

Semantic indeterminacy in object relative clauses [☆]Silvia P. Gennari ^{a,*}, Maryellen C. MacDonald ^b^a Department of Psychology, University of York, Heslington, York YO10 5DD, UK^b University of Wisconsin—Madison, Psychology Department, Brogden Hall, 1202 West Johnson St., Madison, WI 53706-1696, USA

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Abstract

This article examined whether semantic indeterminacy plays a role in comprehension of complex structures such as object relative clauses. Study 1 used a gated sentence completion task to assess which alternative interpretations are dominant as the relative clause unfolds; Study 2 compared reading times in object relative clauses containing different animacy configurations to unambiguous passive controls; and Study 3 related completion data and reading data. The results showed that comprehension difficulty was modulated by animacy configuration and voice (active vs. passive). These differences were well correlated with the availability of alternative interpretations as the relative clause unfolds, as revealed by the completion data. In contrast to approaches arguing that comprehension difficulty stems from syntactic complexity, these results suggest that semantic indeterminacy is a major source of comprehension difficulty in object relative clauses. Results are consistent with constraint-based approaches to ambiguity resolution and bring new insights into previously identified sources of difficulty.

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Research in sentence comprehension has pursued two distinct paths, one addressing the question of how comprehenders resolve temporary syntactic ambiguities and the other investigating syntactically complex but apparently unambiguous structures. Examples of temporary

ambiguity are sentences containing reduced relatives such as *The man examined by the doctor*..., whereas sentences containing center embedded or object relative clauses, such as *The man that the doctor examined* have been the central example of the latter category. This division has had a profound effect on the kinds of accounts that have been proposed for comprehension processes in these two cases.

The ambiguity resolution literature has centered on the debate between two-stage vs. constraint-based approaches to comprehension processes in ambiguous constructions. Two-stage models (e.g., Clifton & Frazier, 1989; Frazier & Clifton, 1989; Frazier & Fodor, 1978; Frazier & Rayner, 1982; Pickering & Traxler, 1998) proposed that comprehenders initially entertained only one analysis for an ambiguous structure by following simple

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parsing principles. This initial parsing triggered a process of reanalysis if later incoming information signaled that the initially postulated structure was incorrect. Comprehension difficulty in this account thus stemmed from the complexity of the reanalysis process. Constraint-based accounts of ambiguity resolution, in contrast, proposed that alternative interpretations are partially activated as a function of their frequency, plausibility, and other constraints (MacDonald, Pearlmutter, & Seidenberg, 1994; McRae, Spivey-Knowlton, & Tanenhaus, 1998; Tanenhaus & Trueswell, 1995; Trueswell, Tanenhaus, & Garnsey, 1994). On this view, the difficulty observed in interpreting ambiguous structures can be traced to competition between alternative interpretations.

The syntactic complexity literature, which we review in detail below, has instead focused on memory demands, thematic role assignments and other hypothesized sources of comprehension difficulty in processing complex structures (e.g., Gibson, 1998; MacWhinney & Pleh, 1988; Waters & Caplan, 1996a, 1996b). One prevailing view within this literature is that key mechanisms of processing operating in ambiguity resolution have little influence in comprehension of complex unambiguous structures such as object relative clauses. Gibson (1998), for example, argued that complexity effects found in comparing structures of varying complexity are not caused by differences in ambiguity, and consequently, neither two-stage nor constraint based theories of syntactic ambiguity resolution make any predictions in these cases (see p. 2). More recently, Gordon, Hendrick, and Johnson (2004) and Grodner and Gibson (2005) have endorsed a similar view and have argued that frequency information, a major constraint in ambiguity resolution, could not account for processing difficulty in object relative clauses.

One notable exception to this general division between the ambiguity and the complexity literature is an account by Traxler, Morris, and Seely (2002) who proposed that complexity effects in object relative clauses are in fact due to a two-stage ambiguity resolution process of the sort proposed in the ambiguity literature. This move thus challenged the basic assumption that object relative clauses had no significant ambiguity and instated an ambiguity resolution theory within the complexity literature. Traxler et al. (2002) argued that a local temporary indeterminacy at the relative pronoun *that* is the major source of comprehension difficulty in object relative clauses, as for example, the noun phrase *the man* in *the man that...* can either be the subject or object of the upcoming relative clause. This local indeterminacy had been previously noted (Gibson, 1998) but has not been considered a major source of comprehension difficulty because the very next word eliminates the indeterminacy, e.g., in *the man that the...* the head noun cannot be interpreted as the subject of the upcoming relative. Thus Traxler et al.'s account has

not had the effect of linking the sentence complexity and ambiguity resolution literature, both because many consider the ambiguity at *that* a trivial one and also because Traxler et al. (2002) did not address constraint-based approaches to ambiguity resolution.

In this paper, we attempt to fill the gap between complexity and ambiguity resolution accounts by investigating whether probabilistic approaches are truly irrelevant to the vast research on object relative clauses. We ask (a) whether object relative clauses display parsing and semantic indeterminacy as they unfold over time, analogous to more traditional syntactic ambiguities, and (b) whether the activation of various competing interpretations (indeterminacy) can account for comprehension difficulty. To foreshadow our results, we do find evidence for significant semantic indeterminacy in object relatives, thus suggesting that constraint based accounts of ambiguity resolution can offer insight into the difficulties associated with interpretation of object relative clauses, a domain previously thought to be outside the range of this approach.

Processing difficulty in object relative clauses

In investigating the comprehension difficulty presented by object relative clauses, researchers have frequently contrasted them with subject relative clauses, as in examples (1a and 1b) used by King and Just (1991).

- (1) a. *Subject relative.* The reporter that attacked the senator admitted the error.
- b. *Object relative.* The reporter that the senator attacked admitted the error.

The distinction between subject and object relatives refers to the fact that the modified noun phrase *the reporter* serves different roles of the verb of the subordinate clause *attacked*—subject in (1a) and object in (1b). A large number of studies have documented that object relative clauses are more difficult than subject relatives by measures such as reading times, often accompanied by error rates in comprehension questions after reading (Gordon, Hendrick, & Johnson, 2001, 2004; Just & Carpenter, 1992; King & Just, 1991; MacWhinney & Pleh, 1988; Mak, Vonk, & Schriefers, 2002, 2006; Traxler et al., 2002; Warren & Gibson, 2002; Waters & Caplan, 1996a, 1996b), and performance errors in tasks such as lexical decision and word recall taking place during or after reading (Baird & Koslick, 1974; Ford, 1983; Waters, Caplan, & Hildebrandt, 1987; Caplan & Waters, 1999).

The choice of subject relatives as a baseline condition from which to observe comprehension difficulty in object relatives has partially determined the kinds of accounts that have been proposed. The words in struc-

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