

Song, G., & Wolff, P. (in press). Linking perceptual properties to the linguistic expression of causation. In M. Achard & S. Kemmer (Ed.), Language, culture, and mind. CSLI Publications.

Linking Perceptual Properties to Linguistic Expressions of Causation

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1 Introduction

In the late 1960s, it was argued that lexical causative expressions, such as *Bill killed Bob*, and periphrastic causative expressions, such as *Bill caused Bob to die*, represented different stages in the derivation of the same underlying semantic structure (e.g. McCawley 1968, Lakoff 1970). However, upon further analysis, the consensus shifted to the position that the two kinds of causatives in fact differed in meaning (Fodor 1970, Cruse 1972, Morreall 1976, Shibatani 1973, Smith 1970, Wierzbicka 1975). Subsequent research attempted to characterize the nature of this difference in meaning (Comrie 1985, McCawley 1978, Pinker 1989, Shibatani 1976, Wierzbicka 1988), and concluded that the difference was related to directness of causation, i.e., lexical causatives expressed direct causation while periphrastic causatives express either direct or indirect causation.

In the course of this work, it was recognized that the distinction between direct and indirect causation might be associated with structures other than lexical and periphrastic causatives (e.g. Brennenstuhl & Wachowicz 1976, Goldberg 1995, Rappaport Hovav & Levin 1999, Pander Maat & Sanders 2000, Pinker 1989). In other words, directness of causation might distinguish general classes of expressions, of which lexical and periphrastic causatives are but two examples. Although this was recognized as likely, the

Language, Culture and Mind
Michel Achard and Suzanne Kemmer (eds.).
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research on expressions of causation rarely moved beyond the examination of lexical and periphrastic causatives. This restriction was likely due, in part, to difficulties in defining the concepts of direct and indirect causation (Frawley 1992). Recently, however, significant progress has been made in the characterization of these notions (e.g. Rappaport Hovav & Levin 1999, Verhagen & Kemmer, 1997, Wolff 2003). Moreover, with the advent of advanced computer visualization programs, these new theories of direct causation can be empirically investigated for the first time. Specifically, by creating and manipulating instances of direct and indirect causation and then eliciting spontaneous descriptions, we can examine the range of expressions that people use to talk about these two types of events. This question is of interest because even though the study of lexical and periphrastic causatives has been useful in examining the notions of direct and indirect causation, periphrastic causatives, in particular, may not be representative of how people describe causal chains in ordinary language. Finally, in analyzing people's descriptions, we can also test theories of causal meaning and hypotheses about the linguistic level at which directness of causation is encoded.

2 Ways of Expressing Causation

Languages have multiple ways of expressing causation. In English, for example, causal relations can be expressed with conjunctions (e.g. *because*, *since*), prepositions (*because of*, *due to*), resultatives (*Peter sanded the stick smooth*), lexical causatives (*Peter broke the branch*), and periphrastic causatives (*Peter caused the branch to break*). While all of these structures can be used to describe causal events, the constructions are not fully interchangeable. The ways in which various causal expressions might differ in meaning has been most fully explored in the case of lexical and periphrastic causatives.

Lexical causatives are single-clause expressions that encode the notions of CAUSE and RESULT. By hypothesis, these two notions are encoded within a single verb such as *melt*, *break*, or *kill*, hence the term 'lexical'. Periphrastic causatives are two-clause expressions (Baron 1977, Cole 1983, Kozinsky & Polinsky 1993, Radford 1988, but see Kemmer & Verhagen, 1994) that encode the notions of CAUSE and RESULT in different clauses. The main (matrix) verb (i.e. *caused* in Figure 1) expresses the notion of CAUSE while the embedded verb (i.e. *break* in Figure 1) expresses the particular RESULT.

It has been commonly noted that the range of situations that can be described by lexical causatives is a subset of the range that can be described by periphrastic causatives (Levin & Rappaport Hovav 1994, Shibatani 1976).

This observation is illustrated by the scenes in Figure 1. In the top picture of this figure, a woman hits a window with a stick, and the window breaks. In the bottom picture, a woman removes a stick that is holding up a window, and the window falls and breaks. Both situations can be construed as causal chains as indicated by the appropriateness of the periphrastic causative description *Alison caused the window to break*. Importantly, however, only the top scene can be described with the lexical causative description *Alison broke the window*.


