ENCYCLODEDIA OF COGNITIVE SCIENCE

Anaphora #212

Introduction

Antecedent-Anaphor Relations

Discourse Anaphora

Identity of Sense and Identity of Reference Anaphora

Pragmatic Anaphora

pronouns#variables#coreference#discourse#quantification

Carlson, Gregory

Department of Linguistics, University of Rochester, Rochester, NY USA

Anaphora refers to referentially dependent expressions in natural language which contribute their meaning by identifying another expression to give them their semantic value.

1. Introduction

Anaphora, in its primary instances, is the establishment of a referential dependency between two (or more) expressions. The pronoun *him* in the example below is one such instance of anaphora:

Mark felt that there was someone watching *him*.

On the understanding that *him* refers to Mark, the pronoun is the *anaphor* and the expression *Mark* is the *antecedent* . Both expressions refer to the same individual. The relationship between these expressions is not an equal one, however, since the reference of the pronoun is dependent upon the reference of its antecedent, whereas the reference of the antecedent is established by virtue of its meaning alone. The term "coreference" is often used to describe this referential connection between anaphor and antecedent. But anaphor-antecedent relations must

be distinguished from the phenomenon of *accidental coreference.* This occurs when two independently referring expressions happen to refer to the same individual. So, for instance, in the following example the two italicized expressions will be coreferential, "accidentally", just in case the president of the company is also the company's best employee:

The president of the company rewarded *the best employee.*

This requires an understanding where the company has a self-rewarding president, but there is no anaphoric connection established between the expressions. Thus, anaphora is a matter of coreference, and something more.

2. Anaphor-antecedent relations

Anaphors depend upon their antecedents to determine their referential content. One reflection of this referential dependency is that in many instances an anaphor cannot be interpreted as coreferential with another Noun Phrase. For instance, in the following examples, the pronouns cannot be construed as non-accidentally having the same reference as the italicized Noun Phrases.

Bob was nominated by him. (him ≠ Bob)
She hoped that *Mary* would win the contest. (She ≠ Mary)

This is because an anaphor cannot receive its reference from another Noun Phrase if that Noun Phrase does not have an appropriate syntactically-defined relationship to the anaphor. This relationship is not simply one of linear precedence, as in many instances an anaphor may precede its antecedent (a phenomenon which is occasionally called *cataphora,* though more commonly *backward anaphora*).

Near *her, Jill* saw a snake.
If *he* wins the race today, *Bret* will be a hero.

Much research has focused on the question of the precise nature of this syntactic relationship. The research is detailed and extensive (for more detail, see the entry on *Binding Theory*). Most agree that the notion of *c-command* is crucial, and that an anaphor cannot c-command its antecedent (Langacker, 1966; Lasnik, 1976) In general, an anaphor cannot c-command its antecedent, and in examples such as those above where the two designated Noun Phrases cannot be interpreted

coreferentially, the pronoun would c-command its antecedent, and a referential connection cannot be established. The reference for the pronoun in these instances needs to be determined by other means, such as finding a another, appropriate antecedent for it, or by providing it with a *deictic* interpretation (see Section 5).

One class of pronouns that has also received extensive attention is that of *reflexive pronouns*, exemplified below:

> We found *ourselves* with too much to do.
> The professor taught *herself* French.

These differ from the other personal pronouns in important respects. Primarily, the syntactic relation to their antecedents are much more limited. In general, reflexive pronouns may only have antecedents within the same clause, though the precise conditions remain a topic of detailed investigation. In the following examples, the reflexive pronoun may not be construed as coreferential with the italicized Noun Phrases:

> *We* thought that [$_S$Jim liked ourselves]
> *The professor* remembered when [$_S$herself lived in Paris]

As there is no appropriate antecedent for the reflexive pronoun within the same clause in these instances, the sentences are not grammatical.

