



Direct causation in the linguistic coding and individuation of causal events

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Abstract

This research proposes a new theory of direct causation and examines how this concept plays a key role in the linguistic coding and individuation of causal events. According to the *no-intervening-cause hypothesis*, a causal chain can be described by a single-clause sentence and construed as a single event if there are no intervening causers between the initial causer and the final causee. Consistent with this hypothesis, participants used single-clause sentences (lexical causatives) more often than two-clause sentences (e.g. periphrastic causatives) for causal chains in which (1) the causer and causee touched (Experiments 1 and 2), and (2) an intervening entity could be construed as an enabling condition rather than another cause (Experiments 2–4). In addition, event judgments paralleled linguistic descriptions: chains that could be described with single-clause expressions were more often construed as single events than chains that could not (Experiments 1–3). Implications for languages other than English, for the linguistic coding of accidental outcomes and for the relationship between cognition and language in general are discussed.
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1. Introduction

Linguistic theory suggests that there are restrictions on the possible meanings of single-clause expressions in English and other languages (e.g. Carter, 1976; Croft, 1990, 1991; Gentner, 1981, 1982; Pinker, 1989; Rappaport Hovav & Levin, 1999). For example, in English, it is not possible to describe, in a single clause, actions such as “... wander[ing]

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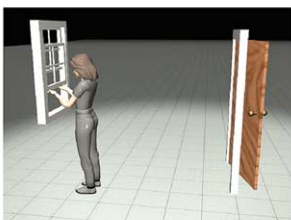
| Causal chain | Linguistic expression |
|---|---|
|  | Sara caused the door to open. Sara opened the door. |
|  | Sara caused the door to open. *Sara opened the door. |

Fig. 1. Pictures depicting two kinds of causal chains and how these chains can be linguistically described by either single- or multi-clause expressions.

through a maze of ropes at an airport or bank even when you are the only person in line” or “... flick[ing] a bulb on and off when it burns out (as if, somehow that will bring it back to life)”.¹ Even though such experiences might be frequent and culturally shared, it is unlikely that they could be expressed by simple statements presumably because they represent the kinds of sequences that cannot be denoted by a single-clause expression.

In this research, I focus on the possible meanings of single-clause statements associated with the encoding of causal relationships. Many researchers have suggested that such meanings are restricted by the concept of *direct causation* (e.g. Brennenstuhl & Wachowicz, 1976; Comrie, 1985; Croft, 1991; Cruse, 1972; Dowty, 1979; Frawley, 1992; Gawron, 1985; Kemmer & Verhagen, 1994; Kozinsky & Polinsky, 1993; 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 single-clause expressions are those in which there is a direct relation between the causer (specified by the subject of the sentence) and causee (specified by the direct object of the sentence). In contrast, when the relation between causer and causee is indirect, the causal chain must be described by a longer, multi-clause expression.

This claim is exemplified by the scenes in Fig. 1. The top picture in this figure shows a causal chain in which a woman turns a knob and pushes a door, which then opens. In the bottom picture, a woman lifts up a window, a breeze enters the room, and the door opens. Both situations can be construed as causal chains as indicated by the appropriateness of the

¹ Nevertheless, Hall (1984) offers the verbs *furble* and *purpitate* to fill these particular lexical gaps. See Pinker (1989) for a discussion of how such words, known as “sniglets” (Hall, 1984), imply the existence of constraints on the meaning of possible words.

two-clause description, “Sara *caused* the door to *open*”. Importantly, however, only the top scene depicts a sequence of events that can be described by a single-clause sentence, as in “Sara *opened* the door”.

In addition to the linguistic coding of causal chains, the concept of direct causation has also been implicated as relevant to the individuation of events (Davidson, 1969/2001; Goldberg, 1995). A number of researchers have claimed that single-clause sentences imply single unitary events (Croft, 1991; Déchaine, 1997; DeLancey, 1983, 1984, 1991; Frawley, 1992; Goldberg, 1995; Haiman, 1983; Kiparsky, 1997; Rappaport Hovav & Levin, 1997; Shibatani, 1976; Wolff & Gentner, 1996). At first glance, this proposal might seem to be contradicted by the fact that single-clause sentences denoting causal relations often imply the occurrence of two events: a causing subevent and a resulting subevent (Croft, 1991; Dowty, 1979; Jackendoff, 1990; Levin & Rapoport, 1988; Levin & Rappaport Hovav, 1995; Pustejovsky, 1991; Van Valin, 1990, among others). However, it is the special nature of events that they may be composed of multiple subevents (Avrahami & Kareev, 1994; Cleland, 1991; Frawley, 1992; Gentner, 1975; Gibson & Spelke, 1983; Rips & Estin, 1997; Zacks & Tversky, 2001; Zacks, Tversky, & Iyer, 2001) and that, in certain kinds of causal chains, these subevents can be unified and viewed as parts of a whole. Hence, there is no inherent contradiction in saying that a particular causal chain can be construed as both one and more than one event. What matters is the availability of a single event construal, and that construal seems to depend on the directness of causation between the initial cause and final causee. Specifically, when the causation is direct, the sequence of events can be viewed as a single event; otherwise, it cannot be viewed as a single event.

1.1. *Defining direct causation*

The link between direct causation and events suggests that direct causation might play a basic organizing role not only in the linguistic description of causal chains, but also in the general conceptual system as a whole. However, for this proposal to be contentful, it is important that the definition of direct causation be independent of the phenomenon it is meant to explain. For example, there is little value in characterizing direct causation as present whenever a causal chain can be described by a single-clause sentence or construed as a single event. Unfortunately, once we move beyond circular definitions, there is little consensus on precisely how this notion should be defined (Frawley, 1992). Thus far, direct causation has been defined in terms of *temporal contiguity* (Fodor, 1970; Goldberg, 1995; Smith, 1970), *control* (Brennenstuhl & Wachowicz, 1976; Smith, 1970), *intentionality* (Cary et al., 1995; DeLancey, 1983; Schlesinger, 1989; see also Kiparsky, 1997; Talmy, 1976, 1988), *mediacy* (Comrie, 1985; Cruse, 1972; Kemmer & Verhagen, 1994; Rappaport Hovav & Levin, 1999; Verhagen & Kemmer, 1997), *physical contact* (Ammon, 1980; Nedyalkov & Silnitsky, 1973; Shibatani, 1976; Wierzbicka, 1975), *efficiency* (Gawron, 1985), *conventionality* (Shibatani, 1973), *stereotypicality* (McCawley, 1978) and *prototypicality* (Lakoff & Johnson, 1980). The quotations in Table 1 illustrate some of the specific proposals that have been made. One of the main goals of this research is to specify and test a non-circular definition of direct causation. As I will show, such a definition is made possible by recent work in force dynamics.

Table 1

Sampling of proposals for what constitutes direct causation over the last three decades^a

| |
|---|
| <p>“transitive verbs require direct control of the activity or change of state, and the explicit causative construction indicates indirect control” (Smith, 1970, p. 106)</p> <p>“It appears that in discussing covert causatives we must understand ‘direct’ to mean that no agent intervenes in the chain of causation between the causer (represented by the subject of the verb) and the sufferer of the effect (represented by the object)” (Cruse, 1972, p. 524)</p> <p>“...it would appear that ‘kill’ and innumerable other causative verbs require a specific reference to physical contact between some two (or three) objects” (Wierzbicka, 1975, p. 495)</p> <p>“...morphological causatives are used to express a high degree of control...periphrastic causatives and causal connectives are used to express a low degree of control...” (control = “ability to carry out whichever of the intentions he chooses”) (Brennenstuhl & Wachowicz, 1976, p. 402)</p> <p>“Where a [lexical] causative verb exists, it is restricted to unmarked causative situations: those involving direct causation, by a standard means if there is one and for a standard purpose if there is one, and the periphrastic causatives are reserved for causative situations that are marked in one of these respects” (McCawley, 1978, p. 268)</p> <p>“the causer must physically manipulate the causee...[with lexical causatives]” (Shibatani, 1976, p. 31)</p> <p>“...the overwhelming proportion of them [i.e. direct manipulations] share features of what we may call a ‘prototypical’ or ‘paradigmatic’ case of direct causation” (Lakoff & Johnson, 1980, p. 70)</p> <p>“We still have a case of mediated causation, but we have added an element of intention...That this qualifies the event for coding in a transitive clause is consistent with the widely-noted relationship between intention and agentivity” (DeLancey, 1983, p. 55)</p> <p>“The distinction between direct and indirect causatives is concerned with the mediacy of the relationship between cause and effect” (Comrie, 1985, p. 165)</p> <p>“The unacceptability of ...[the lexical causative shown above]...is due to the violation of the assumption that there is direct physical contact” (Gergely & Bever, 1986, p. 230)</p> <p>“...lexical causatives apply to cases of causation via direct or physical contact...” (Pinker, 1989, p. 48)</p> <p>“Denominal causative verbs [pocket, paint, shelve, etc.] refer to generically intentional activities” (Kiparsky, 1997, p. 476)</p> <p>“Indirect causation can be defined as a situation that is conceptualized in such a way that it is recognized that some other force besides the initiator is the most immediate source of energy in the effected event” (Verhagen & Kemmer, 1997, p. 67)</p> <p>“...the primitive requirement for direct causation is that there be no intervening event...between the causing subevent and the result subevent” (Rappaport Hovav & Levin, 1999, p. 33)</p> |
|---|

^a The bold highlighting was added by the author.

1.2. The no-intervening-cause criterion and hypothesis

In this section I introduce two proposals: the no-intervening-cause criterion and the no-intervening-cause hypothesis. The no-intervening-cause criterion specifies the conceptual-perceptual conditions people use to distinguish direct from indirect causation. The no-intervening-cause hypothesis specifies the relationship between directness of causation and language, as well as the relationship between directness of causation and the notion of an event. These two proposals are described in turn.

1.2.1. No-intervening-cause criterion

In what I will call the no-intervening-cause criterion, direct causation is present between the causer and the final causee in a causal chain (1) if there are no intermediate entities at the same level of granularity as either the initial causer or final causee, or (2) if any

intermediate entities that are present can be construed as an enabling condition rather than an intervening causer. For causal chains with only two apparent entities, an initial causer and final causee, the relationship between the causer and the causee is direct, so long as the causee is not also a causer, that is, so long as the causee does not act as an intermediate causer upon itself. For example, if a father were to sit his preschool child up in a chair, the causation would count as direct since there is no intermediary between the father and the child, let alone one that could be construed as an intervening cause. In contrast, if a father were to tell his child to sit up, the causation would be indirect since the causee, the child, would also be acting as a causer, hence acting as an intervening cause. For casual chains with intermediaries, the criterion relies on how those intermediaries are construed. If the intermediaries can be construed as enabling conditions, the causal chain can be viewed as direct. If, on the other hand, the intermediaries cannot be construed as enabling the initial cause, the chain is viewed as indirect. As will be discussed in the General Discussion (Section 6), the no-intervening-cause criterion is closely related to several other accounts of direct causation (e.g. Cruse, 1972; DeLancey, 1983, 1984; Goldberg, 1995; Kemmer & Verhagen, 1994; Rappaport Hovav & Levin, 1999; Verhagen & Kemmer, 1997). One of the key differences between these accounts and the no-intervening-cause criterion is that the no-intervening-cause criterion assumes a particular approach to causation, namely one based on the Talmy (1988) theory of force dynamics. As a consequence, the current account makes predictions that can be linked to measurable properties in the outside

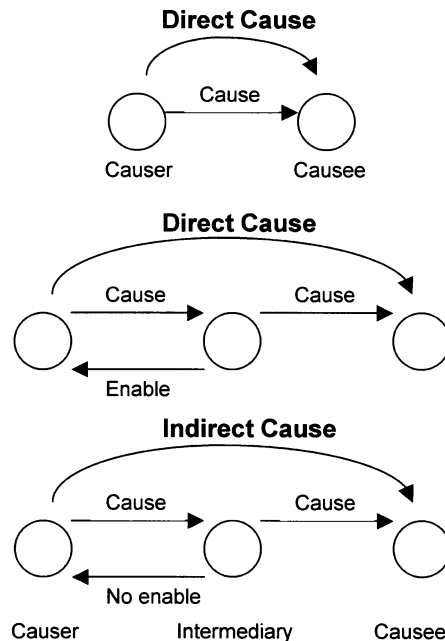


Fig. 2. Direct and indirect causation for three different kinds of causal chains as specified by the no-intervening-cause criterion.

world, which, in turn, allows the criterion to be tested in terms of visual depictions of physical events.

The proposed distinction between direct and indirect causation can be represented graphically, as in Fig. 2. As stated above, the no-intervening-cause criterion specifies that causal chains will be construed as direct if there are no intermediaries at all (see causal chain on top of Fig. 2) or if the intermediaries can be construed as enabling conditions (see causal chain in middle of Fig. 2). An enabling condition is defined as an entity that enables a cause (see Lombard, 1990; White, 2000). Thus, an intermediary will be construed as an enabling condition if the “backwards” link from the intermediary to the causer instantiates an enabling relationship, as defined in terms of force dynamics. Specifically, a “backwards” link from an intermediary to a causer can be viewed as enabling if the intermediary does something that is concordant with the tendency of the causer. (See below for a more detailed description of this definition.) Concordance of this kind is often present when the causer is sentient and capable of intention. When a causer intends a result, an intermediary can be viewed not only as causing a result to the causee, but also as enabling the causer to produce the result. For example, consider a mediated chain in which a woman with her arms full leans against a button that activates a door, the door opens, and she walks through. The button simultaneously causes the door to open and enables the woman to achieve her goal of getting through the door. According to the no-intervening-cause criterion, this chain, though mediated, can nevertheless be viewed as direct because the intervener can be viewed as an enabling condition.