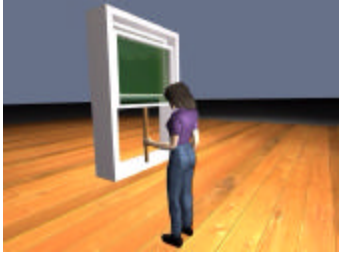
Causal chain	Linguistic expression
	<p>Alison caused the window to break. Alison broke the window.</p>
	<p>Alison caused the window to break. *Alison broke the window.</p>

FIGURE 1. Pictures depicting two kinds of causal chains and associated single- and/or multi-clause causal descriptions.

To explain the difference in meaning between lexical and periphrastic causative sentences, linguists have frequently invoked the concept of *direct causation* (e.g. Brennenstuhl & Wachowicz 1976, Comrie 1985, Croft 1991, Cruse 1972, Dowty 1979, Frawley 1992, Gawron 1985, Kozinsky & Polinsky 1993, Kemmer & Verhagen 1994, Levin & Rappaport Hovav 1994, McCawley 1978, Pinker 1989, Shibatani 1976, Smith 1970, Wierzbicka 1988, among others). Specifically, the claim has been that causal chains that can be described by lexical causatives are those that instantiate direct causation. That is, there

is a direct relation between the causer (the subject of the sentence) and the patient (the direct object of the sentence). In contrast, causal chains that can be described by periphrastic causatives are those that instantiate either direct or indirect causation.

3 The Concept of Direct Causation

Recently, Wolff (2003) has proposed a definition of direct causation that draws on the insights of a number of researchers (e.g. Cruse 1972, Rappaport Hovav & Levin 1999, Kemmer & Verhagen 1994, Verhagen & Kemmer 1997). According to the *no-intervening-cause criterion*, direct causation is present between the causer and the final patient in a causal chain if there are no intervening causers at the same level of granularity as either the initial causer or final patient. For causal chains with only two apparent entities, an initial causer and a final patient, the relationship between the causer and the patient is direct, so long as the patient is not also a causer, that is, so long as the patient does not act as an intermediate causer upon itself. For example, if a father were to sit his preschool child down in a chair, the causation would count as direct since there is no intermediary between the father and the child. In contrast, if a father were to tell his child to sit down—and the child did so—the causation would be indirect since the patient, the child, would also be acting as a causer, i.e. an intervening cause. For causal chains with intermediaries, the no-intervening-cause criterion depends on how those intermediaries are construed. If the intermediaries are construed as intervening causers, the chain will be viewed as indirect. If, on the other hand, the intermediaries can be construed as enabling conditions rather than intervening causers, the chain will be viewed as direct.

The ability of the no-intervening-cause criterion to distinguish direct and indirect causation is demonstrated by the situations depicted in Figure 1. In the top panel of Figure 1, the causer uses a stick to deliberately break the window. When a causer intentionally brings about a result, the intention establishes a tendency in the causer that the intermediary can be viewed as assisting. In this case, then, the stick can be viewed as enabling the woman to break the window. And since the stick can be viewed as an enabling condition, the chain can be viewed as direct. In contrast, in the bottom panel of Figure 1, the causer presumably does not realize that the window will fall when the stick is removed. In this case, the intervening cause is gravity, which cannot be viewed as an enabling condition since the causer has no intention of breaking the window. Therefore, the chain will be viewed as indirect. The two chains then differ with respect to whether or not they can be described by a lexical causative expression.

4 Support for the No-Intervening-Cause Criterion

The results from a series of experiments reported in Wolff (2003) support the claim that direct and indirect causation is determined by the presence of an intervening cause. In Experiment 3, in particular, participants chose linguistic descriptions for animations depicting mediated causal chains. Participants selected from a lexical causative description (e.g. *The girl broke the vase*), a periphrastic causative description (e.g. *The girl caused the vase to break*), or neither. The animations were organized into twelve pairs of causal chains. One animation in each pair depicted an intended result (direct causation) while the other animation depicted a non-intended result (indirect causation). For example, an animation in which a girl intentionally throws a ball at a vase and breaks it (direct causation) was contrasted with one in which a girl loses control of a ball that bounces into a vase and breaks it (indirect causation). A sample pair of animations depicting direct and indirect causation was shown in Figure 1. Two additional pairs are shown in Figure 2.

