What Language Might Tell Us About the Perception of Cause

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Abstract

In English, causation can be expressed with either a lexical or periphrastic causative verb. Lexical causatives include both the notion of CAUSE and the notion of RESULT (frequently change-of-state) (e.g. Mulder *sunk* the boat); Periphrastic causatives encode the notion of CAUSE without the notion of RESULT (e.g. Mulder *made* the boat *sink*). According to many linguists, these two kinds of sentences have different meanings: lexical causatives are used for situations involving *direct causation* while periphrastic causatives are used for situations involving either *direct* or *indirect causation*. This research investigated how this distinction might be cognitively determined. Subjects watched 3D animations of marbles hitting one another and then described the scenes and enumerated the total number of events. When causers were inanimate, lexicalization and enumeration were guided by physical contact. When causers were animate, lexicalization and enumeration were guided by factors other than physical contact, possibly intention or ultimate causation. The results suggest how different kinds of causation and their expression might be related to the perception of events.

Introduction

Languages have multiple ways of expressing causation. Consider a causal happening in which a torpedo moves into a ship causing it to sink. This causal happening can be decomposed into two subevents: a *causing* subevent, the torpedo's movement though the water, and a *caused* subevent, the ship's sinking. In English, there are two major ways of describing a happening of this kind. In one of these ways, the notions of CAUSE and RESULT are encoded in different verbs (see 1a). The verb carrying the notion of CAUSE is refer to as a *periphrastic causative* (e.g. *cause*, *have*, *make*, *get*). A second way is by encoding the notions of CAUSE and RESULT in a single verb (see 1b). Verbs that convey both of these notions are referred to as *lexical causatives* (e.g. *melt, break, kill, sink*).

(1) a. The torpedo *made* the boat *sink*.
b. The torpedo *sank* the boat.

Although the sentences in (1a) and (1b) are highly similar, they are not paraphrastic: Lexical and periphrastic causatives can refer to different kinds of causal situations. Their differences are revealed by that fact that the two kinds of expressions vary in their acceptability in the context of certain kinds of causers.

(2) a. The cracks made the boat sink.
b. *The cracks sank the boat.

The periphrastic causative in 2a, but not the lexical causative in 2b, allows *cracks* as a causer. This difference in acceptability is roughly characterized by the assertion that the range of situations referred to by lexical causatives is a subset of the range of situations referred to by periphrastic causatives (See Figure 1). That is, lexical causatives are choosier about what they refer to than are periphrastic causatives.

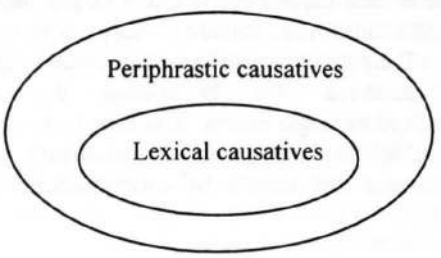

Figure 1. Inclusion relationship holding between many lexical and periphrastic causatives

According to a number of linguists, lexical causatives express *direct causation*, that is, causation that is immediate, strongly coercive or unified, while periphrastic causatives express causation that is either direct or indirect (e.g. Comrie, 1985; Cruse, 1972; Dowty, 1979; Frawley, 1992; Levin & Rappaport Hovav, 1994, Pinker, 1989, Shibatani, 1980; Wierzbicka, 1988, among others). While helpful, this general account of causatives leaves much unsaid. In this research we seek a cognitively motivated account of this distinction by examining how the two ways of expressing causation might be linked to certain properties in the external world, namely *physical contact* and *animacy*.

A related aim of this research is to investigate how these two ways of expressing causation might be associated with the psychological notion of an *event*. It's generally accepted that causatives can be decomposed into two

subevents (e.g. Frawley, 1992; Dowty, 1979; Parsons, 1990; Talmy, 1976). The question is whether and when these two subevents can be conceptualized as a single, unified event. According to the *unitization hypothesis,* lexical causatives, unlike periphrastic causatives, refer to happenings that can be conceptualized (unitized) as single events (for similar proposals see Croft, 1990; Delancey, 1991; Frawley, 1992).