Finally, the no-intervening-cause criterion specifies that a causal chain will be construed as indirect when an intermediary cannot be construed as an enabling condition. In this case, the intermediary will be construed as a cause, that is, an intervening cause, and the entire causal chain will be viewed as indirect. A graphical depiction of this kind of causal chain is shown on the bottom of Fig. 2. Importantly, it is assumed in both direct and indirect causation that an entity can be viewed as an intermediary only if it is fully independent of the causer and causee and is at the same level of granularity as that implied by the causer or causee. For example, we might speak of a lunar eclipse stopping an outdoor concert by distracting the musicians.² In this kind of occurrence, it is possible to enumerate many subevents associated with individual musicians (seeing the moon, noticing fellow musicians putting down their instruments, hearing the murmurs of the audience). However, we would not view these intervening subevents as mediating because they are not at the same granularity level as the rising of the moon or the performance of the concert. Thus, while the stopping of a concert due to an eclipse would involve many entities and associated subevents, the prediction is that the overall chain would be construed as involving only a cause and causee, without intermediaries, thus making the causal chain direct. It is also important that the intermediary be seen as independent of either the causer or causee. So, for example, if someone were to pick up a chair by grabbing the back of the chair and lifting it up, this would not be viewed as a mediated causal chain even though one might argue that the relationship between the lifter and the chair was mediated by the lifter’s hand. The lifter’s hand would not be seen as an intermediary because it is not fully independent of the lifter. However, if a person were to

² I thank an anonymous reviewer for this example situation.

throw a bowling ball at some pins, we could say the chain was mediated because the balling ball can be viewed as fully independent of the bowler.

1.2.2. *No-intervening-cause hypothesis*

In what I will call the no-intervening-cause hypothesis, the linguistic coding of causal chains in English (and possibly in other languages) is determined by the concept of direct causation as defined by the no-intervening-cause criterion. Further, the way in which English speakers (and possibly speakers from other languages) individuate events is also determined by the concept of direct causation as defined by the no-intervening-cause criterion. In terms of linguistic coding, the no-intervening-cause hypothesis holds that in the absence of an intervening cause, a causal chain can be described by a single-clause sentence. In terms of events, the hypothesis holds that when there is no intervening cause, a causal chain can be construed as a single event. Consider, again, the situation depicted in the top of Fig. 1 in which a woman pushes open a door. In this causal chain, there are no intermediaries between the causer and the causee. Hence, according to the no-intervening-cause criterion, there is direct causation between the causer and causee. According to the no-intervening-cause hypothesis, people should be able to describe this situation with a single-clause description, “The woman opened the door”, as indeed they can. Further, this simple sequence of events should be construable as a single event. Now consider the situation depicted in the bottom of Fig. 1 in which a woman opens a window, a breeze enters the room, and the door opens. In this scene, the breeze is not likely to be viewed as an enabler since it is unlikely that the woman intended to use it to open the door. Instead, it is likely to be viewed as a causer. Thus, according to the no-intervening-cause criterion, the link between the initial causer (the woman) and the final causee will be construed as indirect. The no-intervening-cause hypothesis predicts, then, that it should sound odd to describe this chain with a single-clause description, “The woman opened the door”, as indeed it is. Further, people should not view this causal chain as a single event. However, because the various entities in this sequence of events are causally connected, the sequence can be viewed as a causal chain, albeit an indirect one, and hence more aptly described with a multi-clause description such as “The woman caused the door to open”. Notice, however, that if, for some reason, the woman did intend to open the door by opening the window and letting a breeze enter, it would not be inappropriate to describe this rather unconventional method for opening the door with a single-clause description such as “The woman opened the door”.³

The no-intervening-cause criterion and hypothesis depend crucially on the idea that we can clearly distinguish the concepts of CAUSE from ENABLE. This is a distinction that on the surface may seem easy to make since we readily distinguish these notions in everyday speech. For example, we can say “The explosion *caused* the windows to shatter” but not “?The explosion *enabled* the windows to shatter”. Conversely, we say “Gasoline

³ Note that this is problematic for the pragmatic criterion of McCawley (1978), as well as for the prototype criterion of Lakoff and Johnson (1980) (see also Croft, 1991; DeLancey, 1984). If the woman intended to open the door, the scene would be construed of as direct even though the means were pragmatically unusual or otherwise non-prototypical. For an extended discussion of some of the problems associated with defining direct causation in terms of prototypes, see Gergely and Bever (1986).

enables cars to run”, but not “?Gasoline *causes* cars to run”. Such sentences demonstrate that the concepts of CAUSE and ENABLE are not interchangeable. However, specifying precisely how these two concepts differ in meaning has been very difficult, in part because they cannot be distinguished in terms of necessity or sufficiency (Cheng & Novick, 1991, 1992; Einhorn & Hogarth, 1986; Goldvarg & Johnson-Laird, 2001; Hart & Honoré, 1985; Mackie, 1974; Mill, 1872/1973; Turnbull & Slugoski, 1988; Wolff, Song, & Driscoll, 2002). This holds true even when such statements are analyzed in terms of the Mackie (1965) INUS criterion: explosions and gasoline are both *Insufficient* but *Necessary* parts of a complex set of factors that together are *Unnecessary* but *Sufficient* for windows to shatter and for cars to run. Counterfactual accounts fare no better, predicting that “gasoline causes cars to run” – given the truthfulness of the counterfactual “if gasoline had not been present, the car would not have run” – even though gasoline is better thought of as an enabling condition (see Lombard, 1990; see also Mandel & Lehman, 1996; Spellman & Mandel, 1999). In alternative accounts, the difference between CAUSE and ENABLE has been explained in terms of temporal order (Mill, 1872/1973), rarity (Hart & Honoré, 1985), normality (Einhorn & Hogarth, 1986), relevance (Mackie, 1974; Turnbull & Slugoski, 1988), and constancy (Cheng & Novick, 1991). None of these proposals has been entirely successful (Cheng & Novick, 1991; Goldvarg & Johnson-Laird, 2001; Wolff et al., 2002). Recently, however, colleagues and I have formulated a new model of causal relations based on distinctions identified in work on force dynamics. Armed with these distinctions, the concepts of CAUSE and ENABLE can be precisely differentiated and, in turn, used to define the concept of direct causation.

1.3. *The force dynamic model of causation*

A theory of force dynamics was first proposed by Talmy (1988) and has been elaborated by other researchers (most notably Jackendoff, 1990; Kemmer & Verhagen, 1994; Pinker, 1989; Robertson & Glenberg, 1998; Siskind, 2000; Verhagen, 2002; Verhagen & Kemmer, 1997; Wolff et al., 2002; Wolff & Zettergren, 2002). From a force dynamic perspective, the concept of CAUSE is one member of a family of concepts that includes the concepts of ENABLE and PREVENT, among others. Each of these concepts represents an interaction between an affector and a patient.⁴

In an adaptation of Talmy’s theory introduced in Wolff et al. (2002) (see also Wolff & Zettergren, 2002), we distinguish the concepts of CAUSE and ENABLE (as well as PREVENT) in terms of three main dimensions: (1) the tendency of the patient for a result; (2) the presence of opposition between the affector and patient; and (3) the occurrence of a result. The notion of tendency is defined as the patient’s propensity for the result due to properties or activities that are internal to the patient (e.g. an object’s thrust, tendency to fall, or tendency to resist motion due to friction or inertial forces). Opposition between the affector and patient is said to be present when the force exerted on the patient by the affector is not consistent with the patient’s tendency. The notion of result is defined as a particular endstate that a patient could enter into. The way in which these dimensions

⁴ We use the terms affector and patient instead of antagonist and agonist as originally used in Talmy (1988) because they are more familiar.

Table 2

The force dynamic model's representations of prototypical CAUSE, ENABLE, PREVENT

| | Tendency of patient for the result | Opposition between affecter and patient | Occurrence of a result |
|---------|------------------------------------|--|------------------------|
| CAUSE | N | Y | Y |
| ENABLE | Y | N | Y |
| PREVENT | Y | Y | N |

define and differentiate the concepts of CAUSE, ENABLE, and PREVENT is specified in Table 2.

As shown in Table 2, the force dynamic model claims that CAUSE and ENABLE differ with respect to the patient's tendency for the result and the presence of opposition. Consider the example of CAUSE as described in sentence (1a). In this sentence, the tendency of the patient (the boat) is not for the result (heeling), but because the tendency is opposed by the affecter (the blast), the result occurs.

- (1) a. The blast caused the boat to heel.
 b. Vitamin B enables the body to digest food.

In contrast, in the enabling situation described in (1b), the tendency of the patient (the body) is for the result (to digest food). This tendency is not opposed by the affecter (vitamin B). Rather, vitamin B assists in the realization of the tendency, and the result occurs.⁵ In sum, according to the force dynamic model, the expression *X causes Y to VERB* is roughly equivalent to “Y's tendency to not VERB is opposed and overcome by X, leading Y to verb”. Likewise, the expression *X enables Y to VERB* is roughly equivalent to “Y's tendency to VERB is not opposed, and possibly facilitated, by X, leading Y to VERB”.

The force dynamic model has been supported in sorting experiments showing that CAUSE-, ENABLE-, and PREVENT-type verbs are roughly equally similar to each other in meaning, as predicted by the model (Wolff & Song, in press; Wolff et al., 2002). In addition, support for the model has been found in several rating studies in which people made judgments about the dimensions of tendency, opposition, and result in sentences containing causal verbs (Wolff & Song, in press; Wolff et al., 2002). In being able to specify how the concepts of CAUSE and ENABLE differ, the force dynamic model makes it possible to distinguish between direct and indirect causation in mediated causal chains, as will be discussed in more detail below.

⁵ In situations involving preventing, as in *The rain prevented the tar from bonding*, the tendency of the patient (the tar) is for the result (bonding), but this tendency is opposed and blocked by the affecter (the rain), and the result does not occur.

1.4. Ways of coding causation in language

The no-intervening-cause hypothesis makes predictions about the various ways in which causal chains can be coded in English, and possibly also in other languages. English, like other languages, provides many ways of talking about causal relations, including causal conjunctions (e.g. *because*), prepositions (*because of*, *thanks 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 encode the notion of CAUSE, the expressions are not fully interchangeable. Causal chains that can be expressed with one kind of expression cannot necessarily be expressed by another. Differences in meaning among these structures have been most carefully examined in work comparing *lexical* (single-clause) and *periphrastic* (multi-clause) causatives. In seeking to explain the semantic difference between the two types of expressions, linguists have postulated the concept of direct causation. Hence, it is with respect to these two linguistic expressions that the predictions of the no-intervening-cause criterion are particularly relevant.

Lexical and periphrastic causatives are used to express causal relations in many languages (Comrie, 1985; Frawley, 1992; Kemmer & Verhagen, 1994; Nedyalkov & Silnitsky, 1973; Shibatani, 1976). Lexical causatives are single-clause expressions that encode the notions of CAUSE and RESULT (see (2a)).⁶ By hypothesis, these two notions are encoded within a single verb such as *melt*, *break*, *kill*, *sink*, *move* and *turn*, hence the term “lexical”.⁷ 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 (see (2b)). The main (matrix) verb (i.e. *made* in (2b)) expresses the notion of CAUSE⁸ while the embedded verb (i.e. *open* in (2b)) expresses the particular RESULT.

- (2) a. Sarah *opened* the door. (lexical causative)
- b. Sarah *caused* the door to *open*. (periphrastic causative)

The periphrastic causative verbs listed in Appendix A in (14) include most of the periphrastic causative verbs in the English language (see also Wolff et al., 2002). Syntactic and semantic criteria for membership in the lexical and periphrastic classes of verbs are also provided in Appendix A.

It has been commonly noted that the range of situations that can be referred to by lexical

⁶ The question of where in the language events are encoded (i.e. in the verb and/or in the syntax) represents a key problem in language research but is beyond the scope of this paper and does not directly impinge on the issues to be examined (see Goldberg, 1995; Jackendoff, 1997; Ritter & Rosen, 1996; Rosen, 1999; Tenny, 1994).

⁷ In some languages, e.g. Korean (Park, 1993) and Tamil (Talmy, 1991), lexical causative verbs may not necessarily entail the occurrence of a RESULT (see also Van Valin & LaPolla, 1997).

⁸ Both lexical and periphrastic causatives imply EXTERNAL CAUSATION. This kind of causation is initiated outside of an affected object or person and can be contrasted with INTERNAL CAUSATION, that is, causation initiated from within an affected object or person, as encoded in such verbs as *blush*, *bloom*, and *shiver* (see Gelman, Durgin, & Kaufman, 1995; Gelman & Spelke, 1981; Levin & Rappaport Hovav, 1996; Premack, 1990; Spelke, Phillips, & Woodward, 1995; Woodward, Phillips, & Spelke, 1993).

causatives is a subset of the range that can be referred to by periphrastic causatives (Levin & Rappaport Hovav, 1994; Shibatani, 1976). This difference in range is implied in Fig. 1, where the periphrastic causative can be applied to both causal chains, but the lexical causative to only one. Researchers have appealed to the notion of *direct causation* to explain the more restricted use of lexical causatives, that is, lexical causatives are possible only when direct causation is present (e.g. Cruse, 1972; Fodor, 1970; Morreall, 1976; Shibatani, 1973, 1976; Wierzbicka, 1975).

1.5. Predictions of the no-intervening-cause hypothesis

1.5.1. Predictions for the linguistic coding of causal chains

The no-intervening-cause hypothesis makes predictions about how people will use lexical and periphrastic causatives to describe visually presented causal chains. Consider the scene shown in Fig. 3 which shows the first frame of an animation in which a marble (on the far left) bumps into a second marble (in the middle), which then bumps into a third marble (on the far right). In such a causal chain, we can identify two unmediated chains: one that begins with the marble on the far left and ends with the marble in the middle and one (not highlighted in Fig. 3) that begins with the middle marble and ends with the marble on the far right. In contrast, there is only one mediated chain, beginning with the marble on the far left and ending with the marble on the far right.