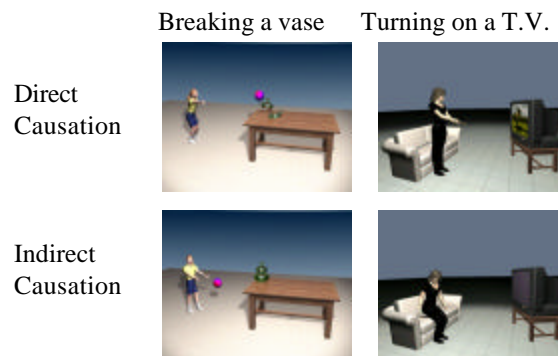


FIGURE 2. Animations of direct and indirect causation.

It was predicted that people would use lexical causatives to describe direct causal chains more often than indirect causal chains. Conversely, it was predicted that people would use periphrastic causatives more often for indirect chains than for direct chains. The results supported these predictions. As shown in Figure 3, chains representing direct causation were described by lexical causatives more frequently than chains representing indirect causation. Participants' tendency to avoid lexical causatives to describe indirect causal chains cannot be attributed to their not perceiving a causal relationship between the initial causer and final patient. As shown in Figure 3, participants were quite willing to describe such relationships with periphrastic

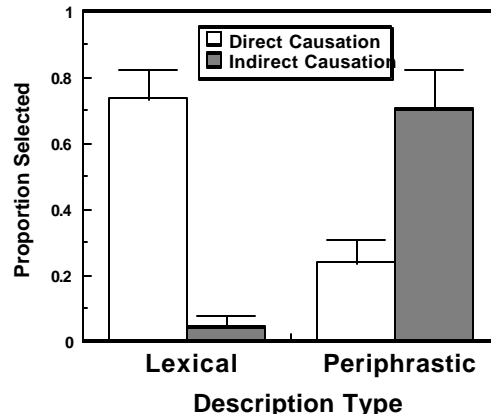


FIGURE 3. Descriptions of direct and indirect causal chains in Experiment 3 of Wolff (2003) with associated 95 percent confidence intervals.

causatives, implying that they did view the first and final entities in the causal chain as causally connected.

The results above help clarify the relationship between linguistic form and meaning in the description of causal events. One issue that remains unresolved, however, is whether the distinction between direct and indirect causation might be realized in structures other than lexical and periphrastic causatives. Linguistic theory suggests that the directness of causation might be encoded at the level of the clause (Croft 1991, Frawley 1992, Goldberg 1995, Wolff & Gentner 1996). In what we call the *no-intervening-cause hypothesis* (not criterion), in the absence of an intervening cause, a causal chain can be described by a single-clause expression (Wolff 2003).

One way in which the no-intervening-cause hypothesis might be tested is to have people describe the very same animations used in the experiment described above. If the no-intervening-cause hypothesis is correct, we should expect that the animations that depict direct causation will be described with single-clause structures, including lexical causatives and resultatives. We should also expect that animations that depict indirect causation should be described with multi-clause structures, including periphrastic causatives, multiple sentences, and clauses conjoined by various conjunctions (causal and non-causal). Beyond addressing the validity of the no-intervening-cause hypothesis, allowing people to simply describe the animations may reveal other interesting details about how causal chains are expressed in ordinary language. These predictions and additional considerations were examined in the experiment below.

5 Spontaneous Descriptions of Causal Chains

5.1 Method

Participants. Twenty-eight University of Memphis undergraduates participated in the experiment.

Materials. The materials were the same as in Experiment 3 of Wolff (2003), as described above. Each animation depicted a mediated causal chain initiated by a sentient causer. The animations were made from an animation package called Discreet 3D Studio Max version 4. The animations varied from 41 to 461 frames, with an average length of 170 frames, and were played at roughly 32 frames/second.

Procedure. Participants were asked to describe all twenty-four animations with a concise description. The animations were randomized for each participant. Participants typed in their descriptions of the animations into a space located below each animation. Participants' descriptions were subsequently analyzed in terms of the number of clauses they contained and the type of grammatical construction.