Pronouns not only may find their reference by identifying an antecedent and using the reference of the antecedent as its own value, but they may function as *bound variables* as well. In such instances, the "reference" of the pronoun is not determined by the reference of its antecedent NP, but rather by the assignment of values to variables that is determined by the quantifier, as in first-order logic. A representation of a sentence such as the following with *Every man* construed as the antecedent of *he* would be as indicated:

> *Every man* thinks that [*he* deserves a raise]
> $\forall x \ [man(x) \rightarrow x$ thinks that [x deserves a raise]]

Bound variable pronouns and their antecedents are syntactically more constrained than identity of reference pronouns and theirs. In the following examples the first precludes any bound variable reading; this is despite the fact that a natural identity of reference reading is available

when the antecedent Noun Phrase has a clear referential value, as with proper names.

> The dean who placed *no student* on probation told *her* to check back in the fall.
> The dean who placed *Hillary* on probation told *her* to check back in the fall.

The first sentence has no bound variable interpretation, because the antecedent is in a syntactic position which precludes this possibility. The relation that must hold, in the case of bound variable readings, is for the antecedent Noun Phrase to c-command the pronoun.

The phenomenon of anaphora is much broader than the personal pronouns discussed thus far. One form of anaphora that has received much attention is *temporal anaphora* (Partee, 1984). This applies not only to pronouns referring back to time Noun Phrases,

> The mail arrived *this morning*. I was at home *then* (=this morning)

but also to the time introduced by the *tense* of a sentence.

> Ali woke up. It was cold *then.*

The study of temporal anaphora includes a wide variety of forms which are used to coordinate the time in one sentence with that of another. Beyond *then*, expressions such as *when, before/after, until, as, while, since, immediately thereafter,* and many others fall within this domain. Perhaps most significantly, tenses themselves appear to function anaphorically. In the examples below, the tense in the second sentence is understood as coordinated with the time reference in the first.

> Samantha opened the door. She *had* been repairing the car.
> Daryl fell down. He was drunk.

Our understanding that the repairing occurred prior to the door opening, or that the falling occurred while Daryl was drunk, is often attributed to temporal anaphora.

A wide variety of other anaphoric forms, beyond personal pronouns and temporal anaphora, make reference to a wide variety of other types of things. These include the demonstratives *this* and *that* (with or without a

following noun), and epithetics such as *the fool* or *the bastard*. Other forms take as antecedents phrases that are not Noun Phrases. *So* may take a verb phrase as an antecedent. *Such* takes a modifier. *There* may take a locative prepositional phrase. *One* may take a noun.

> Sam tried to *win the race* before Al could do *so.*
> If *intelligent* students attend college, *such* students usually do very well.
> Everyone who was *at the party* had a good time *there.*
> I own a big *car,* and you own a small *one.*

In many cases the anaphor is expressed as null. That is, the anaphor is indicated by having some constituent missing from the sentence. The following sentence is missing a noun plus its modifying adjective at the point indicated by the blank.

> Jack owns three *large dogs*, and I own two __.

In this case, the "blank" takes as its antecedent the portion of the noun phrase italicized. It functions as an anaphor in the same way as a pronoun.

Null anaphora extends well beyond nouns and noun phrases. Verb phrases can function as antecedents for null verb phrases (known as VP Ellipsis):

> If you want to____, we can *take a break.*

Verbs, and verb complexes, can serve as antecedents in the *Gapping* construction:

> Joseph *ate* a bagel, and Samuel,___a grapefruit.

Null complement anaphora takes complement sentences as antecedents:

> Kevin claimed *that our television was broken*, but I'm not so sure_____..

This by no means exhausts the range of anaphora expressed by null expressions.

3. Discourse anaphora

"Discourse" is the normal mode of communication: the use of more than one independent sentence or utterance put together in a way that "makes sense". The discussion above was limited to those instances of anaphora that take place within the boundaries of a sentence. Anaphora takes place across sentence boundaries as well. Many instances of anaphora that appear within sentence boundaries take place as well in discourse.

> *Several team members* were suspended. Reportedly, *they* had missed a practice.
> Most people want to *win a million dollars.* Doris doesn't ___.

Certain cases of anaphora that occur within the boundaries of a sentence do not function as discourse anaphors. For instance, the phenomena of reflexive pronouns, gapping, relative pronouns, and bound variable anaphora do not appear to be able to function this way.