In chains like the one shown in Fig. 3, where all of the entities involved are non-sentient, the predictions of the no-intervening-cause hypothesis are straightforward. Specifically, the no-intervening-cause hypothesis predicts that people will use lexical causatives to describe unmediated but not mediated segments of the chain. Mediated chains will be viewed as indirect because the mediating entity cannot be construed as an enabling condition, and thus can only be viewed as a cause. Hence, in chains in which all of the entities involved are non-sentient, the no-intervening-cause-hypothesis is consistent with the commonly made claim that lexical causatives imply causal chains in which the causer and causee make physical contact while periphrastic causatives imply chains in which they

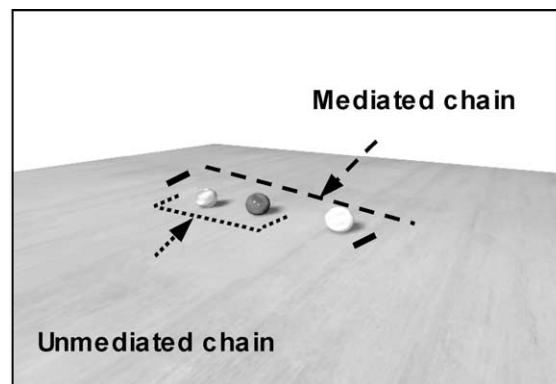


Fig. 3. First frame of an animation that highlights the objects that are involved in an unmediated and mediated causal chain.

do not (e.g. Ammon, 1980; Gergely & Bever, 1986; Nedyalkov & Silnitsky, 1973; Pinker, 1989; Shibatani, 1976; Wierzbicka, 1975).

1.5.2. Predictions for the individuation of events

The no-intervening-cause hypothesis predicts that people will be more willing to say that a single event occurred between entities in the chain that make physical contact than between entities that do not make physical contact. This prediction is consistent with the commonly made claim that event individuation is sometimes made on the basis of *change* (Cleland, 1991; Johansson, 1978; Lombard, 1986; Rosch, 1978; Taylor, 1985), including changes in state or in location, as when the momentum of one ball is perceived to change location once it makes contact with another ball and sends it into motion (Kruschke & Fragassi, 1996; Michotte, 1946/1963).

1.6. Testing the no-intervening-cause hypothesis

The predictions of the no-intervening-cause hypothesis were tested in Experiment 1. Participants viewed causal chains like the one depicted in Fig. 3. They were then asked whether the scene was best described by a lexical causative (e.g. *The red marble moved the blue marble*), a periphrastic causative (e.g. *The red marble caused the blue marble to move*), or neither. Half of the (lexical/periphrastic) sentence pairs described unmediated chains, i.e. the sentences mentioned the two marbles that made physical contact, referring to them by their colors. The other half described mediated chains, i.e. they named the two marbles that did not touch. After choosing descriptions for the causal chains, participants watched the same sequence of causal chains as before, but this time they reported the number of events occurring between the two marbles referred to in each pair of sentences. Again, the no-intervening-cause hypothesis predicts that people will describe unmediated chains with lexical causatives more frequently than with periphrastic causatives. The no-intervening-cause hypothesis also predicts that people will be more likely to say that a single event occurred when the chain is unmediated than when it is mediated.

2. Experiment 1: linguistic descriptions and event judgments of mediated and unmediated chains involving non-sentient initial causers

Experiment 1 tested the predictions of the no-intervening-cause hypothesis for how causal chains are described and individuated in terms of events. Participants were shown animations of marbles hitting one another in sequence and asked to choose linguistic descriptions and make event judgments. According to the no-intervening-cause hypothesis, participants should choose lexical causatives more often when the marbles make contact than when they do not. In addition, judgments about the number of events should mirror linguistic descriptions: specifically, the causal chains that are more often described with lexical causatives should be judged to be single events more often than those that are not described by lexical causatives.

2.1. Method

2.1.1. Participants

The participants were 16 Northwestern University undergraduates.

2.1.2. 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 in succession. The sequences followed one of four possible paths depending on whether the first marble hit the second marble directly or from an angle and on whether the second marble hit the third marble directly or from an angle. Each path was shown from four different perspectives. Animation quality was near photorealistic: all colors, except the background, were done with texture mappings, and all objects, when appropriate, cast shadows. The marbles were placed on a gray surface against a blue background and were colored red, yellow, blue, or green. Like real marbles, their 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. Finally, lexical and periphrastic causative sentences were based on five different (lexical causative) verbs: *move*, *shift*, *relocate*, *budge*, and *advance*.

2.1.3. Procedure

The animations were presented on DOS-based computers with 17-inch monitors. The order of the animations was randomized except for the first two, which served as practice items. After watching an animation, participants recorded their responses on sheets of paper. They were asked to “choose the sentence that best describes” the occurrence, based on “what you see in the animations, as well as your knowledge of verbs”. The choices were a lexical causative description, a periphrastic causative description, or neither. Periphrastic causatives were formed using the verb *make* along with the same verb used in the lexical causative sentence. Within each pair of sentences, the marbles named were the same, e.g. *The blue marble moved the green marble* vs. *The blue marble made the green marble move*. The sentence pairs included eight unmediated chains and eight mediated chains in which the subject was always the first marble of the causal chain. There were also four sentence pairs in which the order of the named marbles did not match their order in the animation. These four reversed chains were drawn systematically from the primary 16 animations and served as catch trials to make sure that participants were on task since the correct option, “neither of the above sentences”, was unambiguous. After participants finished the sentence choice task, they watched the animations again and were instructed to write down on a separate sheet of paper “the number of events that occurred between the two marbles referred to in each sentence set”. The separate sheet of paper listed the two marbles in each animation that were mentioned in the previous sentence choice task. Participants were also asked to “[p]rovide casual, not scientific, answers, as if a friend had asked you to tell him or her how many events had occurred”. In both tasks, participants wrote down their answers on sheets of paper. Progress through the animations was self-paced.

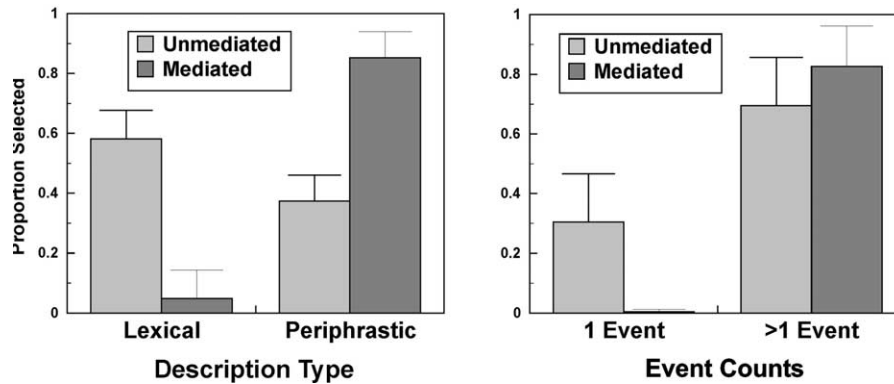


Fig. 4. Proportion of lexical and periphrastic sentences chosen (left) and proportion of 1 and >1 event judgments (right) for unmediated and mediated chains with associated 95% confidence intervals.

2.1.4. Design

Chain type (unmediated vs. mediated) was run within participants for both dependent measures (i.e. sentence choice and event judgment).

2.2. Results and discussion

The predictions of the no-intervening-cause hypothesis were borne out. As expected, participants preferred lexical causatives for unmediated chains ($M = 0.58$, $SD = 0.282$) more frequently than for mediated chains ($M = 0.048$, $SD = 0.201$), which they described with lexical causatives only rarely. (See left panel of Fig. 4.) This difference was significant across both participants ($F_p(1, 15) = 60$, $P < 0.001$) and items ($F_i(1, 15) = 163$, $P < 0.001$).⁹ Importantly, participants' unwillingness to refer to mediated chains with lexical causatives cannot be attributed to their not perceiving a causal relationship between the first and last marbles. The high level of periphrastic responses for mediated chains ($M = 0.85$, $SD = 0.20$) indicates that the majority of the participants viewed the first and last marbles as causally connected, but in a manner different from that between marbles that made contact.¹⁰

As shown in Fig. 4, event judgments mirrored linguistic descriptions. Just as unmediated chains were referred to by lexical causatives more frequently than mediated chains, unmediated chains ($M = 0.31$, $SD = 0.468$) were judged to be single events more frequently than mediated chains ($M = 0$) ($F_p(1, 15) = 6.79$, $P < 0.05$; $F_i(1, 15) = 86.15$, $P < 0.001$).¹¹

⁹ In this experiment, as well as for all other experiments to follow, analyses of sentence choice will be based only on lexical causatives. To also include an analysis of periphrastic causatives would be partially redundant because, as alternatives in a multiple-choice task, their selection was not wholly independent of each other.

¹⁰ Note that the proportions of responses for unmediated and mediated chains do not quite total 1 because the "neither of the above" alternative was occasionally chosen.

¹¹ The proportions of responses for unmediated and mediated chains do not quite total 1 because a few participants said that no events had occurred for some of the chains. In this experiment, as well as for all other experiments to follow, analyses of event judgements will be made with respect to single event choices only.

In sum, the results are consistent with the predictions made by the no-intervening-cause hypothesis. They are also in agreement with previous findings examining the link between linguistic coding and causal chains. In a study by Ammon (1980) (see also Pinker, 1989), children and adults chose one of three pictures in response to an orally presented sentence that contained either a lexical or periphrastic causative. The pictures depicted three kinds of causal chains: unmediated chains in which the causer made contact with the causee (e.g. a cartoon character bouncing a ball), mediated chains in which the causer instructed another causer to make contact with the causee (e.g. a character pointing a finger at another character bouncing a ball, as if directing her to do so), and mediated chains in which neither causer made contact with the causee (e.g. two characters simply watching a ball bounce). When the sentence contained a lexical causative, both children and adults preferred the picture depicting unmediated causation. When the sentence contained a periphrastic causative, responses were mixed. The current results extend those of Ammon's to stimuli depicting actual motion (not just static pictures), and show that the individuation of those chains in terms of events mirrors their linguistic description.

As noted earlier, however, the absence of an intervening entity is only one reason a causal chain might be construed as direct. The no-intervening-cause criterion also specifies that even mediated causal chains can be construed as direct, provided that their intermediaries can be viewed as enabling conditions. Whether an intermediary can be viewed as an enabling condition appears to depend, in many cases, on whether the chain is initiated by a sentient causer. The reason why sentience may be important is because sentient entities can have tendencies in the form of intentions and desires that can be fulfilled or enabled by the outcomes of interactions that are non-immediate and/or that take place between two other entities.

The idea that sentience might affect how a causal chain is described has been suggested by several investigators (Cary et al., 1995; DeLancey, 1983; Schlesinger, 1989; see also Brennenstuhl & Wachowicz, 1976; Kiparsky, 1997; Talmy, 1976, 1988). For example, Talmy (1988) notes that many languages allow complex causal chains to be summarized by mere expression of the initial causer and final result, with the intermediary events left implicit, when the causer is sentient, a process he refers to as "windowing of attention" (Talmy, 1996). As Talmy states, "a volitional Agent's intended goal or results can be treated psychologically as an invariant held across the variation of the range and variety of means that might be marshaled to accomplish the intended result" (Cary et al., 1995, p. 147). A similar proposal has been made by Van Valin and Wilkins (1996). In what they refer to as "metonymic clipping", a sentient causer may stand in for an entire sequence of events leading up to a result.

The no-intervening-cause criterion motivates why sentient agents can have this effect. Importantly, the effect is not due to properties of the lexicon per se. We know this because while the subjects of lexical causatives are often animate, animacy is not strictly required of most of these verbs (Corrigan, 1986; Dowty, 1991; Fillmore, 1968, 1977; Hopper & Thompson, 1980; Slobin, 1981; Slobin & Bever, 1982). Nor do most lexical causatives require that the effect named by the verb be intended, as demonstrated by the fact that accidents can be described by lexical causatives in (3) (see DeLancey, 1983, 1984; Kiparsky, 1997; Pinker, 1989; Schlesinger, 1989). (See the General Discussion (Section 6) for a more detailed discussion of the linguistic encoding of accidents.)

- (3) a. The manager accidentally closed the door.
b. Fred accidentally moved the computer mouse.

Rather, as assumed in the no-intervening-cause hypothesis, the reason why intention may affect the linguistic coding of causal chains is because it changes the way the causal chain is construed (psychologically). Evidence from psychology supports the general idea that the presence of a sentient causer affects how a causal chain is perceived. In fact, the effect of sentience appears to be appreciated even by infants. In a set of studies by Woodward, Phillips, and Spelke (1993) (see also Golinkoff, Harding, Carlson, & Sexton, 1984; Spelke, Phillips, & Woodward, 1995), 7-month-olds were familiarized to causal chains in which one entity hit another entity, propelling the second into motion. For half of the infants, both entities were sentient while for the other half, both entities were non-sentient. During the familiarization phase, the actual point at which the propelling took place was hidden from the infants by a screen. It was predicted that infants would assume the non-sentient entities made contact. As a consequence, they should be especially surprised to see, once the screen was removed, a propelling scenario in which the two entities did not make contact. The results were as predicted. However, the infants shown sentient entities patterned differently: they were no more surprised to see no-contact situations than contact situations. Woodward et al. conclude that infants restrict the principle of contact to non-sentient entities and that, for causal chains involving sentient causers, infants assume that there can be effects from a distance. These findings are consistent with the general observation that people distinguish at least two paradigms of causality: mechanical and teleological. Mechanical causality involves force and is generally constrained to contiguous relationships in time and space. Teleological causality is causality that occurs in the pursuit of goals and can occur across distances and time (Carey, 1985; Keil, 1995; Leslie, 1994, 1995).

