. This co-occurrence can easily be understood in terms of cognitive processes of activation: High accessibility markers signal the *default* choice of continued activation of the current topical referent. Low accessibility anaphoric devices such as full NPs or indefinite articles signal the terminated activation of the current topical referent, and the activation of another topic. Ariel (1990) even argued that binding conditions on the distribution and interpretation of pronominal and anaphoric expressions are actually the 'grammaticalized versions' of cognitive processes of attention and accessibility of concepts that are referred to linguistically. This accessibility theory is based on earlier work by Chafe and Givón: "Chafe (1976, 1994) was the first to argue for a direct connection between referential forms and cognitive status. Accessibility theory can be seen as an extension of his (and later Givón's 1983) basic insight" (Ariel, 2001, p. 60).

Many functional and cognitive linguists have argued that the grammar of referential coherence can be shown to play an important role in the mental operations of connecting incoming information to the existing mental representations. More and more empirical data from corpus studies have become available to underpin this cognitive interpretation of referential phenomena, following a route guided by functional linguists like DuBois (1980). In a distributional study, Givón (1995), for instance, showed that in English the indefinite article *a(n)* is typically used to introduce nontopical referents, whereas topical referents are introduced by *this*. In addition, there is a clear interaction between grammatical subjecthood and the demonstrative *this*: most *this*-marked NPs also appear as grammatical subjects in a sentence, whereas a majority of *a(n)*-marked NPs occurred as nonsubjects. Across languages there appears to be a topic persistence of referents: In active-transitive clauses the topic persistence of subject NPs is systematically larger than that of object NPs.

PSYCHOLINGUISTICS: THE PROCESSING OF REFERENTIAL SIGNALS

Experimental research on text and discourse processing has demonstrated the psychological reality of linguistic indicators of referential coherence. Online studies of pronominal reference have resulted in the formulation of cognitive parsing principles for anaphoric reference (e.g., Garrod & Sanford, 1994; Sanford & Garrod, 1994; see also Ariel, 2001 for a discussion of the relations between linguistic and psycholinguistic insights on these issues). For instance, it is easier to resolve a pronoun with only one possible referent, and it is easier to resolve pronouns with proximal referents than distant ones. Classical eye fixation studies have shown that

anaphoric expressions are most often resolved immediately (e.g., Carpenter & Just, 1977; Ehrlich & Rayner, 1983).

- (3) a. The guard mocked one of the prisoners in the machine shop.
b. He had been at the prison for only one week.

When readers came on ambiguous pronouns such as *he* in (3b), readers frequently look back in the text (i.e., make regressive eye fixations). More than 50% of these regressive fixations were to one of the two nouns in the text preceding the pronoun, suggesting that readers indeed attempt to resolve the pronoun immediately. As for the meaning representation, it has been shown that readers have difficulty understanding the text correctly when the antecedent and referent are too far apart and reference takes the form of a pronoun.

Although less research has been conducted concerning the exact working of accessibility markers as processing instructions, the influence of typical discourse phenomena like prominence of a referent in the discourse context is well-researched. Garrod and Sanford (1985) used a spelling error detection procedure, and Garrod, Freudenthal, and Boyle (1993) did an eye-tracking study based on that earlier experiment with texts like the following, which is a simplified version.

- (4) A dangerous incident at the pool
Elizabeth was an inexperienced swimmer and wouldn't have gone in if the male life-guard hadn't been standing by the pool. But as soon as she got out of her depth she started to panic and wave her hands about in a frenzy.
Target:
Within seconds she sank into the pool. (Thematic, Consistent)
Within seconds she jumped into the pool. (Thematic, Inconsistent)
Within seconds he jumped into the pool. (Nonthematic, Consistent)
Within seconds he sank into the pool. (Nonthematic, Inconsistent).
(A simplified version of experimental texts used by Garrod et al., 1993)

The eye-tracking data show strong evidence for very early detection of inconsistency, as apparent from longer fixations (in this case on the verb), but only in the case where the pronoun maintains reference to the focused thematic subject of the passage, that is, in the thematic conditions. In nonthematic conditions when the pronoun does not refer to the subject in focus, there is no evidence for early detection of inconsistency.

