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Implicit Causality, Negation, and Models of Discourse

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Abstract

Causality plays an important role in giving discourse its characteristic coherence. This paper examines how causality implicit in an utterance helps to organize dynamically constructed mental models of discourse. Experiments are reported suggesting that the linguistic form of utterances contributes significant semantic information about causality to a discourse representation. This view is contrasted with competing claims in the literature that causality only emerges from social psychological inferences or optional inferences on background knowledge.

Implicit Causality in Discourse

A satisfactory account of the cognitive processes involved in language comprehension must provide an explicit understanding of how individuals make sense of a discourse (i.e., a sequence of spoken or written utterances), and how that sense is related to the world it is about. There is substantial agreement in the psycholinguistic literature that such an account will identify explicit mechanisms that map successive utterances onto a dynamic mental model and research on formal semantics adds to this view the requirement that such a model represent objects in the world and relations between those objects (cf. Johnson-Laird, 1983). One important line of research in this effort attempts to ascertain the form of the mental model of a discourse (i.e., discourse model) and poses questions concerning how it is constructed from linguistic input (e.g., Gordon, Grosz, & Gilliom, 1993; Gordon & Scearce, 1995). A second line of inquiry emphasizes how inferences beyond the information directly represented in the linguistic input play an important role in the elaboration of a discourse model (e.g., Graesser, Singer, & Trabasso, 1994). These two research programs are complementary: the first emphasizes the contribution of the "said" (information taken to be directly represented in the linguistic input); the second emphasizes the contribution of the "unsaid" (information not directly represented in the linguistic input but inferred).

In previous work we have examined why natural languages make use of proper names and pronouns to refer to entities in the world (Gordon & Hendrick, 1997). Formal logic constructs formal languages that make no use of pronouns, and our research has been aimed at understanding the role of names and pronouns in dynamic discourse models. Our research suggests that the difference in the linguistic form of referring expressions marks and exploits the orderly elaboration of a discourse model. Common sense suggests that causal connections between utterances of a discourse are also important in establishing a coherent discourse model, and evidence exists that substantiates this point of view (Givón & Gernsbacher, 1995). Subjects can often identify a cause in a single utterance. For example, in the sentence *Robin wrote to Sandy*, *Robin* appears to be the cause of the event of writing. This kind of judgment goes under the label *implicit causality* in the psycholinguistic literature. In this paper we explore the determinants of implicit causality in a discourse model.

Three Views of Implicit Causality

The psycholinguistic literature distinguishes three conceptions of the source of implicit causality and its integration in a discourse model:

1. *Formal semantics* has a tradition of categorizing predicates into simplex functions expressing states and complex functions involving a relation of causation and a resulting state (e.g., Dowty, 1975, Parsons, 1990). Some research has built on this semantic tradition and analyzed causality as a relation expressed by a predicate invoked in an utterance of a discourse. To comprehend an utterance is to understand the relation of causality asserted by invoking a particular predicate. Garvey and Caramazza (1974) and Garvey, Caramazza and Yates (1975) offer a typology of predicates based on whether the subject noun phrase or object noun phrase of a particular predicate is treated as the source of implicit causality in an expressed event.

2. *Social psychology* has led some researchers to analyze the causality implicit in an utterance as originating outside of the linguistic material of a discourse and place it in more general cognitive schemas. Brown and Fish (1983) and Brown (1986) for example observe the same general typology of predicates as Garvey and Caramazza but derive its existence from general, independent principles (of attribution theory) rather than from the semantic nature of linguistic predicates.

3. *Non explicit inferences* generated from discourse models have also been suggested as likely candidates for judgments of implicit causality. Garnham, Traxler, Oakhill, and Gernsbacher (1996) offer an "*integrationist model*" in which inferences about implicit causality are derived from discourse models. These inferences are only produced when

needed for some task (such as fixing the reference of a pronoun or integrating the information of a new clause into a discourse model), and closely resemble inferences made from information not explicitly represented in linguistic input (i.e., from "background knowledge"). This view differs from formal semantic analyses by denying that information about implicit causality is part of the linguistic predicate invoked in an utterance; it diverges from the social psychological analysis by claiming that the inferences are specific to discourse and only optionally constructed as needed.