One treatment of discourse anaphora is to treat all such pronouns as *free variables*, which are assigned a reference independently by an *assignment function*, which designates a referential value for any free variables within its domain (e.g. Cooper and Parsons, 1976). It becomes coreferential with a Noun Phrase in a previous sentence by virtue of being assigned the same reference [see also the contribution on Dynamic Semantics]. So, if a function assigns the same referential value as the proper name *Leonard* has, to the pronoun *he* in the following sentence, then a coreferential reading arises.

> Leonard is a famous conductor. *He* writes operas.

On the other hand, if *he* is assigned a different value (e.g. Fred), then the discourse will be understood as saying that Fred writes operas, and no coreferential reading will occur. All phrases that the pronoun is coreferential with must have a reference value in the first place, if this is to be the appropriate analysis. The case of indefinite Noun Phrases in discourse raises questions, though. Indefinite Noun Phrases are those which appear with a number of different determiners, most prominently the indefinite article *a(n).* Such noun phrases can be "referred back to" by anaphors in discourse.

> *A man* walked into the room. *He* sat down.

Most researchers, however, question whether an indefinite Noun Phrase should be properly assigned a reference value (Kamp, 1981). This is because the reference value determines the truth-conditions of the sentence, and if one assigns a certain individual as the reference of *a man* in a sentence such as the one above, then it would be true if that *particular* man walked into the room, and false if he did not (regardless of whether any other man walked in). However, these are not the truth-conditions for such a sentence, since (an utterance of) the sentence will be true if any man whatsoever walked into the room (and false only if no man at all did). If one assigned a reference for *a man* as some particular man, one could not characterize these truth conditions. It appears that the truth-conditions of the sentences are best represented quantificationally, with an existential quantifier binding a variable:

$\exists x$ [man(x) & x walked into the room]

This treatment raises some problems, however, when we turn to discourse anaphora. The representation of the two-sentence discourse above would have the existential quantifier binding the instance of *he* in the subsequent sentence.

$\exists x$ [man(x) & x walked into the room & x sat down]

Since anaphors referring back to indefinites are both very common and natural, unlike those functioning as bound variables with their antecedent quantified expressions in another sentence, one would need to make a separation between classes of quantifiers, some of which could bind variables in other sentences, and others which could not. This has proven an unsatisfactory analysis of the phenomenon, however, for both syntactic and semantic reasons.. One of the main issues has centered around the treatment of *donkey sentences* (or, *donkey anaphora*). Such examples are so-called because of the lead example, below, commonly cited in the literature.

Every farmer who owns *a donkey* beats *it*.

These sentences pose a problem of logical representation that has been known since medieval times. The problem is this. If one takes *it* in this sentence to be a free variable assigned the same reference as *a donkey*, there is, very clearly, no particular donkey which this sentence is in any way "about". The other, more attractive, possibility is that the pronoun is functioning as a bound variable, bound by an existential quantifier that is

taken to be the meaning of the indefinite article. However, the only consistent representation available is essentially as follows:

∃x [donkey(x) & Every farmer who owns x beats x]

The truth-conditions of this (which are directly reflective of the meaning), however, are very different from the truth-conditions of the sentence itself. This formula is true just in case there is some donkey or other that every owner of it beats, which is far from the meaning of the sentence itself. There is no consistent way of representing the meaning by treating the indefinite article as an existential quantifier which binds the pronoun in the predicate of the sentence.

Replacing the quantificational analysis is one where indefinites are treated as contributing no existential meaning on their own, but only a free variable and a property ascription; so indefinites have neither inherent reference nor inherent quantificational force. The free variable implicitly contributed by the indefinite is bound by an operation of *text closure*. This is where the existential force arises. So, a single sentence such as the following has the representation given immediately below it, and then text closure operates to bind the variable as indicated.

A man walked into the room
man(x) & x walked into the room
　　==> Text closure
∃x [man(x) & x walked into the room]

Text closure is formulated in such a way that it operates over stretches of discourse, as more sentences are added. So a two-sentence discourse would be represented and operated on by text closure as follows:

A man walked into the room. He sat down.
man(x) & x walked into the room & x sat down
　　==> Text closure
∃x [man(x) & x walked into the room & x sat down]

This analysis allows us to distinguish quantified Noun Phrases from indefinites, on the one hand, and allows us to treat the pronouns as free variables at the same time. Also, though not presented here, it offers a solution to the donkey sentences problem.