2.3. Testing the no-intervening-cause hypothesis for chains involving sentient causers

According to the no-intervening-cause criterion, a causal chain will be construed as direct if any intermediaries can be viewed as enabling the causer to reach some goal. One way in which this prediction might be tested is to simply vary the sentience of the initial

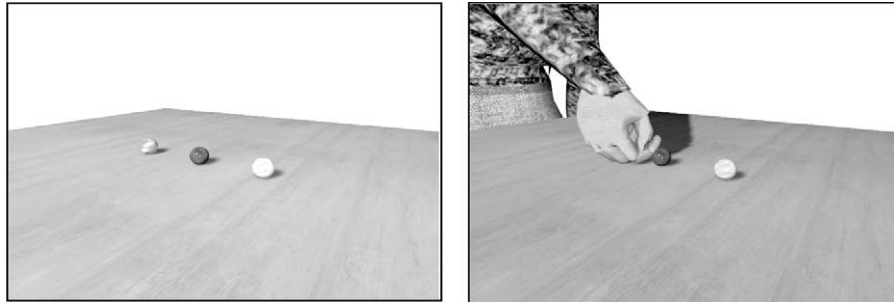


Fig. 5. Animations used in Experiment 2 in which the initial causer was either non-sentient (left) or sentient (right).

causer and see whether it leads to changes in how people describe causal chains and individuate them in terms of events. The presence of a sentient causer does not necessarily mean that the causal chain will be construed as intended. However, because intention requires sentience, a sentient causer should increase the likelihood of this kind of construal. This logic was used in the next experiment.

In Experiment 2, half of the animations were of the same type as in Experiment 1, i.e. involving three marbles. The rest of the animations were the same except that the initial marble was replaced by a person. In terms of descriptions, the no-intervening-cause hypothesis predicts that participants should be more willing to use lexical causatives to describe mediated causal chains if those chains are initiated by sentient causers than by non-sentient causers. When a mediated causal chain is initiated by a non-sentient causer, they should, in fact, be extremely unwilling to use a lexical causative. In terms of events, the no-intervening-cause hypothesis predicts that event judgments should parallel linguistic descriptions: participants should be more willing to classify mediated chains as single events when the initial causer is sentient than when the initial causer is non-sentient.

3. Experiment 2: linguistic descriptions and event judgments of mediated and unmediated chains involving sentient and non-sentient initial causers

One prediction of the no-intervening-cause hypothesis is that sentience of the initial causer should affect how a causal chain is construed and subsequently described and judged in terms of events. To test this prediction, participants were shown animations of causal chains and asked to choose linguistic descriptions and make event judgments. Half of the participants saw the same animations as those used in Experiment 1. The remaining participants saw exactly the same animations, except that the first marble was replaced by a sentient causer, who flicked a marble. In animations with non-sentient causers, the first marble interacted with the second marble of the causal chain by hitting it either directly or from an angle. With sentient causers, a perfectly parallel situation was not possible since flicking must always be done head-on. Therefore, variation in the sentient causer was produced by using two different causer activities. In half of the sequences with sentient causers, a hand flicked a marble at another marble, causing the second marble to move (as depicted in Fig. 5). In the other half, a hand carried a marble to another marble, also causing the second marble to move. As it turned out, the responses to these two kinds of causer actions did not differ.

The no-intervening-cause hypothesis predicts that participants should, on the whole, choose lexical causatives when the two marbles named in the pair of sentences make physical contact and periphrastic causatives when they do not. However, the no-intervening-cause hypothesis also predicts that participants should be more willing to describe mediated chains with lexical causatives when the initiating causer is sentient than when it is non-sentient. In terms of events, the no-intervening-cause hypothesis predicts that event judgments should mirror linguistic descriptions: causal chains that are described by lexical causatives should be judged to be single events more often than those that are not described by lexical causatives.

3.1. Method

3.1.1. Participants

The participants were 32 Northwestern University undergraduates.

3.1.2. Materials

The animations included those used in Experiment 1, plus a new set of animations that were the same as those used in Experiment 1 except that the initiating causer was a hand with an arm and body attached in the background, implying a sentient causer. In these new animations, the causers performed one of two actions. In half of the sequences, a hand flicked a marble at another marble, causing the second marble to move (as depicted in Fig. 5). In the other half, a hand carried a marble to another marble, also causing the second marble to move. Lexical and periphrastic causative sentences were constructed with the same five verbs used in Experiment 1, but the subject of the sentences was changed from *the red/blue/yellow/green marble* to *the man* for those viewing the animations with the sentient causer.

3.1.3. Procedure

The procedures were the same as those used in Experiment 1. In the first part of the experiment, participants chose between lexical and periphrastic causative sentences (e.g. *The man moved the blue marble* vs. *The man made the blue marble move*) by circling sentences written on a sheet of paper. In the second part of the experiment, participants saw the same sequence of animations for a second time and then reported on a second sheet of paper how many events occurred between the initial causer and one of the marbles. Progress through the animations was self-paced.

3.1.4. Design

Chain type (unmediated vs. mediated) was run within participants while sentience (sentient vs. non-sentient) was run between participants for both dependent measures (i.e. sentence choice and event judgment). For participants seeing animations with sentient causers, causer action (flicking vs. carrying) was run within participants.

3.2. Results

The results – as shown in Fig. 6 – provided further support for the no-intervening-cause hypothesis. As in Experiment 1, participants were more willing to describe unmediated chains with lexical causatives than mediated chains. Moreover, as predicted for mediated chains, sentience made a difference: participants were more willing to describe mediated chains with lexical causatives when they were initiated by a sentient causer than by a non-sentient causer. Finally, event judgments mirrored linguistic descriptions as predicted.

3.2.1. Description choices

As found in Experiment 1, unmediated chains ($M = 0.53$, $SD = 0.250$) were described by lexical causatives more frequently than were mediated chains ($M = 0.15$, $SD = 0.162$) ($F_p(1, 30) = 76.35$, $P < 0.001$; $F_i(1, 30) = 16.57$, $P < 0.001$). (See left panel of Fig. 6.) It

is important to note that participants' overall tendency to avoid describing mediated chains with lexical causatives cannot be attributed to their not perceiving a causal relationship between the initial causer and last marble. As in Experiment 1, participants were quite willing to describe such relationships with periphrastic causatives ($M = 0.73$, $SD = 0.212$).

As predicted by the no-intervening-cause hypothesis, the effect of physical contact on the linguistic coding was not as strong when the chain was initiated by a sentient causer. Participants were more willing to describe mediated chains with lexical causatives when the causer was sentient ($M = 0.24$, $SD = 0.161$) than when it was not ($M = 0.07$, $SD = 0.107$). This difference is suggested by a significant interaction between causer sentence and chain length ($F_p(1, 30) = 6.79$, $P < 0.05$; $F_i(1, 30) = 4.24$, $P < 0.05$) and directly confirmed by a planned comparison showing that mediated chains were more often described with lexical causatives when the causer was sentient than when non-sentient ($F_p(1, 30) = 13.3$, $P < 0.01$; $F_i(1, 30) = 9.3$, $P < 0.01$). No other effects or interactions were significant, including those associated with causer activity (i.e. flicking vs. carrying).

3.2.2. Event judgments

As predicted by the no-intervening-cause hypothesis, the pattern for single-event judgments was analogous to that found for lexical causatives. (See right and left panels of Fig. 5.) First, there was an overall tendency for unmediated chains ($M = 0.30$, $SD = 0.40$) to be judged as single events more often than mediated chains ($M = 0.08$, $SD = 0.161$) ($F_p(1, 30) = 10.50$, $P < 0.01$; $F_i(1, 30) = 29.68$, $P < 0.001$). However, as with linguistic coding, the effect of physical contact on event judgments was influenced by the sentence of the causer. Participants were more willing to construe mediated chains as single events when the causer was sentient ($M = 0.16$, $SD = 0.202$) than when non-sentient ($M = 0.01$, $SD = 0.031$). This difference is suggested by a significant interaction between causer sentence and chain length ($F_p(1, 30) = 4.25$, $P < 0.05$; $F_i(1, 30) = 10.77$, $P < 0.01$).

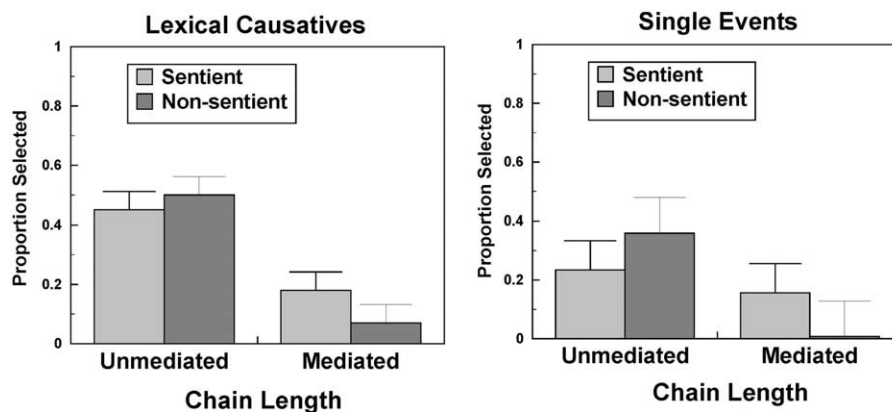


Fig. 6. Proportion of lexical causative responses (left) and single-event judgments (right) based on sentient and non-sentient causers for unmediated and mediated causal chains with 95% confidence intervals in Experiment 2.

and directly indicated by a planned comparison showing that mediated chains were more often judged to be single events when the causer was sentient than when non-sentient ($F_p(1, 30) = 8.5$, $P < 0.01$; $F_i(1, 30) = 12.0$, $P < 0.01$). No other effects or interactions were significant, including those associated with causer activity.

3.3. Discussion

The results supported the no-intervening-cause hypothesis. Participants were more willing to use lexical causatives and report the occurrence of a single event if the chain was unmediated than mediated. However, as also predicted by the no-intervening-cause hypothesis, participants were more likely to use lexical causatives and report single events for mediated chains initiated by a sentient than a non-sentient causer.

While the results so far support the no-intervening-cause criterion of direct causation, there are also several ways in which they are limited. First, the scope of the effects has so far been limited to a small set of events and verbs. If the no-intervening-cause criterion is relevant to the coding of causal chains in general, a much wider range of events and verbs must be considered. Second, the evidence for the importance of enabling conditions in linguistic descriptions and event judgments has so far been indirect. To address the specific predictions made by the no-intervening-cause criterion, we need to know that the perception of direct causation is, in fact, associated with the intermediaries being construed as enabling conditions with respect to the causer's tendency.

These limitations were addressed in the following experiment. The materials in this experiment consisted of 12 pairs of animations depicting mediated causal chains. One animation in each pair depicted an intended result while the other pair depicted a non-intended result. For example, an animation in which a girl throws a ball at a vase, breaking it, was contrasted with one in which a girl loses control of a bouncing ball, which bounces into a vase and breaks it. The initial causer in all animations was sentient (a person). Several dependent measures were of interest: people's linguistic descriptions of the chains, people's event judgments of the chains, and people's judgments regarding the relationship between the intermediary and initial causer (i.e. cause vs. enablement). It was predicted that people would be more willing to use lexical causatives to describe the chains showing intended results than chains showing non-intended results. As discussed above, in an intended causal chain, the intermediary is viewed as an enabler rather than a causer; hence, such a mediated chain will be construed as direct. For chains depicting non-intended results, it was predicted that people would prefer periphrastic causatives to lexical causatives because in these chains the intermediary is not easily construed as an enabling condition. As in previous experiments, it was predicted that people would be more willing to say that a single event occurred for chains compatible with a lexical causative description than with a periphrastic causative description because, according to the no-intervening-cause hypothesis, the notion of direct causation underlies both linguistic description and event construal. Thus, it was predicted that people would be more willing to say that a single event occurred for chains in which the result was intended than for chains in which the result was not intended. Finally, as predicted by the no-intervening-cause criterion, it was predicted that people would be more willing to say that the intermediary enabled the causer when the result was intended than when the result

was not intended. This last prediction was tested by having people make judgments about the relationship between the initial causer and the intermediary in both “forward” relationships, i.e. whether the causer caused or enabled the intermediary to produce the result, and “backward” relationships, i.e. whether the intermediary caused or enabled the initial causer to produce the result.

4. Experiment 3: linguistic descriptions and event judgments of complex mediated causal chains

In this experiment the implications of the no-intervening-cause hypothesis were considered for a relatively wide range of events and verbs. All of the chains were mediated and organized into pairs: one depicting a result that was intended and the other depicting the same result, but not intended. The key dependent measures were people’s linguistic descriptions, event judgments, and judgments regarding the relationship between the causer and intermediary. When the result of a mediated chain is intended, the intermediary can be viewed as an enabling condition, and the chain can be construed as direct. Thus, when the result is intended, the no-intervening-cause hypothesis predicts that people will construe the intermediary as an enabler and, as a consequence, will be willing to describe it with a lexical causative and classify it as a single event. When the result is not intended, the no-intervening-cause hypothesis predicts that people will not construe the intermediary as an enabler and hence will not describe it with a lexical causative nor view it as a single unified event, but rather as a chain of events.

4.1. Method

4.1.1. Participants

The participants were 56 University of Memphis undergraduates. Sixteen of these undergraduates participated in the linguistic description task, another 16 undergraduates participated in the event judgment task, and the remaining 24 undergraduates participated in the role-of-the-intermediary task.