This paper reports evidence supporting the view that implicit causality is represented in a discourse model and is strongly influenced by the way in which information is encoded by predicates. This evidence is not naturally modeled in social psychological terms or as non explicit inferences.

Does Implicit Causality Reduce to a Social Psychological Inference?

Humans exhibit recurrent patterns of thought and feeling as they engage in social life, and this provides the subject matter for social psychology. Attribution theory explains how individuals ascribe causes to events in order to give meaning and coherence to their experience (Kelley, 1967). The intuition at its core is that causality is attributed to what is informative in the scene of a perceived event. This leads to a significant asymmetry between attributions of causality by observers of an event and participants in that event. An observer attributes causality to the participant in motion (because they are perceptible and informative) while a participant tends to attribute causality to the other co-participant (because only the other participant's movements are informative).

Brown and Fish contrast three groups of predicates exemplified by *cheat*, *attract*, and *admire*. Predicates like *cheat* typically lead speakers to ascribe causality to the subject noun phrase (what is identified in the semantic literature as the *agent*) in active sentences as opposed to the direct object (the *patient*). Predicates such as *admire* or *please* denoting mental states (the so-called "psychological predicates") sometimes attribute causality to the subject of the predicate (as *please* does) and sometimes to the direct object (as *admire* does). The correct generalization here is that causality is attributed to what the semantic literature terms the *stimulus* of the experience rather than the *experiencer* and that these predicates differ as to whether the stimulus is linked to the subject noun phrase position or the direct object position.[1] Brown (1986) explains this variation in the perception of causality as a principled consequence of attribution theory. Subjects estimate the cardinality of the set of experiencers (e.g., admirers) and of stimuli (e.g., admirees), as suggested by Figure 1; the set of experiencers is (claimed as) larger than that of stimuli; therefore the stimulus always carries more information value to an observer. In this way agents and stimuli are more likely to receive attributions of causality than either experiencers or patients.

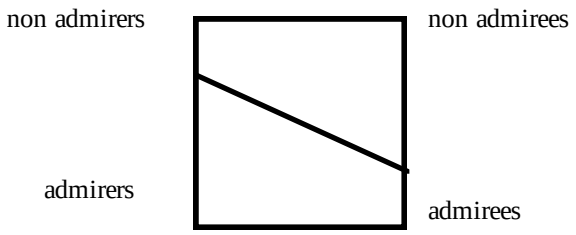

Figure 1. Relative proportions of different types of people based on Brown's (1986) of implicit causality in terms of attribution theory.

If the difference in the psychological predicates reduces to the estimated cardinality of the set of stimuli and experiencers as Brown envisioned, then this analysis should predict that the judgments of causality should reverse in negated sentences because they involve comparing the cardinality of the complement set of experiencers (e.g., the non-admirers) with the cardinality of the complement set of stimuli (e.g., the non-admirees). Our first experiment is designed to test this claim.

Experiment 1

Method

Participants. 72 undergraduates participated in this experiment. They were enrolled in introductory psychology courses at the University of North Carolina.

Materials. These were modeled on those of Brown and Fish. Subjects were asked to respond to questions like those shown in Table 2. The verb *like* in the example was systematically replaced by each of the 36 verbs in Table 1. These verbs are grouped into three classes that vary the type and order of the semantic roles they assign to their noun phrase arguments (i.e., <agent, patient>, <stimulus, experiencer>, <experiencer, stimulus>).

Table 1: Verbs used in stimuli.