One way of motivating the unitization hypothesis is in terms of iconicity. *Iconicity* is the general claim that features or relationships in the world can be reflected in the grammatical structure of a language (Haiman, 1980, 1983; Givón, 1990; see Fisher, in press, for a similar claim). An often cited example is the generalization that concepts that are conceptually close tend to be placed close together in the sentence. Another often cited example is the pattern in which the temporal order of a sequence of events is reflected in the temporal order of clauses. Cases of iconicity deserve notice. Only a handful of conceptual distinctions can be captured in a language's grammatical structure; those that do get captured are likely to be cognitively significant (Slobin, 1995; Talmy, 1983).

Applying these ideas to English, we can ask whether lexical and periphrastic causatives represent another kind of iconicity. The patterns are quite suggestive: Lexical causatives encode happenings within a single clause while periphrastic causatives encoding happenings over two clauses. Language may reserve one-clause expressions, lexical causatives, for happenings that can be conceptualized as single events. Conversely, language may employ multiple clause expressions, periphrastic causatives, for happenings that cannot be conceptualized as single events.

The Contact Criterion. If the distinction between lexical and periphrastic causatives is conceptually important how might it be grounded in the world? In our first experiment, we focused on the role of physical contact. Physical contact has been suggested by a number of linguists as important to the notion of direct causation (Gergely & Bever, 1986; Pinker, 1989; Nedyalkov & Silnitsky, 1973; Shibatani, 1980) and has been studied extensively by psychologists interested in the perception of cause. It is generally acknowledged that although causation does not require physical contact (e.g. Bullock, Gelman, & Baillargeon, 1982; Shultz, 1982; Woodward, Phillips, & Spelke, 1993), contact can make causation easier to perceive (Cohen & Oaks, 1993; Leslie, 1982, Michotte, 1963). It seems reasonable, then, that language might use a property like physical contact to distinguish between different kinds of causality. Specifically, language might reserve lexical causatives for happenings in which the causer and causee make physical contact, using periphrastic causatives for happenings in which they don't. We will refer to this proposed relationship as the *contact criterion*[1].

The principle is exemplified by the sentences in (3).

(3) a. Scully moved the chair.
b. Scully caused the chair to move.

The sentence in (3a) strongly suggests physical contact between the causer, Scully, and the causee, the chair, while the sentence in (3b) does not.

There is some empirical evidence for the link between physical contact and the expression of causation. In a study by Ammon (1980), children and adults chose one of three pictures in response to an orally presented sentence which was either a lexical or periphrastic causative. The pictures depicted three kinds of contact: direct contact (e.g. a cartoon character bouncing a ball), indirect contact (e.g. a character pointing a finger at another character bouncing a ball, as if directing her to do so), and no contact (e.g. two characters simply watching a ball bounce). Both children and adults preferred the picture depicting direct contact when the sentence contained a lexical causative. When the sentence contained a periphrastic causative, responses were mixed. Ammon's findings suggest that physical contact may affect how children and adults describe a causal happening. However, certain aspects of her methodology preclude strong conclusions: 1) only three verbs were tested under all sentence types, 2) the sentences used real verbs, so that subject's knowledge may have been specific to these verbs, and 3) the causal happenings were presented as static pictures rather than as actual scenes involving motion and change. (As shown by Kaiser, Proffitt, Whelan, and Hecht (1992), presentation method (either dynamic or static) influences how an event is evaluated.) The first study investigated whether the property of physical contact affects linguistic expression.

Testing the Contact Criterion. The contact criterion makes predictions about how people will chose to describe a causal chain. Imagine a scene where one marble (M1) bumps into a second marble (M2) which then bumps into a third marble (M3) (see Figure 2). If people limit lexical causatives to happenings involving physical contact, they should be willing to use a lexical causative to describe the relationship between M1 and M2, but not M1 and M3.