4.1.2. Materials

Twelve pairs of 3D animations were made from an animation package called Discreet 3D Studio Max version 4. Each animation depicted a mediated causal chain initiated by a sentient causer. Three sample pairs of animations depicting intended and non-intended results are shown in Fig. 7. A description of all of the animation pairs is listed in Table 3. One member of each pair depicted a scene in which the causer intended the result to the causee. The other member of each pair depicted a scene in which the causer did not intend the result to the causee. To check whether the two sets of animations did indeed differ in intention, 16 undergraduates were shown each animation and asked whether the causer intended the effect that occurred to the causee, e.g. “Yes or No: The woman intended to crack the window”. The animations that were designed to depict an intended result were indeed rated as more intentional ($M = 94\%$) than the animations designed to depict an unintended result ($M = 17\%$), across participants ($t_p(15) = 25.7, P < 0.001$) and items ($t_i(11) = 8.7, P < 0.001$). Except for this difference in intention, the scenes in each pair of

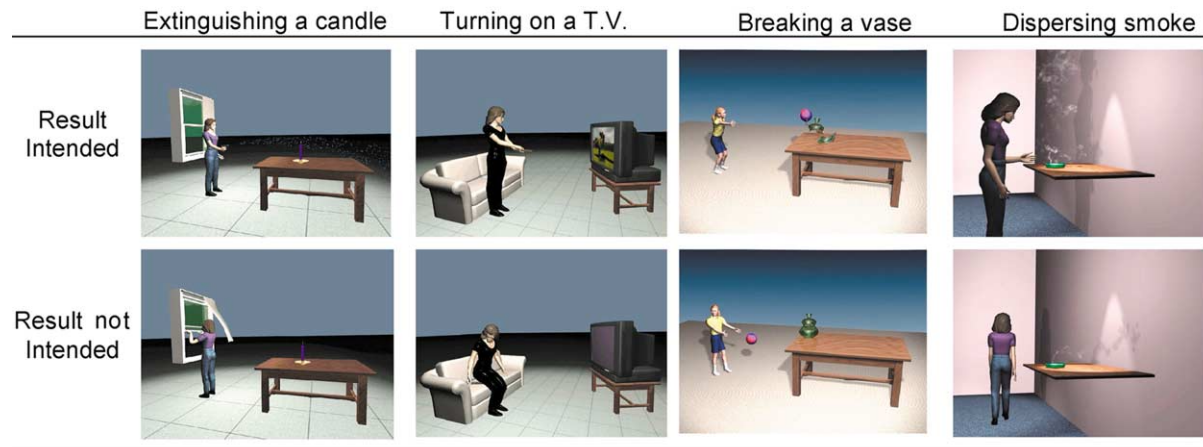


Fig. 7. Three of the 12 pairs of animations used in Experiments 3 and 4 in which a sentient causer either intentionally or unintentionally affected an entity via an intermediary.

Table 3
List of 12 pairs of animations with associated sentences used in Experiment 3

| Pair | Intended | Non-intended | Result | Lexical and periphrastic causatives |
|------|--|---|-------------------------------|---|
| 1 | A girl throws a ball directly at vase. | A ball bounces off a girl's foot. | The vase breaks. | The girl broke the vase. The girl caused the vase to break. |
| 2 | A girl jabs a balloon with pencil. | A girl stands up; the balloon she is holding touches a hot ceiling light. | The balloon pops. | The girl popped the balloon. The girl caused the balloon to pop. |
| 3 | A man places a plate of butter on a burner. | A man places a plate of butter next to a burner. | The butter melts. | The man melted the butter. The man caused the butter to melt. |
| 4 | A man brings a playing card down against a house of cards. | A man places a playing card on top of a house of cards. | The house of cards collapses. | The woman collapsed the house of cards. The woman caused the house of cards to collapse. |
| 5 | A woman pushes a light dimmer down. | A woman pushes a toaster switch down. | The lights in the room dim. | The woman dimmed the lights. The woman caused the lights to dim. |
| 6 | A woman sprays a lit candle with a water gun. | A woman opens a window in a room with a lit candle. | The candle extinguishes. | The woman extinguished the flame. The woman caused the flame to extinguish. |
| 7 | A man lights a match and brings it to a piece of paper. | A man tosses a piece of paper up against a heater. | The paper catches on fire. | The man burned the piece of paper. The man caused the piece of paper to burn. |
| 8 | A man uses a cue stick to hit a white ball into a red ball. | A man uses a cue stick to bounce a white ball against the bumper into the red ball. | The red ball moves. | The man moved the red ball. The man caused the red ball to move. |
| 9 | A woman waves her hand towards smoke rising from an ashtray. | A woman walks past smoke rising from an ashtray. | The smoke disperses. | The woman dispersed the smoke. The woman caused the smoke to disperse. |
| 10 | A woman presses a remote control. | A woman sits down on a remote control. | The TV turns on. | The woman turned on the TV. The woman caused the TV to turn on. |
| 11 | A man moves a 6-foot flagpole back and forth. | A man raises a 6-foot flagpole over a wall; the wind is blowing. | The flag waves. | The man waved the flag. The man caused the flag to wave. |
| 12 | A woman strikes a window with a stick. | A woman pulls out a stick supporting a window; the window falls. | The window cracks. | The woman cracked the window. The woman caused the window to crack. |

animations were kept as similar as possible in terms of objects in the scene, camera angle, length, and most importantly, in terms of the end result, which was always exactly the same. The animations varied from 41 to 461 frames, with an average length of 170 frames, and were played at roughly 32 frames/second.

4.1.3. Procedure

Participants performed one of three tasks: choose a linguistic description, make an event judgment, or make a causer-intermediary relationship judgment. In each task, all 12 pairs of animations were presented, in random order, on windows-based computers. In the linguistic description task, participants selected from a lexical causative description, a periphrastic causative description, or neither. The periphrastic causatives used the verb *cause* as the matrix verb along with the same result verb used in the lexical causative sentence. Within each pair of sentences, the causer and the causee were the same, e.g. *The girl popped the balloon* vs. *The girl caused the balloon to pop*. The specific lexical and periphrastic causative sentences used are listed in Table 3 in the rightmost column. Participants recorded their responses by clicking a radio button next to one of the choices. Progress through the animations was self-paced, and participants were allowed to repeat animations.

Participants making event judgments were shown each animation and asked whether the animation depicted a single event, e.g. “Yes or No: This animation showed a single event”. Participants recorded their responses by clicking a radio button next to the words “Yes” or “No” shown below the statement above. Progress through the animations was self-paced, and participants were allowed to repeat animations.

Participants judging causer-intermediary relationships made, in fact, four kinds of judgments. They made two kinds of forward relationship judgments, specifically (1) whether the initial causer *caused* the intermediary to produce the result (e.g. “Yes or No: The woman caused the remote control to turn on the TV”) and (2) whether the initial causer *enabled* the intermediary to produce the result (e.g. “Yes or No: The woman enabled the remote control to turn on the TV”). Participants also made two kinds of backward relationship judgments, specifically (1) whether the intermediary *caused* the initial causer to produce the result (e.g. “The remote control caused the woman to turn on the TV”) and (2) whether the intermediary *enabled* the initial causer to produce the effect (e.g. “Yes or No: The remote control enabled the woman to turn on the TV”). These four kinds of relationships were asked for each animation. Thus, the total number of judgments made, given two directions, two kinds of relations, and 24 animations, was 96. Because asking any one participant to make this many judgments would have been especially taxing, participants were asked to make only 24 of the possible 96 judgments. This was achieved by showing each participant only six of the 12 possible pairs of animations (pairs 1–6 or 7–12 in Table 2) and only half of the possible judgments that could be made for those six possible pairs. Thus, completion of all 96 judgments was achieved by counterbalancing across subjects two sets of animation pairs (1–6 or 7–12), the direction of the relationship (forward or backward) and the kind of relationship (cause or enable).

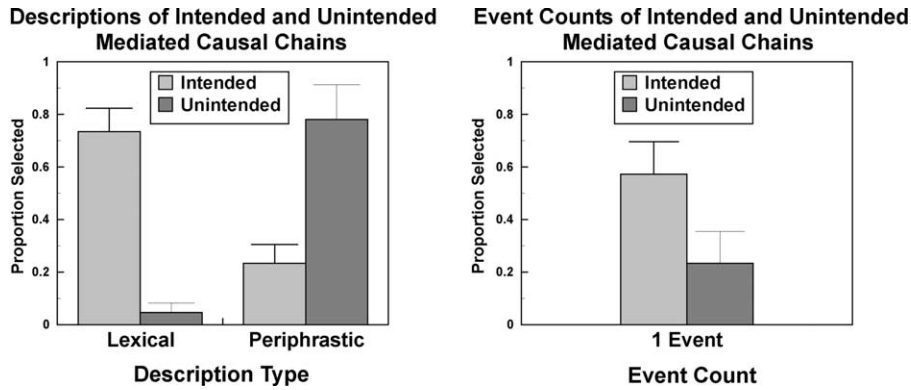


Fig. 8. Proportion of lexical and periphrastic causative sentences chosen (left) and proportion of single-event judgments (right) for intended and unintended causal chains with associated 95% confidence intervals in Experiment 3.

4.2. Results and discussion

The results – as shown in Fig. 8 – provided further support for the no-intervening-cause hypothesis. As predicted, participants were more willing to describe mediated chains with lexical causatives when the chains were intended than when they were unintended. In addition, as predicted by the no-intervening-cause hypothesis, participants were more

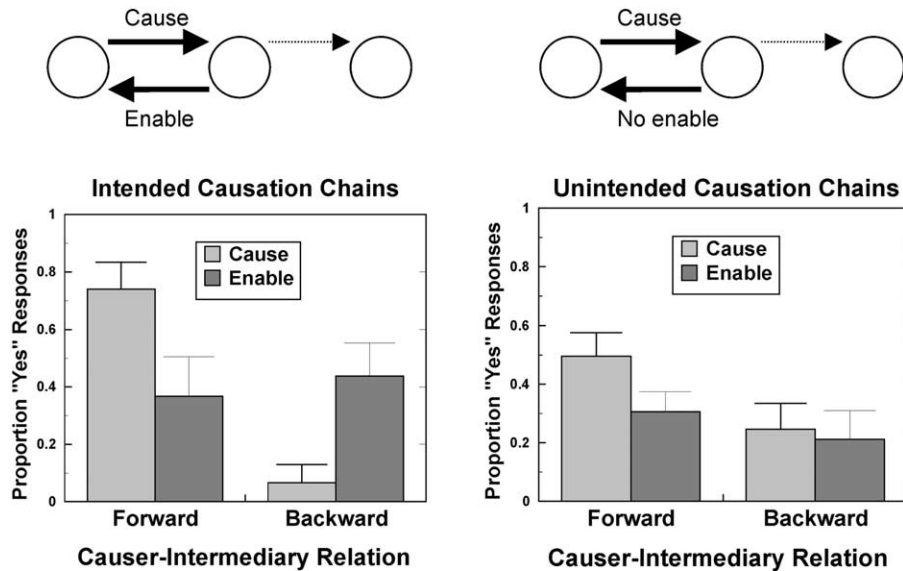


Fig. 9. Proportion of cause- and enable-relations between the causer and the intermediate entity in forward and backward directions for intended and unintended causal chains with associated 95% confidence intervals in Experiment 3. The predicted relations for intended and unintended causal chains are depicted above the graphs.

willing to say that a single event occurred for chains that were intended than for chains that were unintended. Importantly, as shown in Fig. 9 (specifically, compare backward relations in both panels), participants were much more willing to construe the intermediary as an enabling condition for intended chains than for unintended chains, as predicted by the no-intervening-cause criterion.

4.2.1. Description choices

As predicted, intended mediated causal chains ($M = 0.73$, $SD = 0.170$) were described by lexical causatives more frequently than unintended mediated chains ($M = 0.04$, $SD = 0.061$) ($F_p(1, 15) = 232.08$, $P < 0.001$; $F_i(1, 11) = 79.81$, $P < 0.001$). (See left panel of Fig. 8.) It is important to note that participants' overall tendency to avoid using lexical causatives to describe unintended mediated chains cannot be attributed to their not perceiving a causal relationship between the initial causer and causee. As shown in the left panel of Fig. 8, participants were quite willing to describe such relationships with periphrastic causatives ($M = 0.70$, $SD = 0.224$).

4.2.2. Event judgments

As shown in the right panel of Fig. 8, event judgments mirrored linguistic descriptions. Participants were more willing to say a single event occurred for sequences that were intended ($M = 0.57$, $SD = 0.231$) than for sequences that were not intended ($M = 0.234$, $SD = 0.224$) ($F_p(1, 15) = 43.65$, $P < 0.001$; $F_i(1, 11) = 31.51$, $P < 0.01$).

4.2.3. Causer-intermediary relationships

As shown in Fig. 9, causer-intermediary relationships were as predicted by the no-intervening-cause criterion. The graphs in Fig. 9 show the proportion of times people reported cause- and enable-relationships between the causer and the intermediate entity in forward and backward directions for intended and unintended causal chains.

As the graphs in Fig. 9 show, people viewed the forward relation from the initial causer to the intermediary as more causing than enabling. This was indicated by the fact that people more frequently said that the initial causer *caused* the intermediary to produce an effect than that the initial causer *enabled* the intermediary to produce the effect. The preference for cause relations over enable relations held for both intended and unintended causal chains.