Agent-Patient	Stimulus-Experiencer	Experiencer-Stimulus
apologize-to	astonish	abhor
cheat	attract	admire
compete-with	charm	despise
criticize	deceive	detest
defy	delight	dread
disobey	exasperate	enjoy
dominate	impress	esteem
flatter	influence	honor
harm	repel	like
help	scorn	loathe
protect	shock	notice
slander	trouble	pity

[1] The stimulus of *attract* is linked to its subject while the experiencer is in the direct object position in a sentence such as *Ted attracts Paul*. The predicate *admire* works in the opposite way: the experiencer is its subject and the stimulus is the direct object in a sentence like *Ted admires Paul*.

Table 2. Sample stimuli for the first experiment.

affirmative:
Ted likes Paul.
How likely is it that this is because:
A. Ted is the kind of person that likes people.
Not likely 1 2 3 4 5 6 7 8 9 Definitely likely
B. Paul is the kind of person that people like.
Not likely 1 2 3 4 5 6 7 8 9 Definitely likely
C. Some other reason.
Not likely 1 2 3 4 5 6 7 8 9 Definitely likely

negated main clause
Ted doesn't like Paul.
How likely is it that this is because:
A. Ted is not the kind of person that likes people.
Not likely 1 2 3 4 5 6 7 8 9 Definitely likely
B. Paul is not the kind of person that people like.
Not likely 1 2 3 4 5 6 7 8 9 Definitely likely
C. Some other reason.
Not likely 1 2 3 4 5 6 7 8 9 Definitely likely

negative relative clause
Ted doesn't like Paul.
How likely is it that this is because:
A. Ted is the kind of person that doesn't like people.
Not likely 1 2 3 4 5 6 7 8 9 Definitely likely
B. Paul is the kind of person that people don't like.
Not likely 1 2 3 4 5 6 7 8 9 Definitely likely
C. Some other reason.
Not likely 1 2 3 4 5 6 7 8 9 Definitely likely

Design. The three types of verbs were crossed with the three types of negation, with each participant rating a given verb in only one negation condition. Across participants each verb appeared in all three negation conditions. Three different randomizations of items were used.

Procedure. Each participant filled out one questionnaire. The following instructions, taken from Brown and Fish, introduced the questionnaire:

> Each item in this questionnaire begins with a statement followed by three possible explanations of the event described by the statement. You are asked to rate each of these explanations on how likely it is to have caused the stated event. Do so by circling the appropriate numbers. Please make the rating for each cause (A, B, and C) independent of the other causes, in that, the three circled numbers are not required to sum to any particular value. Please also make the ratings of each sentence-event independent of each other sentence-event. The same proper names (Paul and Ted) are used throughout and are not intended to have any significance. You should not, for instance, think of Paul (or Ted) as one person who should be rated in a consistent way from one sentence-event to another. The names are arbitrary and have been randomly permuted in sentence position.

Results and discussion.

Table 3 presents the mean causality ratings as a function of type of verb and negation.[2] Table 4 presents the difference between attribution of causality to the first noun phrase and to the second noun phrase, yielding a concise measure of whether greater causality is attributed to the first noun phrase argument of the predicate or to the second. Significant main effects of verb type [$F(2,142) = 89.1$, $p < .001$] and negation [$F(2,142) = 6.2$, $p < .005$] were observed, as was a significant interaction of the two factors [$F(4,284) = 7.6$, $p < .001$].

Table 3. Results of Experiment 1. Mean ratings of causality attributed to different arguments of the predicate.

