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## Cognitive Psychology

journal homepage: [www.elsevier.com/locate/cogpsych](http://www.elsevier.com/locate/cogpsych)



# The road to understanding is paved with the speaker's intentions: Cues to the speaker's attention and intentions affect pronoun comprehension



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### ARTICLE INFO

#### Article history:

Accepted 25 December 2013

Available online 15 February 2014

#### Keywords:

Pronoun resolution

Language comprehension

Attention

Common ground

### ABSTRACT

A series of experiments explore the effects of attention-directing cues on pronoun resolution, contrasting four specific hypotheses about the interpretation of ambiguous pronouns *he* and *she*: (1) it is driven by grammatical rules, (2) it is primarily a function of social processing of the speaker's intention to communicate, (3) it is modulated by the listener's own egocentric attention, and (4) it is primarily a function of learned probabilistic cues. Experiment 1 demonstrates that pronoun interpretation is guided by the well-known N1 (first-mention) bias, which is also modulated by both the speaker's gaze and pointing gestures. Experiment 2 demonstrates that a low-level visual capture cue has no effect on pronoun interpretation, in contrast with the social cue of pointing. Experiment 3 uses a novel intentional cue: the same attention-capture flash as in Experiment 2, but with instructions that the cue is intentionally created by the speaker. This cue does modulate the N1 bias, demonstrating the importance of information about the speaker's intentions to pronoun resolution. Taken in sum, these findings demonstrate that pronoun resolution is a process best categorized as driven by an appreciation of the speaker's communicative intent, which may be subserved by a sensitivity to predictive cues in the environment.

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## 1. Introduction

Successful communication relies upon listeners understanding the speaker's intended meaning. A significant component of this task is the correct assignment of reference, as the listener must determine which specific items, people, and events the speaker means to discuss. This task is complicated by the fact that all linguistic referring expressions are ultimately ambiguous. An extreme example of referential ambiguity is presented by pronouns, which occur commonly and yet are highly dependent on the context for their interpretation. Although listeners prioritize finding a referent that matches lexical features of the pronoun, e.g. a female for "she" (Arnold, Eisenband, Brown-Schmidt, & Trueswell, 2000), there still may be many entities available as potential referents.

The question we ask here is how the listener solves this problem of referential identification, and specifically, how it is guided by evidence about the speaker's attention and intentions. We focus on the ambiguous personal pronouns *she* and *he*, in discourse contexts that include more than one character matching the gender of the pronoun. We examine the psychological mechanisms by which listeners identify the speaker's intended referent, specifically the effects of social-communicative cues like pointing and gazing.

Gaze and gestures provide a testing ground for distinguishing several potential mechanisms of pronoun resolution. They are dynamic, transitory cues, and thus do not form part of the preceding discourse context in the same way as textual cues, such as syntactic prominence or recency of mention. Yet at the same time, they are systematically related to the speaker's and listener's attention, both of which are also hypothesized to be constrained by the discourse context.

We consider several explanations for pronoun resolution. Note that these explanations are not mutually exclusive: (1) the Grammatical constraints hypothesis, (2) the Speaker-intention hypothesis, (2) the listener's egocentric attention hypothesis, and (4) probabilistic cues to successful understanding. We examine how social-communicative cues (gazing and pointing) are related to both the speaker's and listeners' attention, and provide evidence of the speaker's referential intentions. These effects are considered against the backdrop of well-known discourse context effects.

There is extensive evidence that pronoun resolution is highly constrained by the discourse context (e.g., Arnold, Eisenband et al., 2000; Clark & Sengul, 1979; Gernsbacher, 1989; Gordon, Grosz, & Gilliom, 1993; Sanford & Garrod, 1981). A number of discourse factors predict which characters will be most accessible to subsequent pronoun resolution, including recent mention, parallelism between pronouns and antecedents, and grammatical and thematic roles of antecedents (inter alia, Ariel, 1990; Arnold, 1998; Gernsbacher & Hargreaves, 1988; Givón, 1983; Grosz, Joshi, & Weinstein, 1995; Gundel, Hedberg, & Zacharski, 1993). For example, in the utterance, "Yesterday, Homer ate breakfast with Bart. He had some eggs," most listeners will interpret the pronoun "he" as referring to Homer, since Homer is the first-mentioned character and the subject in the preceding sentence, as well as the referent that is in the parallel syntactic position to the referring pronoun, which is also in subject position.

The most common explanation for these discourse constraints is that some information in the context is salient, and thus is in the focus of attention of all discourse participants (Brennan, 1995; Chafe, 1994; Grosz et al., 1995; Gundel et al., 1993; see Arnold, 2010, for a review). The kind of focus that matters to pronoun interpretation is related to indicators of topicality (e.g., Ariel, 1990; Givón, 1983), as opposed to the linguistic category of focus, which tends to denote the new or focal part of a sentence (Arnold, Kaiser, Kahn, & Kim, 2013). There is ample evidence that discourse focus is a strong determinant of listeners' preferences for pronoun referents, but there are numerous processes that are likely to correlate with discourse focus. Here we outline four mechanisms that could underlie the effects of discourse focus on pronoun interpretation. We then present three experiments designed to tease these mechanisms apart, by examining how listeners' interpretations of pronouns are influenced by the social-communicative cues of pointing and gazing at referents.

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