The key question is how people viewed the backward relation going from the intermediary to the initial cause. As the graphs in Fig. 9 show, in the case of intended sequences, people tended to view the intermediary as enabling rather than causing the initial causer to produce the final result. In contrast, in the case of unintended sequences, the intermediary was viewed as causing the initial causer to produce the final result just as often as it was viewed as enabling. This pattern was supported by a significant three-way interaction between intention (intended vs. unintended) \times direction (forward vs. backward) \times relation type (cause vs. enable) ($F_s(1, 23) = 21.85$, $P < 0.001$; $F_i(1, 11) = 18.53$, $P < 0.01$).

Another interesting result is that people were more likely to say that the intermediary caused the initial causer to produce the result for unintended chains than intended chains ($t_p(23) = 5.79$, $P < 0.001$; $t_i(11) = 3.30$, $P < 0.01$). This effect implies that when the

result was unintended, people were not only less likely to view the intermediary as an enabler, but also more likely to view it as a causer. To the extent that the intermediary is viewed as a causer, the chain should be viewed as indirect, as was implied by people's linguistic descriptions and event judgments.

ANOVA revealed several other effects. First, there was an effect of intention: people were more likely to say that there was a relationship, either cause or enable, between entities in either direction for intentional causal chains than for unintentional causal chains ($F_p(1, 23) = 43.55$, $P < 0.001$; $F_i(1, 11) = 6.97$, $P < 0.05$). Second, people were more likely to say that there was a relationship, either cause or enable, for the forward direction than for the backward direction ($F_p(1, 23) = 74.65$, $P < 0.001$; $F_i(1, 11) = 36.04$, $P < 0.001$). Third, there was a significant interaction of direction and type of relation: people were more likely to choose a cause than an enable relationship in the forward direction than in the backward direction ($F_p(1, 23) = 6.72$, $P < 0.001$; $F_i(1, 11) = 16.96$, $P < 0.01$). Finally, as discussed above, there was a significant three-way interaction of intention, direction and type of relation. No other effects or interactions were significant across both participants and items.

In sum, participants were far more likely to view an intermediary as an enabler in intended chains than in unintended chains. According to the no-intervening-cause hypothesis, when the intermediary is viewed as an enabler, the causal chain can be described with a single-clause expression and construed as a single event. The results from the current experiment were consistent with these predictions. The results from the current experiment were also consistent with those found in Experiment 2. In Experiment 2, participants were more willing to describe mediated causal chains with lexical causatives when they were initiated by a sentient causer than a non-sentient causer. The results from the current experiment suggest that the effect of sentence in Experiment 2 was not simply due to the presence or absence of a sentient causer. If the presence of a sentient causer was all that was needed, people should have been as willing to use lexical causatives for unintended chains as they were for intended chains in the current experiment, but they were not. As noted above, the presence of the sentient causer does not necessarily imply intention; it only increases the likelihood that a result can be construed as intended. This may explain why the effect of sentence in Experiment 2 was rather modest. In the current experiment, not only were the intended chains initiated by sentient causers, but the sentient causers did something that clearly indicated that what they were doing was indeed intentional.

While differences in intention resulted in differences in linguistic description and event construal, it is not intention per se that is predicted to determine whether a causal chain is conceptualized as direct. The problem with intention is that while it may be necessary for the perception of direct causation in the case of mediated causal chains, it clearly is not sufficient. Causal chains that are intended are not necessarily direct. This point was made, in effect, by Shibatani (1973) when he characterized certain types of periphrastic causatives as denoting "directive causation", that is, causation in which a sentient entity tells another what to do. Consider, for example, the periphrastic causative sentence in (4a), which implies an intended causal chain. Even though the result is intended, the same situation cannot be expressed using a lexical causative, as in (4b). If intention was all that was needed to use a single-clause expression to express a

mediated causal chain, the sentence in (4b) should have been compatible with the meaning of the sentence in (4a), but it is not.

- (4)
 - a. The mother had the children walk the dog.
 - b. The mother walked the dog.
 - c. The children enabled the mother to walk the dog.

According to the no-intervening-cause criterion, the reason why the sentence in (4b) cannot have the meaning of the sentence in (4a) is that the intermediaries do not in fact act as enabling conditions for the cause, as indicated by the oddness of the sentence in (4c). Thus, while intention may often allow an intermediary to be viewed as an enabler, it doesn't guarantee that it will, and unless the intermediary is viewed as an enabler, a single-clause description of the situation will be unavailable. It is important to note that the oddness of the sentence in (4b) is not simply due to the fact that the intermediary in this particular causal chain is sentient. As noted by several investigators (Goldberg, 1995; Rappaport Hovav & Levin, 1999; Shibatani, 1973), single-clause expressions can be used to describe causal chains involving sentient intermediaries, as in (5).

- (5)
 - a. The Nelsons had the realtor sell their home.
 - b. The Nelsons sold their home.
 - c. The invalid owner had the trainer run his favorite horse in the race.
 - d. The invalid owner ran his favorite horse.¹² (Goldberg, 1995, p. 169)

Notice, however, that in contrast to (4c), in the scenarios described in the sentences in (5), the intermediaries can be construed as enabling conditions, as implied in (6).

- (6)
 - a. The realtor enabled the Nelsons to sell their home.
 - b. The trainer enabled the invalid owner to run his horse in the race.

While the results from Experiment 3 support one of the main claims of the no-intervening-cause criterion – that mediated chains can be construed as direct if the intermediaries can be construed as enabling conditions – they are also consistent with a somewhat less interesting possibility. Rather than being based on the general notion of enablement, there is the possibility that the results might be tied to just the verb *enable* itself. Many discussions of enabling conditions do, in fact, use the verb *enable* (e.g. Cheng & Novick, 1991, 1992). However, another verb that is sometimes used to capture this general notion is *allow* (e.g. Goldvarg & Johnson-Laird, 2001). In the next experiment we tested whether

¹² This sentence was used in Goldberg (1995) and Rappaport Hovav and Levin (1999) to illustrate how mediated causal chains can be expressed with lexical causatives when the chains describe conventional scenarios (see also Shibatani, 1973). An alternative explanation, as expressed above, is that this expression can be encoded with a lexical causative because the intermediaries can be viewed as enabling conditions.

the results would replicate in a causer-intermediary relationship judgment task with this new verb. If the results were based on a more general concept of enablement (e.g. as defined by force dynamics) rather than just on the particular verb *enable*, the same set of findings should be found with a different verb.

5. Experiment 4: relation judgments using the verbs *cause* and *allow*

The purpose of this experiment was to test the generality of the causer-intermediary relationships found in Experiment 3. If such judgments are based on a general concept, it should be possible to replicate them with a different but related verb. In this experiment we used the same materials and procedures for the judgment of relations as used in Experiment 3. However, in this experiment we replaced the verb *enable* with the verb *allow*.

5.1. Method

5.1.1. Participants

Sixteen University of Memphis undergraduates participated in the experiment.

5.1.2. Materials

The materials were the same as in Experiment 3.

5.1.3. Procedure

The task involved making causer-intermediary relationship judgments as in Experiment 3. Participants made two kinds of forward relation judgments: whether or not the initial causer caused the intermediary to produce the result and whether or not the initial causer allowed the intermediary to produce the result. Participants also made two kinds of backward relation judgments: whether or not the intermediary caused the initial causer to

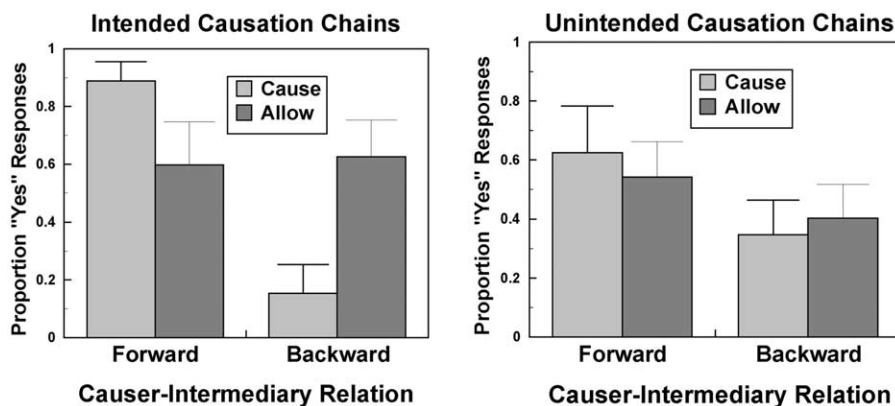


Fig. 10. Proportion of cause- and allow-relations between the causer and the intermediate entity in forward and reversed directions for intended and unintended causal chains with associated 95% confidence intervals in Experiment 4.

produce the result and whether or not the intermediary allowed the initial causer to produce the result. As in Experiment 3, participants only saw six of the 12 possible pairs of animations and the direction of the relationship (forward vs. backward) and the kind of relationship (cause vs. allow) were counterbalanced across participants.

5.2. Results

The results – as shown in Fig. 10 – provided further support for the no-intervening-cause criterion. The graphs in Fig. 10 show the proportion of times people reported cause- and allow-relations between the causer and the intermediate entity in forward and backward directions for intended and unintended causal chains. As predicted, participants were more willing to describe intermediaries as enabling conditions – based on the verb *allow* – when the causal chain was intended than when it was unintended (compare backward relations in both panels).

As the graphs in Fig. 10 show, in the case of intended sequences, people viewed the intermediary as *allowing* the initial causer much more than *causing* the initial causer to produce the final effect. In contrast, in the case of unintended sequences, people were no more likely to view the intermediary as allowing the causer than causing it to produce a result. This pattern was supported by a significant three-way interaction of intention (intended vs. unintended) \times direction (forward vs. backward) \times relation type (cause vs. allow) ($F_p(1, 23) = 35.53, P < 0.001$; $F_i(1, 11) = 7.96, P < 0.05$).

Another interesting effect is that people were more likely to say that the intermediary caused the initial causer to produce the effect for unintended chains than for intended chains ($t_p(23) = 3.076, P < 0.01$; $t_i(11) = 2.56, P < 0.05$). This effect implies that when the result was unintended, people not only were less likely to view the intermediary as an enabler, but also more likely to view it as a causer.

ANOVA revealed several other effects. First, there was an effect of intention: people were more likely to choose cause and allow relations for intentional causal chains than for unintentional causal chains ($F_p(1, 23) = 5.5, P < 0.05$; $F_i(1, 11) = 4.93, P < 0.05$). Second, there was an effect of direction: people were more likely to use the verbs *cause* and *allow* in the forward direction than in the backward direction ($F_p(1, 23) = 31.18, P < 0.001$; $F_i(1, 11) = 48.10, P < 0.001$). Third, there was a significant interaction of direction and relation: people were more likely to confirm cause and allow relations in the forward direction than in the backward direction ($F_p(1, 23) = 28.31, P < 0.001$; $F_i(1, 11) = 22.74, P < 0.01$). Finally, as discussed above, there was a significant three-way interaction of intention, direction and relation. No other effects or interactions were significant across both participants and items.

One way in which the results from the current experiment differ from those in Experiment 3 is that the overall level of responding is higher in this experiment. There is no clear reason why this occurred, other than the experiment was based on a different set of participants. Another way in which the results from the current experiment differ from those in Experiment 3 is that people reported more cause- than allow-relations in the forward direction only in the case of intended causal chains. As can be seen in Fig. 10, there was a tendency to use *cause* more than *allow* in the case of unintended chains, but this difference was not significant.

6. General discussion

This research proposed and investigated a new theory of direct causation drawing on work from force dynamics. According to the no-intervening-cause criterion, direct causation is present when there are no intervening causers between the initial cause and the final causee. The results from Experiments 1–4 indicate that this way of understanding direct causation accurately predicts how causal chains will be described linguistically and construed in terms of events. In Experiments 1 and 2, causal chains in which the causer and causee made physical contact – and hence were unmediated – were more likely to be described with lexical causatives and described as single events than mediated chains. In Experiment 2, people were more willing to describe mediated chains with lexical causatives and construe them as single events when the chain was initiated by a sentient (rather than a non-sentient) causer. Experiment 3 showed that the effect of sentence was tied to intention: chains were more likely to be described with lexical causatives and construed as single events when the sentient causer intended the effect to the final causee than when the sentient causer did not intend the effect. According to the no-intervening-cause hypothesis, the reason why intention is important is that it establishes a tendency in the causer that can be assisted by an intermediary. This allows the intermediary to be construed as an enabling condition rather than an intervening cause. Experiment 4 indicated that the notion of an enabling condition was associated with a concept that is broader than the meaning of the verb *enable* itself, since the same causer-intermediary relationships found in Experiment 3 with the verb *enable* were also found with the verb *allow*.

6.1. Generalizability of the phenomenon

The results from Experiments 1–4 demonstrate how direct causation, as defined by the no-intervening-cause criterion, underlies the difference in meaning between lexical and periphrastic causatives. However, the no-intervening-cause hypothesis was formulated to cover single-clause and multi-clause expressions of causation in general. Thus, in addition to lexical causatives, it is suggested that the concept of direct causation will restrict the meanings of several other kinds of linguistic constructions. One type of construction that is predicted to be restricted by the notion of direct causation is the resultative construction (Bowerman, 1982; Goldberg, 1995; Jackendoff, 1997; Levin & Rappaport Hovav, 1995; Rappaport Hovav & Levin, 1999; Simpson, 1983). The resultative construction 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 postverbal NP. There are several subtypes of resultative constructions (see Rappaport Hovav & Levin, 1999). Here we focus on those in which the main verb is followed by an NP and an XP (an adjective or prepositional phrase indicating a new state or location) since such resultatives receive a causative analysis (Rappaport Hovav & Levin, 1999), as shown in (7).¹³

¹³ Resultatives without a postverbal NP (e.g. *The gate swung shut*; *The pond froze solid*) do not appear to receive a causative analysis (Rappaport Hovav & Levin, 1999; Van Valin & LaPolla, 1997; but see Croft, 1991; Foley & Van Valin, 1984).