Descriptions were classified as examples of various grammatical constructions according to the following criteria. Descriptions were coded as lexical causatives if they included in a single-clause expression (1) verbs that are traditionally considered to be lexical causatives, i.e. verbs that name a change-of-state and participate in the causative alternation, e.g. *break, pop, dim, burn*, etc. (Levin & Rappaport Hovav 1994), (2) phrasal verbs (e.g. *turn off, put out*), some of which participate in the causative alternation, (3) or verbs that strongly imply a result even though they do not participate in the causative alternation (e.g. *destroy* and *extinguish*).

Another type of single-clause causal expression is the resultative, which consists of a main verb that implies the notion of CAUSE and a phrase that denotes the RESULT achieved by the referent of the immediately post-verbal noun phrase (NP) (see Rappaport Hovav & Levin 1999). In our analysis, descriptions were coded as resultatives if the main verb was followed by an NP (the direct object) and an adjective or prepositional phrase indicating the new state or location of the NP, e.g. *bank the ball into the corner, set/catch the paper on fire, hit the ball into the pocket*.

We also noted whether single-clause descriptions included either a causal preposition (*because of, due to*) or a coordinating conjunction (*and, but*). These structures were sometimes used to explicitly describe different parts of the causal chain.

Multi-clause descriptions were classified into four different categories. First, periphrastic causatives were coded as such if they included a peri-

phrastic causative verb followed by a clausal complement referring to the result.

Descriptions were coded as including causal connectives if clauses expressing a cause and a result were joined by a connective that explicitly encoded a causal relationship (e.g. *because, so*): *The man tossed the paper onto the table, catching it on fire because it was to (sic) close to the heater.* Descriptions were coded as including a coordinating conjunction if clauses expressing a cause and a result were joined by a conjunction that merely implied a causal relation rather than explicitly encoded one (e.g. *and*): *A girl bounced a ball and the ball shattered the vase.* Finally, descriptions were coded as multiple sentences if various parts of the causal chain were expressed in separate sentences: *A woman opens a window. Then, the air from the window blows out a flame of a candle.*

5.2 Results and Discussion

The following analyses were based on a subset of the total number of descriptions collected in the experiment ($N=672$), specifically, descriptions in which the result was explicitly mentioned. For example, with respect to the vase-breaking animation, we only analyzed descriptions in which participants noted something about the breaking or shattering of the vase. If participants noted, for instance, that a girl was bouncing a ball or even that the ball hit the vase without mentioning an explicit result, their descriptions were not included in the analysis. We did this so that our comparison of single and multiple clause descriptions, as well as direct and indirect causal chains, could be made with respect to the same resulting events. Fortunately, most descriptions, 79 percent, explicitly described the result. Of those that did not name the relevant result, 3.5 percent named an alternative result (*A man was playing pool and none of his balls went in*) while 17.5 percent named no result at all (*A man is playing pool*).

As shown on the left panel of Figure 4, the results supported the predictions of the no-intervening-cause hypothesis. Participants were far more likely to use single-clause expressions to describe causal chains instantiating direct causation than indirect causation, $t(11) = 7.61, p < .001$. Conversely, participants used multi-clause expressions more often to describe causal chains instantiating indirect causation than chains instantiating direct causation, $t(11) = 7.65, p < .001$.

By way of comparison, it is interesting to see how descriptions of direct and indirect causal chains differed in terms of the number of verbs. As shown in the right panel of Figure 4, participants were more likely to use single-verb expressions to describe causal chains involving direct than indi-

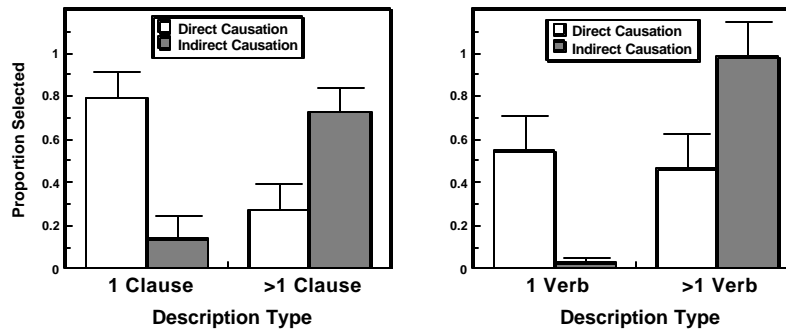


FIGURE 4. Proportion of single- and multi-clause descriptions of direct and indirect causal chains with associated 95 percent confidence intervals.

rect causation, and visa versa for multi-verb expressions. Importantly, however, for chains instantiating direct causation, participants were just as likely to use multi-verb expressions as they were to use single-verb expressions. In contrast, direct causation was more often described by single-clause expressions and indirect causation, by multi-clause expressions. Thus, we are better able to predict how a causal chain will be described in terms of the number of clauses than in terms of the number of verbs. This provides further evidence that the link between direct causation and language is with respect to clauses as opposed to, for example, the number of verbs.