		Type of Negation		
Type of Verb	Cause Attributed to	None	Main Clause	Relative Clause
Agent-Patient	agent	7.21	6.89	7.12
	patient	5.03	5.27	5.24
Stimulus-Experiencer	stimulus	6.89	6.31	6.48
	experiencer	5.00	5.49	5.18
Experiencer-Stimulus	experiencer	5.45	5.79	5.82
	stimulus	6.54	6.33	6.01

The affirmative stimuli in our experiment elicited the same judgments of causality that Brown and Fish discovered. Subjects attributed causality to those noun phrases serving the semantic role of agent or stimulus and resisted attributing causality to experiencers or patients. The stimuli with negation exhibit the same pattern only more weakly: causality is attributed to agent and stimuli but only weakly to experiencers or patients. We find that the degree of difference between attributions of causality to the semantic role of agent vs. the patient or the stimulus vs. the experiencer is reduced in negative contexts. However the attribution of causality did not reverse in the negated sentence-events, casting doubt on Brown's claim that the relative cardinality of the set of experiencers and stimuli

Table 4. The difference between the ratings of causality for first and second noun phrase in Experiment 1.

	Type of Negation			
Type of Verb	None	Main Clause	Relative Clause	Mean
Agent-Patient	2.18	1.62	1.89	1.90
Stimulus-Experiencer	1.87	.81	1.28	1.32
Experiencer-Stimulus	-1.08	-.55	-.19	-.61
Mean	.99	.63	.99	

[2] Values for response c ("other" responses) did not vary significantly as a function of condition.

determines inferences about implicit causality. Two possible explanations suggest themselves for the significant effect of negation. One line of explanation might appeal to the fact that negated statements typically pose processing problems for subjects (Clark, 1974, Sherman, 1973). A second explanation might be based on the content of semantic roles. Dowty (1991) suggests that traditional semantic roles (agent, patient, stimulus, experiencer, instrument, etc.) should be modeled in formal semantics as drawing upon two primitive roles, proto-agent and proto-patient. These are analyzed as fuzzy sets defined by factors licensing semantic inferences. The factors contributing to proto-agenthood are volitional involvement in an event or state, sentience or perception, causing an event or change of state in a participant, and movement.[3] Proto-patients undergo change of state, are causally affected by another participant, and are stationary. The first noun phrase in a sentence like *Jones assaulted Smith* is a stereotypical agent from this point of view, and is a somewhat better agent than the first noun phrase in a sentence like *Harvard rejected Smith* because *reject* does not entail movement nor does it imply a change of state in *Smith*. Experiencers are poor agents because they are only sentient, and lack the other stereotypical properties of proto-agent; they also have limited proto-patient properties (typically only being causally affected by another participant). The semantic role stimulus is also a weak agent because it only causes a change of state in another participant. Refraining from an act or psychological state is semantically treated as volitional and thus related to causality by the proto-agent role. In the sentence *Ted flatters Paul* causality is attributed to Ted, while in a sentence like *Ted likes Paul* causality is attributed to Paul. Refraining from flattery or liking can be deliberate and appear somewhat causal: thus Ted appears more causal in sentences such as *Ted doesn't like Paul*. At the same time, the fact that an event failed to take place might diminish the perceived causality of an agent or stimulus. There is no reason in our data to prefer the explanation in terms of processing difficulties of negation or in terms of the interaction of negation with semantic roles. Indeed these two consequences of negation are not incompatible and they might both contribute to the effect of negation in our data.

Does Causality Reduce to an Inference from Background Knowledge?

Garnham, et al. (1996) argue that implicit causality is not a property of predicates but that such causal relations are part of one's knowledge about what events are usually like. This store of information is accessed only where needed for a task (e.g., the comprehension task of resolving pronominal reference). This theoretical point of view attributes implicit causality to background knowledge that can be used in the production of non explicit inferences. Languages have a wide range of anaphoric devices used to reinvoke information already present in a discourse model. Pronouns are surely the most well studied anaphoric form, but others exist as well. In particular, English has anaphoric verbs like *do* (and phrasal variants like *do so*, *do that kind of thing*); these anaphoric expressions index previously invoked events in a discourse; we will call these expressions *event anaphors*.[4] Event anaphors do not integrate another event to a discourse but instead refer back to an event already represented in the model. From the perspective of Garnham, et al. (1996), they should, as verbs, correlate with no implicit causality effects of their own. This expectation stems from the fact that they represent no privileged event but instead are linguistic wild cards, able to represent virtually any event in a discourse. Our second experiment is designed to test whether the implicit causality of event anaphora gives the same results as our other experiment or whether such verbs contribute distinct patterns of implicit causality.