- (7) a. Pat wiped the table clean. (Rappaport Hovav & Levin, 1999, p. 7, (4))
 b. Frank sneezed the tissue off the table. (Goldberg, 1995, p. 152, (2))

According to Rappaport Hovav and Levin (1999), resultatives with postverbal NPs have the same underlying event structures as do lexical causatives and also share with lexical causatives the requirement that the underlying causation be direct (see also Goldberg, 1995).

Another way in which causal chains can be described is with causal conjunctions like *because*, *so* and *since* (Brennenstuhl & Wachowicz, 1976; Halliday & Hasan, 1976; Lagerwerf, 1998; Millis, Graesser, & Haberlandt, 1993; Pander Maat & Sanders, 2000; Sanders & Noordman, 2000; Sanders, Spooren, & Noordman, 1992, 1993; Sweetser, 1990). Examples of causal conjunctions are shown in (8).

- (8) a. They didn't want him because he was so outspoken.
 b. There's a hole in the screen door because I tripped over the cat.
 c. He left early so he could coach soccer that night.
 d. The decision affects lots of kids since most don't live within the city limits.

According to Brennenstuhl and Wachowicz (1976) (see also Comrie, 1981; DeLancey, 1983, 1984) causal connectives, like periphrastic causatives, are compatible with indirect causation. These intuitions are consistent with that predicted by the no-intervening cause hypothesis. According to the no-intervening-cause hypothesis, when a causal chain is not direct, it cannot be encoded by a single-clause sentence; rather, it must be encoded by a multi-clause expression. Expressions using causal connectives are often multi-clausal. Hence, they are able to encode causal chains that are not direct. Note, as discussed in the Introduction (Section 1), the no-intervening-cause hypothesis does not hold that multi-clause expressions are strictly limited to indirect causation. Rather multi-clause expressions can be used to express either direct or indirect causation while single-clause expressions are limited to direct causation. It is in this sense that single-clause expressions can be used to express a subset of the causal chains that can be expressed by multi-clause expressions. However, given pragmatic principles, it is expected that when people do use a multi-clausal expression, the underlying causation is most likely indirect. Another way in which a causal chain can be expressed across multiple clauses includes lexicalized connectives like *as a result*, *that's why* and *on the grounds that*, among others (Pander Maat & Sanders, 2000). As with causal conjunctions, these ways of encoding causal relations are likely to be associated with indirect causation since, like causal connectives, they are used in expressions involving more than one clause. In addition, it is predicted, per the no-intervening-cause hypothesis, that these multi-clause approaches to encoding causation will, when the underlying causation is indirect, imply situations that cannot be construed as a single event.

6.2. Linguistic coding of psychological interactions and abstract entities

The results from Experiments 1–4 provide support for the no-intervening-cause hypoth-

esis in the case of causal chains involving physical interactions between well individuated, tangible entities. Of course, this focus leaves out a host of examples that involve non-physical changes and abstract entities. While such causal chains were not directly addressed in the experiments, it is expected that the linguistic coding of such causal chains should still be guided by the no-intervening-cause hypothesis. Consider the sentences in (9).¹⁴

- (9) a. Sam taught Bill French.
- b. Margaret irritated Jane (by cracking her knuckles).

According to the no-intervening-cause hypothesis, these psychological interactions qualify for a single-clause expression because they do not obviously involve the participation of an intervening cause. For example, in the first sentence, *Sam taught Bill French*, while the chain of events leading from Sam's activities to Bill's might be relatively long, there is no intermediate entity that obviously suggests itself as a potential intervener. Note that if Sam had directed someone else to teach Bill French, the sentence *Sam taught Bill French* would not be appropriate. Rather, we would say *Sam had someone teach Bill French*, that is, we would use a two-clause expression. The same line of reasoning applies to the sentence in (9b). In (9b), the effects of Margaret's actions are not necessarily intended, but they do not need to be given that there are no obvious causal interveners between Margaret's actions and Jane's psychological reaction, as specified by the no-intervening-cause hypothesis.

According to the no-intervening-cause criterion, intervening causers must be at the same overall level of granularity as that suggested by the initial causer and the final causee. Without a granularity restriction, even the most direct interactions between two physical entities could be construed as indirect if viewed at a sufficiently fine level of granularity (e.g. muscle movements, neural impulses, atoms). This granularity restriction helps explain why certain complex chains of events can be described by single-clause descriptions even when they may not be intended. Consider the sentences listed in (10).

- (10) a. William the Conqueror changed the English language
 (by occupying England in 1066).
- b. Prince Charles is destroying the monarchy (with his undignified behavior).
- c. The eclipse stopped the concert.
- d. The stock market crash destroyed Sam's life

In all of the sentences in (10), the causer and causee denote an entire collection of events, activities and/or states. In order for there to be an intermediary between the causer and causee, it must be at the same level of abstractness as the causer and/or causee, as well

¹⁴ I thank an anonymous reviewer for many of the sentences listed in (9) and (10).

as separable from these two entities. For all of the sentences in (10), such an intermediary is hard to imagine. For example, in the sentence in (10a), William the Conqueror refers to a very large set of events: the battle of Hastings, the march on London, the crowning at Westminster, the Dane rebellion, among other events. Further, in saying that all of these events changed the English language, what is referred to are the myriad interactions between people in which the new overlords of the government, church and courts used a dialect of Old French that brought in an infusion of Romance words. Clearly, the sentence in (10a) involved a long chain of interactions. Importantly, however, there are no obvious intervening entities at the same level of abstractness as that associated with William the Conqueror or changes in the English language. Thus, while composed of many small events, such events are conceptualized as simply composed of two parts, a causer and causee, each standing in for a set of related events, which qualifies them for direct causation, as specified by the no-intervening-cause criterion.

6.3. *Alternative approaches to the notion of direct causation*

In the Introduction (Section 1), I made brief reference to several of the ways in which direct causation has been defined. Here, I explain in slightly more detail how some of the most prominent of these accounts relate to the no-intervening-cause criterion.

6.3.1. *Direct causation and subjecthood*

One approach to direct causation has been to associate it with the conditions that allow an entity to appear as the subject of a simple single-clause sentence. At least two major conceptual criteria have been associated with the subject of a single-clause sentence. One of these is that the subject of such a sentence is often the *ultimate cause* of the causal chain being described. An ultimate cause is the entity that initiates a sequence of events that ends in a particular result; it is the initial node in a causal chain (Croft, 1991; DeLancey, 1984). According to DeLancey (1984), an “ultimate cause can only be an act of volition on the part of a (thus defined) prototypical agent”. It is understandable, then, from this perspective, why so many sentences should begin with animate entities (Corrigan, 1986; Dowty, 1991; Fillmore, 1968, 1977; Hopper & Thompson, 1980; Slobin, 1981; Slobin & Bever, 1982), and if not animate entities, natural forces (e.g. lightning, wind; see DeLancey, 1984, 1985), and why in so many languages (unlike in English), inanimate instruments cannot serve as subjects (e.g. DeLancey, 1991; Van Valin & Lapolla, 1997). While the notion of ultimate cause may explain some of the general patterns we see in the selection of sentential subjects, the notion does not accurately characterize the concept of directness of causation. The key reason why ultimate causation does not help explain the notion of direct causation is that ultimate causers readily serve as subjects for multiple-clause sentences expressing indirect causation (e.g. *The sergeant had them crawl through the mud*), as demonstrated in Experiments 2 and 3: people were quite willing to describe causal chains initiated by sentient entities with both lexical and periphrastic causatives.

It has also been suggested that when the subject is not the ultimate cause of a causal chain, it must be the *proximate* (or penultimate) cause of the causal chain in order for it to be the subject of a sentence (Schlesinger, 1989; Talmy, 1976). While being a proximate cause generally licenses an entity to be the subject of a sentence, not all subjects are

proximate causes. As discussed above, there is no clear way in which non-proximate causes can be differentiated with respect to whether they can appear as the subject of a single-clause sentence. We might be tempted to suggest that direct causation is present when an entity can be construed as both an ultimate and a proximate cause. One problem with conjoining these two notions is that it would limit the set of entities that can appear as subjects to those that are proximate causes. But, again, the set of entities that can appear as the subject of a single-clause sentence is clearly larger than the set of entities that are proximate causes. In sum, while the notions of ultimate and proximate cause might help characterize many of the entities that can appear as sentential subjects, they cannot replace the concept of direct causation.

6.3.2. *Direct causation and mediacy*

Several researchers have distinguished the notions of direct and indirect causation in terms of mediacy (Comrie, 1985; Croft, 1991; Cruse, 1972; DeLancey, 1983, 1984; Goldberg, 1995; Kemmer & Verhagen, 1994; Rappaport Hovav & Levin, 1999; Verhagen & Kemmer, 1997). Specifically, a causal chain is direct if there exists no intermediary between the cause and the causee. However, as discussed above, single-clause descriptions can be used to describe certain kinds of mediated chains, suggesting that certain kinds of mediated chains can be construed as direct (DeLancey, 1983, 1984; Goldberg, 1995; Rappaport Hovav & Levin, 1999). For example, causal chains involving instruments (e.g. hammers, drills, remote controls) constitute mediated causal chains. Nevertheless, such causal chains are readily described with simple single-clause expressions across languages (DeLancey, 1984; Schlesinger, 1989). To make the notion of mediacy more useful, researchers have proposed restrictions on precisely what kinds of intermediaries can disrupt a causal chain. According to some, a causal chain is indirect if an intermediary can be recognized as “some other force besides the initiator” (Verhagen and Kemmer, 1997, p. 67; see also Kemmer & Verhagen, 1994; Verhagen, 1998). One potential problem with this criterion is that causal chains containing intermediaries with their own independent force are not necessarily indirect. As demonstrated in Experiment 3, causal chains containing remote controls, lit matches, and gas burners were readily described with lexical causatives, yet such intermediaries would appear to have independent forces.

Another proposal for identifying particular intermediaries is suggested by Cruse (1972). Specifically, a causal chain is counted as unmediated if no *agent* intervenes between the causer and the causee of the causal chain. Cruse’s proposal is very similar to that of the no-intervening-cause criterion, depending on how the notion of agent is defined. A precise definition of the concept of agent has been, of course, very difficult to specify (e.g. DeLancey, 1984; Dowty, 1991; see also Clark & Carpenter, 1989). Several researchers have, in fact, suggested that causal chains are made indirect via the presence of an intervening cause, though mostly in passing (e.g. Croft, 1991; DeLancey, 1984; Goldberg, 1995). Thus, in some ways, the no-intervening-cause criterion resembles several earlier proposals made in the literature. Perhaps the key way in which the no-intervening-cause criterion differs from these earlier proposals is that it offers a precise characterization of the relationship between the initial causer and intermediary that is based in turn on an observable distinction between the notions of CAUSE and ENABLE (Wolff & Song, in press).

6.4. *Causation and events: revisiting Davidson's hypothesis about the individuation of events*

Another proposal for distinguishing direct and indirect causation has recently been made by Rappaport Hovav and Levin (1999). They argue that the relationship between the causer and causee is construed as direct if there are no intervening events in the causal chain between the causing subevent and the result subevent. The proposal nicely predicts that proximal causes should be construed as direct: when the cause is proximate, no events can occur between the causing event and the resulting event. The proposal also allows for the possibility of temporal gaps between the causing and result events, provided there is no intervening event. The strength of this proposal depends, however, on how the notion of an event is defined and how well this definition captures how we isolate events in a stream of experience – the individuation of events.

One prominent way in which events might be individuated is on the basis of change, that is, in terms of the occurrence of a transition in space or state (Baldwin, Baird, Saylor, & Clark, 2001; Cleland, 1991; Gibson & Spelke, 1983; Johansson, 1978; Lombard, 1986; Rosch, 1978; Sharon & Wynn, 1998; Taylor, 1985; Wynn, 1996). The notion of change as a criterion for the individuation of events has much intuitive appeal: occurrences involving distinct changes are easy to imagine (e.g. “the shattering of a window”, “the breaking of a stick”, “the falling of a plate”), and all such occurrences seem to qualify as events. However, if events are individuated on the basis of change, Rappaport Hovav and Levin's proposal seems to make the wrong predictions. For example, several of the causal chains shown in Experiment 3 contained intermediary events involving distinct changes (e.g. pressing the trigger of a squirt gun and water traveling from a squirt gun to a lit candle). Nevertheless, participants described these chains with lexical causatives rather than periphrastic causatives. If events were individuated on the basis of change, participants should have viewed the whole causal chain as including an intervening event and so should have preferred periphrastic causatives.

Of course, change might not be the only way in which events are individuated. An additional possibility is that events are individuated on the basis of direct causation.¹⁵ Such a proposal was, in fact, argued for by Davidson (1969/2001) in his test for event identity: “[e]vents are identical if and only if they have exactly the same causes and effects” (p. 179) (see also Croft, 1991). Individuating events in terms of direct causes and effects allows for the individuation of events that consist of mediated causal chains. Further, such a proposal is supported by the results in Experiment 3. People reported the occurrence of a single event far more often when the chain was composed of only one cause (plus an enabler) than when the chain was composed of two causes (i.e. when the intermediary could only be described as a cause rather than an enabling condition).

The Rappaport Hovav and Levin (1999) proposal and that of the no-intervening-cause

¹⁵ A related proposal is that events might be individuated on the basis of goal structures and intentions (e.g. Woodward & Sommerville, 2000; Zacks & Tversky, 2001; Zacks, Tversky, & Iyer, 2001). However, as discussed above, intention per se does not guarantee that a causal chain will be construed as instantiating direct causation, hence intention does not guarantee that the chain can be construed as a single event (see Shibatani, 1973). I suggest, then, that the notion of direct causation may be a more accurate criterion for the individuation of events than intention.

criterion could be very similar if, in Rappaport Hovav and Levin's proposal, events are individuated in terms of causation. Indeed, they might be viewed as variants of each other given that causal relations can often be described in terms of either relations between objects or events (Croft, 1990). Intuitively, when a causal chain involves interactions between relatively concrete, physical entities, it often seems more useful to think about causality in terms of objects. However, when a causal chain involves relatively abstract entities, it may be more natural to think about causality in terms of relations between events.