The analysis in Figure 4 can be broken down by type of construction. As shown in Figure 5, the most frequent type of single-clause description was the lexical causative. The error bars indicating 95 percent confidence intervals make clear that lexical causatives were used more often to describe animations depicting direct causation than indirect causation. Turning to multi-clause constructions, we see that periphrastic causatives were used more often to describe animations depicting indirect causation than direct causation, just as found in Wolff (2003) with the most frequent periphrastic causative verb being *cause* (70 percent), followed by *make* (21 percent) and *let* (9 percent). However, the results also show that the most common way of describing indirect causation was to use the coordinating conjunction *and*. It is interesting to note that *and* was also often used in single-clause descriptions of animations depicting direct causation. However, in these descriptions, *and* was simply used to list a series of noun or verb phrases, e.g., *A girl threw a ball at a vase and broke it*. In multi-clause descriptions, in contrast, *and* connected two clauses, e.g., *A girl bounced a ball near a vase and the vase broke*. One potential worry that could be raised is that people used

used

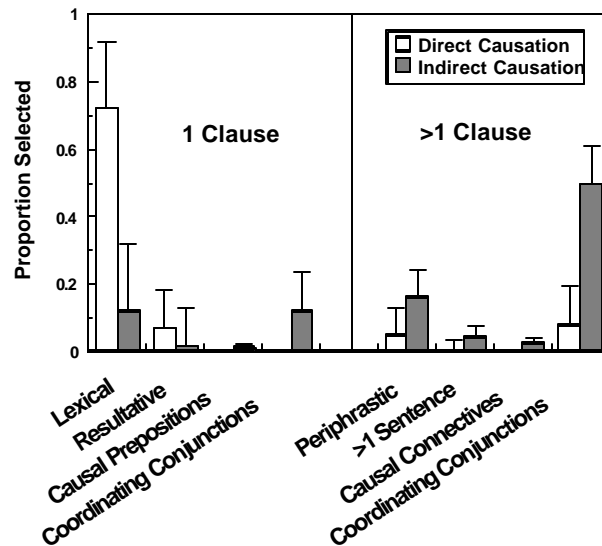


FIGURE 5. Proportion of construction types in spontaneous descriptions of direct and indirect causation with associated 95 percent confidence intervals.

coordinating conjunctions for the indirect animations more often than for the direct animations because they did not actually interpret the chain of events in the indirect animations as causally connected. However, as shown in Figure 3, participants were highly willing to describe the very same animations with periphrastic causatives, suggesting that they did, in fact, perceive a causally related series of events. Finally, as shown in Figure 5, participants also used multiple sentences and causal connectives (e.g. *because*) to describe animations depicting indirect causation, though relatively infrequently. In contrast, in describing direct causation, participants never used multiple sentences and only rarely used causal prepositions.

6 General Discussion

It has been long been recognized that the distinction between direct and indirect causation might apply to broader categories of expression than just lexical and periphrastic causatives. This hypothesis was difficult to test, however, since one cannot search a corpus for cases of direct and indirect causation and then examine what constructions emerge, that is, without assuming the answer to the question being tested. However, by using non-

linguistic stimuli (i.e. computer animations created according to specifications of a particular theory of causal meaning), hypotheses of this kind can be tested. In particular, people can view and describe non-linguistic depictions of the distinction being tested, and their descriptions can be analyzed. By using such a methodology, we have confirmed the intuition that the distinction between direct and indirect causation is indeed linguistically relevant and realized in structures other than lexical and periphrastic causatives. In fact, while the most common description for direct causal chains was the lexical causative, the most common descriptions for indirect causal chains were two or more clauses joined by coordinating conjunctions. More broadly, our results show that the best linguistic characterization of this distinction can be stated with respect to the clause.

Thus, we have shown that the conceptual distinction between direct and indirect causation appears to have linguistic reflexes. Exploring connections such as this may allow us to make good on the idea that grammatical categories may reveal important categories of the mind.

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