In recent approaches to discourse anaphora, the modeling of this type of discourse focusing is pivotal, see especially *Centering Theory* (Walker, Joshi, & Prince, 1998), which aims at modeling the center of attention in discourse in terms of the relationship of attentional state, inferential complexity and the form of referring expressions in a given discourse segment. Centering theory makes explicit predictions about the referent that is 'in focus' at a certain moment in a discourse. It is even predicted that the degree of coherence exhibited by a textual sequence is

determined by the extent to which such a sequence conforms to the Centering constraints. These constraints suggest that topic continuity is the default discourse situation, because frequent topic-shifting results in less local coherence.

The precise predictions of Centering Theory not only show how linguistic expressions of referential coherence can function as processing instructions, they also suggest that there is a referential linguistic system at the discourse level, which is a challenging topic for further investigation (see Cornish, 1999).

Vonk, Hustinx, and Simons (1992) also showed the relevance of discourse context for the interpretation of referential expressions. Sometimes anaphors are more specific than would be necessary for their identificational function (i.e., full NPs are used rather than pronominal expressions). The authors convincingly argue that this phenomenon can be explained in terms of the thematic development of discourse: If a character is referred to by a proper name after a run of pronominal references, then the name itself serves to indicate that a shift in topic is occurring. Readers process the referential expressions differently, as becomes apparent from reading times.

Where anaphoric reference modulates the availability of previously mentioned concepts, cataphoric devices change the availability of concepts for the text that follows. Gernsbacher and Shroyer (1989) demonstrated the reader's sensitivity for this type of linguistic indicator of reference. They contrasted cataphoric reference by way of the indefinite *a(n)* versus the definite *this* to refer to a newly introduced referent in a story. For example, the new referent *egg* was introduced either as 'an egg' or as 'this egg'. It was hypothesized that the cataphor *this* would signal that a concept is likely to be mentioned again in the following story and that therefore the *this*-cataphor results in a higher activation. Participants listened to texts and were then asked to continue the text after the critical concept. They appeared to refer sooner and more often to a concept introduced by *this* than by *an*. These and other results show that concepts that were marked as a potential discourse topic by *this* are more strongly activated, more resistant to being suppressed in activation, as well as more effective in suppressing the activation of other concepts (Gernsbacher & Jescheniak, 1995). It is this type of finding that provides the psycholinguistic underpinning for the idea of 'grammar as a processing instructor'.

By now, the results of online studies of pronominal reference enable the formulation of cognitive parsing principles for anaphoric reference (cf. Garrod & Sanford, 1994 for an overview; also Gernsbacher, 1989; Sanford & Garrod, 1994). Person, number, and gender obviously guide pronominal resolution. More interestingly, data from reading time, eye-tracking, and priming studies show that it takes less processing cost to

- resolve pronouns with only one possible referent than several;
- resolve pronouns with proximal referents than distant ones;
- resolve reference to topical concepts than to less topical ones.

One obvious explanation for these findings is accessibility: Anaphors are instructions to connect incoming information with already mentioned referents, and the referent nodes can be more or less accessible. As a result, it takes more or less processing time to understand anaphors (Gernsbacher, 1990).

TEXT PRODUCTION

So far, we discussed the relevance of linguistic signals of accessibility as well as the dynamic process of incremental text and discourse comprehension. It is important to note that similar tendencies exist in research on production, even though there is in general less attention for production studies. Levelt (1989) suggested this is due to the bias in psycholinguistics toward perception research, at the cost of production research. Along the same lines, Kintsch, presenting an overview of discourse psychological work (1994, p. 728) remarked that "many psychological studies have concerned themselves with this problem in the past few years, although overwhelmingly with the comprehension rather than the production side."

Where empirical findings such as longer or shorter reading times of segments are taken to indicate the level of activation of a concept being processed during text understanding, the online registration of pause times opens a promising route to gain further insight into the online processes of text production. Schilperoord (1996) used the method of analyzing the location and duration of pauses during written discourse production to open up the 'black box' of a discourse producer's cognitive representation. He found that text producers tend to pause longer before segments located high in a structural hierarchy of the text under production, than before segments located low in such a hierarchy. If we assume that differences in pause time reflect differences in cognitive effort needed to retrieve mental representations, then it can be hypothesized that the hierarchical structure of discourse is a crucial factor in determining the online accessibility of information (Schilperoord & Sanders, 1997, 1999). This line of work, in which a cognitively inspired text-analysis (Sanders & van Wijk, 1996) is combined with online psycholinguistic research methods, is another example of how the combination of linguistic and psycholinguistic methods contributes to the development of integrated theories of language structure and language processes.