This approach raises issues of its own, as illustrated in the following sentence.

>There is a man in the garden. The dog is barking at *him.*

The "There is..." construction in English quite plausibly introduces an existential quantifier of its own, rendering the variable contributed by "a man" unavailable for binding by text closure. But the pronoun in the second sentence could be bound by text closure. If this is so, then the text would have the meaning "Some man is in the garden. The dog is barking at someone." Another problem with text closure is that the representation:

>$\exists x$ [man(x) & x is in the garden & the dog is barking at x]

will be true also in cases where there are more men in the garden than just one. However, the original text means--or possibly strongly implies--that there is one and only one man in the garden.

Evans (1980) has argued that there is a need for still another category of pronoun, which he calls *E-type pronouns.* These pronouns, like the bound variable and coreferential pronouns, share all the same forms, but function differently: they are disguised definite descriptions, picking out a unique individual given the information present in the context. Informally, the analysis of the pronoun *him* would be:

>There is a man in the garden. The dog is barking at him (=*the man that is in the garden.*)

Since these descriptions can contain pronouns, or variables of their own, one can obtain solutions to problems like the following (an example that is often called a *pronoun of laziness,* a term coined by Peter Geach since it was a "lazy" way to avoid repeating an entire Noun Phrase.

>The woman who deposited *her paycheck* in the bank was wiser than the woman who gave *it* to her teenage son.

In this case, analyzing *it* as meaning *her paycheck,* with *her* in this instance assigned the same value as the second woman rather than the first, will give the right reading. However, on a coreferential reading (or a bound variable reading) the paychecks would have to be one and the same.

4. Identity of Sense and Identity of Reference Anaphora

A traditional distinction is made between what are called "Identity of sense" and "Identity of reference" anaphora. The distinction between sense and reference goes back to the writings of the philosopher Gottlob Frege. In the case of Noun Phrase meanings, this distinction concerns whether the individuals designated by the antecedent and the anaphor must be interpreted as identical. So, in the first example below the cars driven by Lyle and Maria must have been the same; however, in the second example they need not:

> Lyle drove *a car*. Maria drove *it*, too.
> Lyle drove *a car*. Maria drove *one*, too.

The difference between the anaphors *it* and *one* (the latter taking a noun meaning as its antecedent) would seem to suggest that anaphors themselves fall into these two classes. While this is so to a certain extent, many instances of anaphora can be identified in which the same form can play both roles. Consider the following:

> *The President* (of the United States) walked off the plane. *He* waved to the crowd.
> *The President* is elected every four years. *He* has been from a southern state ten times.

The reference of the phrase *The President of the United States* is whoever happens to be in that office at the time--currently it is George W. Bush; the sense, on the other hand, is that which picks out the president at the time, whoever it may be. In the first example above, *he* refers to a certain individual--Bush, for instance. The sentence *he* appears in would be synonymous with saying "Bush waved at the crowd". In the second example, *he* is anaphoric to the sense of the term, not its reference. It does not follow that any particular president, such as the current one, has been from a southern state ten times. Rather, this instance of the pronoun is talking about the presidents of the U.S. across time, regardless of who that individual may be. That is, it refers to the sense of the antecedent, not its reference..

When we turn to other types of anaphora, it is more difficult to make this sense/reference distinction. Consider null VP anaphora.

Zelda will *get up early* if Harry does___.

The question that arises in this case is whether verb phrases themselves have a sense/reference distinction in their meanings to begin with. If, for instance, verb phrases have individual events as their reference, and have classes of events as their sense, then VP anaphora would be sense anaphora (as presumably Harry waking and Zelda waking would be distinct events). One can make reference to individual events by using the pronoun *it*, as exemplified below, but VP anaphora does not appear to ever make reference to events in this particular way.

The train blew its whistle. *It* (=the blowing of the whistle) was heard for miles.