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1 Spelke (1991; Woodward, et. al., 1993) and her colleagues have argued that infants employ a constraint, the *principle of contact*, in their reasoning about the motions of inanimate objects. The constrant is similar to the contact criterion (discussed above), but not the same. The principle of contact states that inanimates will act upon each other if and only if they come into contact. The principle concerns, then, the presence or absence of a causal relationship. The contact criterion, in contrast, concerns whether or not a causal relation is direct or indirect, not present or absent.

Causal relationships between M1 and M3 should only be describable using a periphrastic causative.

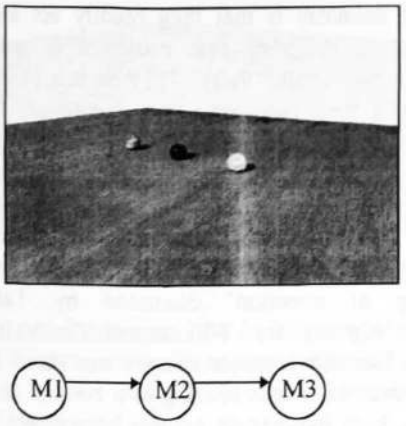


Figure 2. A simple causal chain. Marble 1 bumps into marble 2 which bumps into marble 3.

In Experiment 1, the contact criterion was tested using this logic. Subjects watched causal chains involving three marbles. They then chose between two sentences, a lexical and periphrastic causative. In half of the sentence pairs, the two marbles made physical contact. In the other half of the sentence pairs, the two marbles did not make physical contact. According to the contact criterion, subjects will choose a lexical causative sentence only when the marbles in that sentence make physical contact. In cases where the marbles don't make physical contact, subjects will choose a periphrastic causative sentence, because the lexical causative, which requires contact, is barred.

Testing the Unitization Hypothesis. The unitization hypothesis predicts a strong correlation between happenings that can be described with a lexical causative and those that can be counted as single events. The *chain of marbles* scenario described above can be used to test this prediction. If the unitization hypothesis is correct, subjects will report single events for marbles making physical contact more frequently than for marbles that do not make physical contact.

Experiment 1

Method

Subjects. The subjects were 20 Northwestern University students.

Materials. Sixteen 3D animations were made from an animation package called Autodesk 3D Studio® release 4. Each animation depicted a sequence in which three marbles rolled into one another. The sequences followed one of four possible paths based on whether the second or third marbles hit head on or at an angle. Each path was viewed from four different perspectives. Animation quality was near photorealistic. All colors, except the background, were done with texture mappings. All objects, when appropriate, cast shadows. The marbles were placed on a gray surface against a blue background and were colored either red, yellow, blue, or green. Like real marbles, these colors varied a bit so that their rolling motions could be seen. Each animation was 50 frames in length and was run at approximately 15 frames/second.

Procedure and Design. The animations were presented on DOS-based computers with 17" monitors. The order of the animations was randomized except for the first two which served as practice items. After watching an animation, subjects were asked to "choose the sentence that best describes" the occurrence, based on "what you see in the animations, as well as on your general knowledge of verbs." The choices were a *lexical causative*, a *periphrastic causative*, or *neither of these sentences*. To encourage use of general knowledge we used nonce verbs (e.g. *fendle*, *klop*): Periphrastic sentences were formed using the verb *make* along with the same nonce verb used in the lexical causative sentences. Within a sentence set, the marbles were the same for both sentence types: e.g. "The blue marble fendled the green marble" vs. "The blue marble made the green marble fendle." The sentence sets named three kinds of events: eight in which the marbles made physical contact, eight in which the marbles didn't make physical contact, and four in which the marbles made contact, but did not agree with the sentences. The last four events were drawn systematically from the primary sixteen animations, and served as catch trials, since the correct option, "neither of the above sentence," was unambiguous. After subjects finished the sentence choice task, they watched the animations again and were told to simply count the number of events. The main factor of interest, *contact type*, was within subject and had two levels, contact and gap.

Results

The predictions of the contact criterion and the unitization hypothesis were borne out. As predicted by the contact criterion, lexical causatives were chosen more frequently when the marbles made physical contact (M=78%) than when they were gapped (M=8%) (Table 1).