Experiment 2

Method

Participants. 72 new participants, drawn from the same population as the previous experiment, were tested.

Materials. Subjects were asked to respond to questions like those in Table 5. The verb *admire* was systematically replaced by each of the 36 verbs in Table 1 exemplifying different three different ordered pairs of semantic roles (i.e., <agent, patient>, <stimulus, experiencer>, <experiencer, stimulus>).

Design and procedure. The design and procedure were the same as in the previous experiment.

Table 5: Sample stimuli for the second experiment

negated main clause
Ted doesn't admire Paul.
How likely is it that this is because:
A. That is not the kind of thing that Ted does.
Not likely 1 2 3 4 5 6 7 8 9 Definitely likely
B. That is not the kind of thing that happens to Paul.
Not likely 1 2 3 4 5 6 7 8 9 Definitely likely
C. Some other reason.
Not likely 1 2 3 4 5 6 7 8 9 Definitely likely

Results and discussion.

Table 6 presents the mean causality ratings as a function of type of verb and negation.[5] Table 7 presents the difference between attribution of causality to the first noun phrase and to the second noun phrase, yielding a concise

[3] The role of proto-agent correlates probabilistically, according to Dowty, with occupying the position of subject of a sentence. The fact that experiencers and stimulus are sometimes subjects and sometimes direct objects is a consequence of only weakly approximating the proto-agent role.

[4] To illustrate this process consider the sentence *Jane managed to land a better job, but few others will do so.* Here *do so* is anaphoric to *land a better job*. The verb *happen* is also anaphoric in sentences such as *Many people hope to win the lottery but few happen to*.

[5] There is a small but significant increase in response c, "other" from agent-patient to stimulus-experiencer to experiencer-stimulus verbs. This pattern is consistent with our argument that the anaphoric predicate influences judgments of causality.

Table 6. Results of Experiment 2. Mean ratings of causality attributed to different arguments of the predicate.

Type of Verb	Cause Attributed to	Type of Negation: None	Main Clause	Relative Clause
Agent-Patient	agent	7.15	6.89	6.97
	patient	4.76	4.44	4.70
Stimulus-Experiencer	stimulus	6.41	6.03	6.13
	experiencer	5.11	4.88	5.03
Experiencer-Stimulus	experiencer	5.32	5.63	5.62
	stimulus	5.69	4.96	4.93

measure of whether greater causality is attributed to the first noun phrase argument of the predicate or to the second. A significant main effect of verb type [$F(2,142) = 74.8$, $p < .001$] was observed but there was no significant main effect of negation [$F(2,142) = 2.65$, $p > .05$]. The interaction of these two factors was significant [$F(4,284) = 5.8$, $p < .001$]. *Post hoc* contrasts showed that greater causality was attributed to the experiencer than the stimulus when negation was in the main clause [$t(71) = 7.23$, $p < .001$] and when it is in the relative clause [$t(71) = 7.34$, $p < .001$]. This pattern is a reversal of the implicit causality effect first found by Brown and Fish (1983) and shown in many subsequent studies.

The results of this experiment challenge theories that deny that predicates make a contribution to the calculation of implicit causality independent of the representation of events in a discourse model.[6] Experiencers in this experiment were more likely to be judged as causal than in our first experiments.[7] This is remarkable in that the events described are the same. Apparently *do* requires an agentive subject while at the same time being able to recapitulate a previously mentioned event. These data also provide some further evidence of the influence of negation on semantic roles. In our first experiment we found a significant effect of negation and noted that it could be due to either an asymmetry in the processing load (of affirmative and negative statements) or an asymmetry in the concept of volition implicated in the semantic role of agent. The presence of negation in conjunction with the event anaphora was able to make an experiencer appear significantly more causal than a stimulus. Garnham, et al. (1996) are unable to explain the increased causality of experiencers when accompanied by the verb *do*, or the reversal in attributions of causality to experiencers when negation is used with conjunction with an anaphoric verb.