Accessibility and Coherence in this Issue

The overview we have presented so far has shown how accessibility is one of the most important challenges at the intersection of linguistic and psycholinguistic studies of text and discourse processing. There is a logical division of labor: (text and discourse) linguists identify the relevant signals that guide the interpretation,

develop theories on how the linguistic realization of information systematically varies as to 'instruct' the interpreters, and—ideally—check the validity of their theoretical work in natural language corpora. Psycholinguists develop cognitive theories on how the actual processing occurs and test these theories in psycholinguistic experiments.

This sketch of an interdisciplinary field in which this division of labor and the interaction about the results actually take place may sound idealistic. Still, we think that this special issue shows it really exists. We have been lucky enough to get a group of prominent researchers together¹, who are important representatives of their line of work in the study of accessibility, from linguistic and psycholinguistic study, and in the latter case from interpretation as well as production. These five articles show how accessibility phenomena need to be studied from a linguistic and a psycholinguistic angle.

Ariel discusses the linguistic means of reference to discourse entities, and in doing so distinguishes between discourse profiles and discourse functions. Elaborating on her Accessibility theory, she formulates three hypotheses she encourages psycholinguists to test.

Linderholm, Virtue, Tzeng, and van den Broek discuss a typically psychological framework to model allocation of attention in their *Landscape Model of Reading*. The model addresses how various text characteristics (linguistic, discourse-structural) guide the reader's attention during reading and how they affect the mental representations readers construct. The referential forms discussed earlier are one of these textual devices determining the workings of the model, which is claimed to be an adequate model of the online reading process. This article once again underscores the importance of the notion of 'activation' as an explanatory concept in understanding the reading process and its result: a coherent mental representation of the information expressed in the text.

Gernsbacher, Robertson, Palladino, and Werner use Gernsbacher's *Structure Building Framework* to explain new experimental data about readers' mental representations during narrative comprehension. They specifically investigated whether readers' access to their mental representations of the main character in a narrative becomes enhanced (producing a "benefit") when the character is rementioned, and whether readers' access to the main character in a narrative becomes weakened or interfered with (producing a "cost") when a new character is introduced. Readers demonstrated increased accessibility to the main character when it was rementioned in the narrative, and readers demonstrated reduced accessibility to the main character when a new character was introduced. Their work suggests that successful narrative comprehension involves managing mental representa-

¹Most articles in this special issue are based on papers presented at the International workshop on text representation: Linguistic and psycholinguistics aspects, held at Utrecht University in July 1997.

tions of salient and often times interfering characters. This study is a convincing example of a dynamic processing theory of accessibility in discourse.

Then we move to discourse production. Maes, Arts, and Noordman investigate the effect of two language-in-use factors on the introduction and maintenance of referents in instructive discourse. These factors, which were implemented as conditions in an instructive production task, were the assumed visual identity for the reader of the objects or referents to be referred to in instructions (*visually same* vs. *visually different*) and the assumed goal of the reader (*reading to do* vs. *reading to learn*). The results show that both factors have a strong impact on the writers' referential behavior. *Visually same* referents are introduced and reintroduced fairly systematically by means of perceptually overspecified NPs. *Visually different* referents are introduced systematically by extra propositional identification speech acts and they are reintroduced more often by attenuated anaphoric expressions. Apart from that, writers show a number of referential strategies which fit with the assumed reader's goal. Writers in the *reading to learn* condition use more overspecified expressions than writers in the *reading to do* condition.

The results of the study by Maes and colleagues are important, not only because they concern production, but also because they give rise to an extension of accessibility and other theories that account for the form of referential expressions. Their results suggest that referential expressions that are more informative than necessary for identification purposes do not only occur when the activation level of discourse referents is low, but also when the writer anticipates specific conditions in which the information will be used by the reader. This shows how an adequate account of accessibility should not only include the linguistic and psycholinguistic aspects discussed here, but also *functional* aspects like the writers' and readers' communicative goals. For instance, when writers assume readers to be very precise processors of the textual information because they use the text as an instruction, they will use a different referential strategy than when readers are expected to process the information as 'just' an informative or narrative text.

Together, these contributions augment our growing knowledge of accessibility in text and discourse processing. These contributions illuminate how accessibility is marked in a text or a discourse; how readers and listeners respond to those markings; how mental representations evolve and change as a direct result of accessibility. These contributions epitomize one strength of the journal, *Discourse Processes*: its interdisciplinary welcome and offerings. It is our hope as editors of this special issue that the text we have amassed will affect the journal's readers' representations in just the ways that we as linguists and psycholinguists theorize as beneficial.

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