		Relationship Between Marbles: Contact	Gap
Sentence Type	**Lexical**	**78%**	**8%**
	Periph.	20%	63%
	Total Causal	98%	71%

Table 1: Percentage of sentence types chosen in Experiment 1

This difference was significant across both subjects, $t_s(19)=13.86$, $p < .001$, and items, $t_i(15)=10.2$, $p < .001$. Subjects were markedly unwilling to use lexical causatives in the gapping condition. (Their 8% response level was significantly less than chance if we assume chance = .5 by sign test, $p< .05$.) This unwillingness to use lexical causatives in the gapping condition cannot be attributed to their not perceiving a causal relationship. The high level of periphrastic responses in this condition (63%) indicates that the majority of subjects viewed the gapped events as causally connected, but in a sense different from that implied by the lexical causatives.

		Relationship Between Marbles	
		Contact	Gap
	1 event	**24%**	**3%**
Num of events	More than 1 event	76%	97%

Table 2: Percentage choosing one event vs. more than one event in Experiment

Table 2 shows the results with respect to the unitization hypothesis. Single events were reported more frequently when the marbles made physical contact (M=24%) than when they were gapped (M=3%) across both subjects, $t_s(19)=2.5$, $p < .05$, and items, $t_i(15)=13.73$, $p < .001$. This result is consistent with the hypothesis that the kinds of happenings described by lexical causatives are those that can be conceptualized as single events.

Discussion

The results are consistent with the predictions made by the contact criterion and the unitization hypothesis. However, problems arise when the contact criterion is generalized to a wider range of situations. It is not hard to find sentences that violate the contact criterion, as in (4).

(4) The landlord evicted the tenants.
Nixon bombed Cambodia.

Both sentences in (4) imply causation in which the causer and causee don't make physical contact. The contact criterion, while useful, must not be the whole story. What, then, might allow people to group objects that don't make physical contact? In terms of the unitization hypothesis, what might allow people to view an extended chain of events as a single event?

The Role of Animacy. The answer might be linked to animacy. Animate causers have properties which may give them special status in causal interactions (Leslie, 1994; Talmy, 1976). One of these properties is *intention*. By means of intention, objects that are spatially distant might be made psychologically close, and as a consequent, causally direct. This hypothesis, in one form or another, has been linked to the notion of direct causation by a number of linguists (e.g. Brennenstuhl & Wachowicz, 1974; Gergely & Bever, 1986; Kozinsky & Polinsky, 1994). Another property of animates is that they readily act as *ultimate causes*, that is, the very first cause of a causal chain (Delancey, 1991; Croft, 1990). They do this by being able to self-initiate their own actions and generate their own forces (Gelman, Durgin, Kaufman, 1995). Roughly speaking, an ultimate cause might be viewed as a direct cause by being the entity that produces the force that creates an effect. One nice feature of the ultimate cause hypothesis is that it fits nicely with the notion of 'windowing of attention' discussed by Talmy and 'metonymic clipping' by Wilkins and Van Valin (1993), that is, the idea that animate causers can stand in for the entire sequence of events leading to a result. In different ways, then, both hypotheses explain how direct causation might occur by means of animate agents. Linguistic support for this effect has been suggested by Schlesinger (1989). As he notes, "inanimate objects can be agents [of actions involving instruments] only if they act without mediation." The sentences in (5) exemplify this prediction.

(5) a. Two bullets wounded the president.
b. *The rifle wounded the president with two bullets.
c. The assassin wounded the president with two bullets.

The sentence in (5a) describes a happening involving physical contact between the agent and patient, allowing, by hypothesis, the agent to be inanimate. The sentences in (5b) and (5c) describe happenings in which the agent and patient do not make physical contact. As predicted, an inanimate agent, (5b), sounds odd while an animate agent, (5c), is acceptable.

Testing the effect of animacy. To test the effect of animacy, we modified the events used in Experiment 1. If animacy allows people to go beyond physical contact, replacing the initiating marble with a hand (indicating an animate agent) should allow people to form lexical causatives between the causer and the last marble, M3 (see Figure 3). If this is true, then the unitization hypothesis makes a further prediction. To the extent that subjects use lexical causatives when agents are animate, they should also tend to conceptualize these happenings as single events.