Table 7: difference between attribution of causality to the first and second noun phrase

Type of Verb	Type of Negation: None	Main Clause	Relative Clause	Mean
Agent-Patient	2.39	2.45	2.27	2.37
Stimulus-Experiencer	1.30	1.15	1.09	1.18
Experiencer-Stimulus	-.37	.68	.69	.33
Mean	1.11	1.43	1.35	

General Discussion

Judgments of implicit causality are complex. This situation stems from the multiple sources of information that people can appeal to in attributing causality. Undoubtedly knowledge of what events are typically like can contribute to such inferences, and it is equally probable that subjects are influenced in these calculations by their perceptions of social interactions. However, we believe that the experiments presented here cast doubt on attempts to reduce attributions of implicit causality to either of these factors exclusively. They also make what seems to us to be a point of common sense: the predicates employed in an utterance have a significant impact on how implicit causality is judged by virtue of how they contribute their (semantic) information to the dynamically constructed discourse model.

The social psychological explanation of implicit causality is weakened by its unwillingness to recognize the traditional wisdom that predicates perform important semantic work. The failure of Brown's conjecture about the source of implicit causality can be attributed to its appeal to an insufficient semantic theory. For Brown a statement like *Paul admires Ted* semantically involves an admirer and an admiree (homologous to the interpersonal relation), and it is this fact that warrants calculating the cardinality of the respective set of admirers and admirees. Work on formal semantics (Parsons, 1990) suggests that this view is mistaken and that a more adequate analysis would treat such a sentence as conjoining three bits of information: there is an act of admiration, Paul is its experiencer and Ted is its stimulus. From the perspective of this semantic analysis it is much more difficult to say with confidence that the cardinality of the set of experiencers *tout court* is greater or smaller than the set of stimuli.

The integrationist model of Garnham, et al. (1996) is weakened because it does not attempt to make explicit the inferences that bear the explanatory burden of their claim. The study of semantics shows that they are distinct classes of inferences; they differ for example in whether they are necessary or deniable, whether they are licensed as a social convention, or by some aspect of the linguistic context (cf. Chierchia & McConnell-Ginet, 1990). The broad category of non explicit inferences that is appealed to in some psycholinguistic work obscures these important distinctions. Predicates carry with them information that licenses inferences about causality. Furthermore this information can be affected by negation and other aspects of the linguistic

[6] The problem identified here would hold for reductions in other directions, such as Hilton's (1990) conversational model.

[7] Our results on this point converge on those of Pesetsky (1995) who provides very different arguments that experiencers can be causal when in subject position.

context (such as event anaphora) as our two experiments show.

The fact that the perception of implicit causality is susceptible to such influences is also important because it may warrant a modification of standard semantic roles in favor of graded prototypical roles, along the lines suggested by Dowty (1991).[8] On this account, it is possible that additional sources of information might influence how closely a particular participant is to the proto-typical agent. The advantage of such an approach would be that it offers a means of expressing the contribution that the linguistic form of a predicate makes to the calculation of causality attributed to a predicate's argument.

The experiments we have reported here extend the exploration of implicit causality by varying the linguistic context in which agent-patient, stimulus-experiencer, and experiencer-stimulus verbs are assessed for the locus of causality. We have found that the original effect reported by Brown and Fish that causality is preferentially attributed to the semantic roles of agent and stimulus over experiencers can be influenced by the aspects of the linguistic context in which they appear. Negation and event anaphora significantly influence such judgments, and in combination can reverse the Brown and Fish effect.

Acknowledgments

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[8] We have framed our results in terms of Dowty's semantic roles but they may also be expressible in the framework of Grimshaw (1992) where roles are situated in hierarchies on several dimensions.