A similar situation holds for anaphora to sentence meanings. In a Fregean analysis, the sense of a sentence is a proposition, and its reference is a truth-value (T or F). However, with Null Complement Anaphora, which takes sentences as antecedents, the proposition rather than the truth-value is clearly the value assigned to the anaphor.

Bruno was selling drugs. When the FBI found out____, he was arrested.

Thus, the sense/reference distinction is most useful in describing anaphora to Noun Phrase meanings.

5. Pragmatic Anaphora

Pragmatics, that is knowledge of how the world works and what it contains, the circumstances under which a sentence is uttered, and of how language is used, is crucial for the study of anaphora. In most instances, a pronoun or other anaphor could, in principle, find more than one unique antecedent in the sentence or discourse, as in the following:

Mary told the man talking to *her sister* that *Leslie* was sick today. *She* then turned and walked away.

While *she* could, in principle, find any of the previous Noun Phrases as its antecedent, in practice only one "makes sense" and so is the one that is readily understood (in this instance, *Mary). Centering Theory* is one

proposal that attempts to deal with this phenomenon (Grosz, Joshi, and Weinstein, 1995).

Another area requiring pragmatic knowledge to resolve reference of anaphora is *bridging inferences* (Clark 1975). The listener or reader must make use of real-world knowledge to appropriately interpret a definite noun phrase. For example:

John bought *a new car. The engine* was painted bright red.

Here, one knows that the engine is the engine in the car that John bought, making use of real-world knowledge that cars have engines.

Much work in "pragmatic anaphora" focuses not on the process of selecting an appropriate antecedent from candidates given in the text or discourse, but on instances where the sentence or discourse itself provides no possible antecedents for an anaphor. For instance, imagine I was standing on the street with someone else when a man walks by very abruptly. Under these circumstances I can say:

He appears very upset.

In so doing, I refer to the man that just walked by even though there is no expression within the previous discourse to serve as an antecedent for the pronoun. The man himself, in some sense, provides the "antecedent" for the pronoun. When elements themselves in the real-world context of use provide the values for anaphoric expressions, they are said to be *pragmatically-controlled*.

The example above might suggest that perceptual evidence establishes possible antecedents for deictic uses of pronouns. However, having the referent perceptually available is not always necessary. Consider the case where I am walking down the hallway at work, and a student is knocking on the door of the office of another faculty member. I can say, under the circumstances:

I haven't seen *her* today.

even though the professor is not perceptually available for reference at the time. Thus, some contexts are "rich" enough to support pragmatic control even in the absence of who or what is being referred to.

Most (but not all) instances of anaphora may be pragmatically controlled, including certain instances of reflexive pronouns and *logophoric* pronouns. These are pronouns, indicated by specialized forms in some languages, which are canonically used in indirect discourse to make reference to the person whose speech is reported (e.g. "Ariel said that *he*[logophoric] was going to write a paper.") Below are instances of other types of anaphora that may be controlled pragmatically:

> [Picking up a coat from the coat-check attendant] "*This* is torn!"
> [Pointing through the glass at the candy counter] "A green *one* and a red *one*, please."
> [Sally hides cigarettes in her room. Her sister, seeing this, says:]
>   "Better hope our parents don't find out___"
> [Trying on suits, and the salesman says:] "*Which* appeals to you most?"

Certain instances of anaphora cannot be pragmatically controlled (Hankamer and Sag, 1976). These are the instances of *Surface anaphora,* which, unlike *Deep anaphora*, require a specifically linguistic antecedent. The distinction between Deep and Surface anaphors hinges not only on whether they may be pragmatically controlled, but also on whether, when there is a linguistic antecedent, the syntactic details of the antecedent determine the possibility of it serving as an antecedent, regardless of what meaning is expressed (which applies to surface anaphora but not deep).

Gapping, null anaphora to a verb or verb complex, requires an explicitly (Surface) linguistic antecedent, even in very clear contexts, and cannot be pragmatically controlled; the example below is not felicitous:

> [Bob throws a baseball] "...and Cary, a basketball."
> (Contrast with: "Bob threw a basketball, and Cary, a baseball.")

