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# The Representation and Processing of Co-Reference in Discourse

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A model is presented that addresses both the distribution and comprehension of different forms of referring expressions in language. The model is expressed in a formalism (Kamp & Reyle, 1993) that uses *Construction Rules* to map syntactic representations onto *Discourse Representation Structures*. Each construction rule is composed of a *triggering condition* that delineates the linguistic input that causes the rule to apply, and specific instructions for replacing part of the linguistic representation with information in the Discourse Representation Structure. The material added to a Discourse Representation Structure by a Construction Rule is termed a *condition set*, which consists of entities (*discourse referents*) and predications of those entities. Basic interpretive rules are developed for names, pronouns, definite descriptions and quantified descriptions. The dynamic interaction of these rules with syntactic input and with the representation of a discourse accounts for the ease of achieving co-referential interpretations among different linguistic forms as measured by intuitive judgments of grammaticality (Gordon & Hendrick, 1997) and by online measures of language comprehension (Gordon, Grosz & Gilliom, 1993). The model uses the same basic interpretive mechanisms for co-reference within and between sentences, thereby linking the domain of co-reference that has traditionally been studied by generative linguists (Chomsky, 1986) to the broader domain of co-reference discourse which has been of greater concern to computational linguists (Grosz, Joshi & Weinstein, 1995).

The model includes three basic construction rules to handle reference and co-reference. The construction rule for names is triggered by the occurrence of a name in the syntactic representation of the input sentence. It then posits a new discourse entity in the discourse model that the name is a predicate of. The construction rule for pronouns is triggered by a pronoun; it then attempts to find a referent introduced into the discourse model by a *suitable antecedent*. Failing that, it posits a new discourse entity. The final construction rule for equivalence is triggered by the presence of two instances of the same name predicated on distinct discourse entities. It adds a condition set to the discourse representation equating the two entities. These three rules provide a straightforward account of the grammatical acceptability and the ease of processing co-reference involving different forms of referring expressions. Co-reference of a pronoun with an earlier expression is highly acceptable because the construction rule for pronouns directly seeks a referent in the discourse model. Co-reference of a name with a preceding name is less acceptable

because the construction rule for names always posits a new entity. Thus, the same name will be predicated on two different entities creating a sense of disjoint reference that can only be resolved by the application of the construction rule for equivalence. Co-reference of a name with a preceding pronoun is largely unacceptable because the triggering conditions for the construction rule for equivalence are not met and therefore there is no way to equate the entity introduced by the name with the entity introduced previously by the pronoun.

Accounting for the effects of c-command on co-reference (Chomsky, 1986) requires that we incorporate notions of linguistic prominence into the construction rules. In our formulation, linguistic prominence is inversely related to depth of embeddedness. Prominence affects the construction of discourse representations in two ways: (1) It influences the order of processing triggers, with more prominent syntactic representations leading to earlier processing of triggers than less prominent representations. (2) It contributes to an ordering of the entities referred to in the discourse representation, and this ordering influences the efficiency with which the construction rules for establishing co-reference operate. This second effect of prominence is equivalent to the notion in centering theory (Grosz, Joshi & Weinstein, 1995) that the representation of an utterance in coherent discourse includes an ordered set of forward-looking centers.

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