Experiment 2

Method

Subjects. The subjects were 20 Northwestern University students.

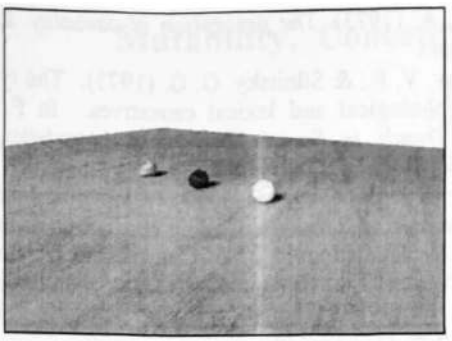


Figure 3. Causal chain initiated by inanimate causer

Design and Procedure. As in Experiment 1, the main factor of interest, *contact type*, was within subject and had two levels, contact and gap. The procedures were as those used in Experiment 1.

Materials. The animations were as used in Experiment 1, except that all of the initiating causers were animate, namely, a hand with arm and body attached in the background. In order to increase the number of sequences, the agents performed two kinds of actions. In half of the sequences, a hand flicked a marble to another marble, causing it to move. In the other half, a hand carried a marble to another marble, causing it to move.

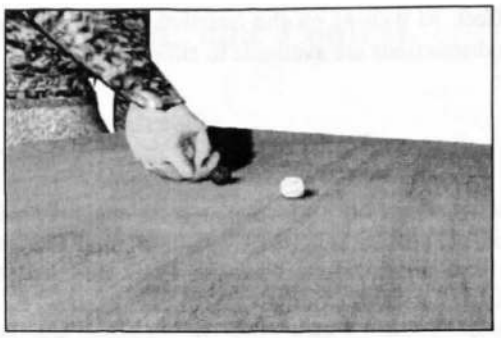
Results

The pattern of results changed dramatically from Experiment 1. When given animate agents, subjects were willing to use lexical causatives in the absence of physical contact (42% as compared to 8% in Experiment 1) (Table 3).

		Relationship Between Marbles	
		Contact	Gap
Sentence Type	**Lexical**	**61%**	**42%**
	Periph.	23%	52%
	Total Causal	83%	94%

Table 3: Percentage of sentence types chosen in Experiment 2

However, even with animate agents, contact still had an effect on lexicalization. As in Experiment 1, lexical causatives were chosen more frequently when the marbles made contact (M=61%) than when they were gapped (M=42%) (significant across items, $t_i(15)=2.6$, $p < .02$, but not subjects, $t_s(19)=1.66$).



Causal chain initiated by animate causer

		Relationship Between Marbles	
		Contact	Gap
Num of events	**1 event**	**29%**	**24%**
	More than 1 event	71%	76%

Table 4: Percentage choosing one event vs. more than one event in Experiment 2

The results provided additional support for the unitization hypothesis. Animacy appeared to have an effect on how the events were enumerated. Subjects were willing to report single events even when the marbles did not make physical contact (see Table 4). In contrast with the pattern in Experiment 1, subjects were equally likely to see the happening as a single event whether the marbles made physical contact (M=29%) or were gapped (M=24%). Taken together, these results support the hypothesis that the kinds of happenings described by lexical causatives are those that can be conceptualized as single events.

Conclusions

Language may tell us something about the perception of cause. Specifically, people may differentiate two different kinds of causality, direct and indirect, and people may use the properties of physical contact and animacy in distinguishing between these two kinds of causality. The role played by these two properties can be summarized by the following conclusions (1) In mechanical causation (i.e. when the causing objects are inanimate), lexicalization is guided by the contact criterion; (2) In agentive causation (i.e. when the causing object objects are animate), lexicalization is guided by further factors, possibly intention or ultimate causation; and (3) lexicalization might be an index of whether a happening can be conceptualized (unitized) as a single event. The results are consistent with the possibility that the properties that determine how a causal event gets expressed are basic to the perception of events. Future research will focus on the nature of the

animacy effect, as well as on the question of whether and when these distinctions are available to children.

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