Sluicing likewise requires a linguistically-introduced "Surface" antecedent, so the following too sounds strange:

> [From outside, a scream; a shot is fired; and a thud] "I wonder who___?"

Similarly, the phenomenon of bound variable pronouns is not amenable to pragmatic control.

Bibliography

Clark, H. (1975). Bridging. In: R. Schank and B. Nash-Webber (eds.), *Theoretical Issues in Natural Language Processing*. Cambridge, MA: MIT Press.

Cooper, R. and T. Parsons (1976). Montague grammar, generative semantics, and interpretive semantics. In: B. Partee (ed.), *Montague Grammar*. 311-362. New York: Academic Press.

Evans, G. (1980). Pronouns. *Linguistic Inquiry* **11**, 337-362.

Grosz, B. A. Joshi, and S. Weinstein (1995). Cenering: a framework for modeling the local coherence of discourse. *Computational Linguistics* 21:2.

Hankamer, J. and I. Sag (1976) Deep and surface anaphora. *Linguistic Inquiry* **7**: 391-428.

Kamp, H. (1981) A Theory of Truth and Representation. In J. Groenendijk, T. Janssen, and M. Stokhof (eds) *Formal Methods in the Study of Language,* pp. 277-322. Amsterdam: Mathematisch Centrum.

Langacker, R. (1966). On pronominalization and the chain of command. In: W. Reibel and S. Schane (eds), *Modern Studies in English*, pp. 160-186. Englewood Cliffs, NJ: Prentice Hall.

Lasnik, H. (1976). Remarks on coreference. *Linguistic Analysis* **2**, 1-22.

Lewis, D. (1979) Scorekeeping in a language game. *Journal of Philosophical Logic* **8**: 339-359.

Partee, B. (1984) Nominal and temporal anaphora. *Linguistics and Philosophy* **7** pp. 243-286.

Reinhart, T. (1983). *Anaphora and Semantic Interpretation*. Chicago: University of Chicago Press.

For further reading

Chomsky, N. (1981) *Lectures on Government and Binding.* Dordrecht: Foris.

Chierchia, G. (1992) Anaphora and Dynamic Binding. *Linguistics and Philosophy* 15, 2, 111-183.

Jacobson, P. (2000) Paycheck pronouns, Bach-Peters sentences, and variable-free semantics. *Natural Language Semantics* 8: 77-155.

Roberts, Craige, 1989. Modal Subordination and Pronominal Anaphora in Discourse, Linguistics and Philosophy 12, 683-721.

Van der Sandt, R. (1992) Presupposition projection as anaphora resolution. *Journal of Semantics* 9: 333-377.

Glossary

anaphor: a pronoun, determiner, or null expression which requires finding an antecedent in language or context

bound variable: an expression which takes on a range of values in the semantic evaluation of a sentence.

null anaphor: an anaphoric expression which has no phonological content, but a syntactic presence.

E-type pronoun: pronouns that function as definite descriptions

pragmatic control: an expression whose semantic value is determined by something in the non-linguistic context of the utterance

pronoun of laziness: a personal pronoun which has an antecedent Noun Phrase but has a reference value that is of the same class but distinct from the reference value of the antecedent (also, informally called a "paycheck pronoun" due to the original example sentence)

donkey anaphora: instances where the appropriate anaphor-antecedent relation cannot be expressed as a formula of classical logic. This is so in instances such as "Every farmer who owns *a donkey* beats *it.*"

gapping: a form of null anaphora where the antecedent is a verb or verb complex in a previous conjoined sentence (e.g. "Rich *will review* your proposal, and you, ___ Rich's proposal."

sluicing: a form of null anaphora which replaces an indefinite noun phrase in a previous sentence with a question word, with anaphora to the remainder of the previous sentence (e.g "*I heard* someone *come into the office*, but I don't who ____ (i.e. who *I heard come into the office*).

deep and surface anaphora: two classes of anaphors distinguished by whether they are subject to pragmatic control (Deep anaphors may be, and surface anaphors may not) and their sensitivity to details of the syntactic form of any linguistic antecedent (Surface anaphors are so sensitive, and Deep anaphors are not).