Individuating events in terms of causation does, however, raise a potential problem. As noted above, causal relations may be thought of as composed of events themselves (the causing and resulting subevents). Of course, the process of event individuation never ends if the subevents of causal relations must be themselves individuated by still other causal relations (Avrahami & Kareev, 1994; Quine, 1985). The recursion ends, however, if there is more than one way a causal relation can be individuated. A change criterion, for example, might be used for the individuation of relatively simple events, while causation is used for the individuation of relatively complex events. Another way in which the recursion might be arrested is if the notion of cause can be defined in such a way that it need not involve two underlying subevents. Such a definition is, in fact, suggested in the Talmy (1988) theory of force dynamics and in the related proposal made by Wolff and Zettergren (2002), in which causal relations are defined in terms of spatial relationships between force vectors. Thus, while Davidson's proposal has been criticized (e.g. Avrahami & Kareev, 1994; Lombard, 1986; Quine, 1985), it appears that the most important criticism – the recursion problem – can be overcome. As a consequence, an account based on causation may hold considerable promise for explaining how we unitize relatively large sections of temporal experience.

6.5. *The linguistic coding of accidents*

According to the no-intervening-cause hypothesis, intended outcomes allow intermediate entities to be viewed as enabling conditions, permitting the chain as a whole to be described by a single-clause expression. However, there are certain kinds of mediated chains that can be described by single-clause expressions even when their final outcomes are unintended, namely accidents. Consider the vase-breaking scenario used in Experiment 3 and depicted in Fig. 7. In the unintended version of this scenario, a girl unintentionally bounces a ball off her foot, and the ball hits a vase and breaks it. As predicted, participants overwhelmingly preferred to describe this scenario with a periphrastic causative ($M = 88\%$) than with a lexical causative ($M = 6\%$), suggesting that they construed the scenes as both causal and indirect. Intuitively, however, it seems that participants could have used a lexical causative if they had been asked, "Who broke the vase?" A natural answer to this would be "The girl did", that is, "The girl broke the vase". DeLancey (1985) describes a similar situation. Imagine a man using a hammer to nail something down when he inadvertently loses his grip, the hammer flies through the air and breaks a kitchen window. If someone were to ask what happened to the window, it would not be appropriate to say, "The hammer broke it". Rather, a more apt reply would be, "The man broke it

(accidentally)”. Despite the fact that the causal chain is mediated and unintended, the chain could be described with a lexical causative.

At first glance, accidents might seem to contradict the predictions made by the no-intervening-cause hypothesis. If all unintended outcomes counted as accidents, and if accidents could always be described with single-clause expressions, then any situation could be described with a single-clause expression regardless of whether it was intended or not. Hence, there is no point in emphasizing, as the no-intervening-cause hypothesis does, that an intentional causer affords the linguistic coding of mediated causal chains by a single-clause expression. Importantly, however, not all unintended acts are readily construed accidents.

Consider two more scenarios from Experiment 3 that depict unintended outcomes (see Table 3). In one, a woman walks past a smoking cigarette in an ashtray, and the breeze produced by her movement disperses the smoke. In another, a man places a dish of butter next to a burner that he does not realize is on. These scenarios, like the vase-breaking scenario, were judged by participants to be both causal and indirect. However, unlike the vase-breaking scenario, they are not readily classified as “accidents”. Moreover, for these unintended, but not accidental, causal chains, single-clause descriptions are not readily available. For example, it sounds odd to say, “The woman dispersed the smoke accidentally”, or “The man melted the butter accidentally”.

Interestingly, the key property that seems to distinguish accidents from other kinds of unintended events is intentionality. This is suggested, in part, by the fact that only events caused by sentient entities can be construed as accidental. For example, we cannot say “the branch accidentally fell on the house” because non-sentient entities cannot have intentions. Rather, what makes an outcome an accident seems to be the presence of preceding effects that were, in fact, intended. So, for example, in the vase-breaking scenario, a girl intentionally bounces a ball. When she loses control and the ball hits the vase, we can say, “The girl accidentally broke the vase”. In the hammer example discussed above, the man intentionally swings the hammer, but loses control and unintentionally breaks the window. In contrast, in the smoke-dispersing scenario, the woman does not intentionally create the breeze. Therefore, we cannot say she accidentally dispersed the smoke. In the butter-melting scenario, because the man does not intentionally place the butter close to a heat source (i.e. he is unaware that the burner is on), it sounds odd to say that he accidentally melted the butter.

In the case of accidents, because the intermediate events are intended, they can be construed, in an extended sense, as enabling conditions. In turn, such unintended outcomes can be described with single-clause expressions, though they are often distinguished from intended outcomes either by the discourse context or by the use of words or phrases such as *inadvertently*, *unintentionally*, *accidentally* or *by accident*. In contrast, when an intermediate event leading to an unintended outcome is unintended, the corresponding entity cannot be construed as an enabling condition and, hence, the chain as a whole cannot be readily described by a single-clause expression. Thus, while at first it might seem that accidents represent exceptions to the no-intervening-cause hypothesis, further analysis of these kinds of causal chains suggests that the linguistic coding of these chains is, in fact, consistent with the claims of the no-intervening-cause hypothesis.

6.6. *The encoding of direct and indirect causation across languages*

According to Comrie (1985), there are three basic ways in which languages around the world express causal situations, namely analytic, morphological, and lexical. Comrie's analytic category maps onto periphrastic causatives and causal connectives while his lexical category maps onto lexical causatives. Morphological causatives, the middle category, are causatives formed by adding a causative morpheme to a verbal stem. For example, in Turkish the verb for *die*, *öl*, can be causativized by adding the suffix *dür* to form the verb *kill*, *öl-dür* (= cause to die). Languages such as Japanese, Turkish, Hungarian, Finnish, Russian, and Swahili, among many others, make frequent use of morphological causatives (Ammon & Slobin, 1979; Brennenstuhl & Wachowicz, 1976; Comrie, 1981; Haspelmath, 1994; Shibatani, 1973; Van Valin & LaPolla, 1997). According to Comrie (1981), the three basic ways of describing causal situations form a continuum from analytic via morphological to lexical causation in which analytic causatives are associated with indirect causation and lexical causatives with direct causation. However, there is some evidence that languages may differ with respect to the degree of direct causation denoted by different points along the analytic-to-synthetic (lexical) continuum. For example, according to van Voorst (1996), English, French and Dutch systematically vary in the range of situations that can be referred to by a single-clause construction. Of the three languages, English is the least restrictive about what can be described by a single-clause description, followed by French, then Dutch. In Dutch, for example, the range of situations that can be referred to by a single-clause expression may be limited to those involving proximate causation, i.e. causation in which there are no intermediaries (van Voorst, 1996). Thus, while there is a general correlation between the directness of causation and the various linguistic structures that can be used to encode causation, the range of situations that may be referred to by any particular structure may vary across languages (Kemmer & Verhagen, 1994). Still to be determined is whether these differences in coding reflect differences in how the notions of direct and indirect causation are conceptualized or differences in how different linguistic constructions are constrained.

6.7. *Conclusions: possible words and possible concepts*

This research provides empirical evidence for the long held intuition that simple transitive expressions of causation differ systematically in meaning from more complex statements of causation. The basic difference in meaning is tied to the notion of direct causation, which can be defined in terms of the absence of an intervening cause between the initial cause and final causee. One issue associated with the concept of direct causation concerns whether it is a concept that is relevant only in the use of language, or whether it might have a broader role in cognition in general. The results suggest that in addition to constraining the use of two general categories of linguistic expressions, the notion of direct causation also plays a role in the individuation of events. Hence, the concept of direct causation seems to play a role in general cognition as a whole. This conclusion was reached by using a methodology that translated linguistic distinctions into measurable properties of the world. Such a methodology may help to make good on the long-standing goal of investigating language to reveal basic categories of the mind.

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Appendix A

A.1. Semantic and syntactic criteria for membership in the lexical causative class of verbs

A lexical causative verb is traditionally defined as a verb that encodes the notions of CAUSE and RESULT and thus allows speakers to describe a causal situation in a single clause. There are two main classes of lexical causative verbs: those that encode a change of state and those that encode a change of location in a particular manner (Bowerman, 1996; Jespersen, 1927; Levin & Rappaport Hovav, 1994; Pinker, 1989; Smith, 1970). Examples of these two classes of verbs are shown in (11a) and (11b), respectively (see Levin, 1993).

- (11) a. *awake, balance, bend, break, burn, capsize, change, chill, clog, close, collapse, crack, crumble, decompose, deflate, defrost, degrade, dissolve, divide, drain, enlarge, expand, explode, flood, fold, freeze, hush, ignite, melt, open, pop, rip, reproduce, rupture, scorch, shatter, shrink, sink, snap, split, tear, thaw, topple*
 b. *bounce, coil, drift, drop, float, glide, move, revolve, roll, rotate, slide, spin, swing, turn, twirl, twist, whirl, wind*

A potential third class of lexical causative verbs is represented by certain verbs of light and sound emission (e.g. *shine, beam, buzz, jingle, ring, rustle*) that have both transitive and intransitive variants (e.g. *The salesperson rang the bell/The bell rang*). Because such verbs participate in the causative alternation, they pass a conservative test for membership as a lexical causative. In addition, like other lexical causatives, they denote processes that result from a causer's externally directed actions (Levin & Rappaport Hovav, 1994). However, unlike the lexical causatives in (11), these verbs do not describe discrete two-state transitions.

Several semantic and syntactic criteria are used for determining whether a given verb can be counted as a lexical causative. First, most lexical causatives entail the occurrence of a change of state or location (Levin & Rappaport Hovav, 1991; Pinker, 1989; Shibatani,

1976; Song, 1996). It is this entailment that distinguishes lexical causatives from two-argument activities (Levin, 1993). Example two-argument activity verbs are shown in (12).

- (12) *bang, bump, belt, clobber, club, dust, flog, hammer, hit, jab, kick, knock, lick, nudge, pinch, poke, pound, pluck, push, pull, punch, prune, rub, scratch, slam, spank, shoot, shove, slug, stab, strap, strike, stroke, suck, sweep, swab, touch, wallop, wash, whack, wipe*

Two-argument activities, like lexical causatives, denote actions directed towards an entity. However, they differ from lexical causatives in that they do not strictly entail the occurrence of a change of state or location even though failure of such a result might be unlikely (Levin & Rappaport Hovav, 1994; Pinker, 1989; Shibatani, 1976; Song, 1996). This difference in semantics between the two classes of verbs is revealed when their (possible) results are explicitly denied as shown in (13) (taken from Shibatani, 1976).

- (13) a. *John *melted* the ice, but nothing happened to it.
b. John *kicked* the ice, but nothing happened to it.

The sentence in (13a) is a contradiction because the verb directly encodes the occurrence of a result. In contrast, the second conjunct in (13b) is not a contradiction because *kick* does not entail a resulting state, although one might be inferred. There is, however, one subtype of two-argument activities, in particular certain verbs of putting (e.g. *pour, jam, stuff, slop*), that, on this test, might be classified as lexical causatives, but on the basis of other criteria, are excluded from this class. While these verbs entail that something happens to their direct object, they actually specify the manner of activity of either the subject or object rather than a distinct resulting state.

Another way that lexical causatives and two-argument activities can be distinguished is by their contrasting syntactic behavior. For example, one prominent way of distinguishing the two kinds of verbs is through their participation in the causative alternation, illustrated in (14) (e.g. Levin & Rappaport Hovav, 1994, 1996; Pinker, 1989; Smith, 1970; Song, 1996). While most lexical causatives (14a) have intransitive variants, two-argument activities (14b) do not.

- (14) a. The lumberjack *split* the log./The log *split*.
The cook *melted* the butter./The butter *melted*.
b. The player kicked the ball./*The ball kicked.
Roger drove the car./*The car drove.

The intransitive form of the lexical causative verbs is sometimes called the *anticausative* or *detransitive*. While participation in the causative alternation is arguably sufficient evidence for membership in the lexical causative category of verbs, it isn't necessary.

Certain verbs that on semantic criteria should be classified as lexical causatives lack such intransitive variants, specifically verbs of cutting, killing, and creation (e.g. *cut*, *carve*, *strangle*, *poison*, *write*, *build*, *kill*). The non-participation of these verbs in this alternation is likely related to the fact that some of these verbs require a sentient causer (*poison*, *write*) while others encode something about the *means* used to affect the change (*cut*, *carve*). Thus, their exclusion from the causative alternation can be semantically predicted (Levin & Rappaport Hovav, 1994).

A.2. *Semantic and syntactic criteria for membership in the periphrastic causative class of verbs*

Periphrastic causative verbs imply the occurrence of a causal interaction together with an embedded verb that specifies a resulting state or location. It has been claimed that periphrastic causatives are limited to a small, grammatically determined set of words (Ammon, 1980; Baron, 1977; Shibatani, 1976), the most common being *make*, *get*, *have*, *let* and *cause*. However, recent work in force dynamics suggests that the class of periphrastic causative verbs is much larger than originally thought (see Goldberg, 1995; Miller & Johnson-Laird, 1976; Pinker, 1989; Talmy, 1988; Wolff & Song, in press; Wolff et al., 2002). Moreover, recent work suggests that the periphrastic causative verbs fall into three main groups: CAUSE-type verbs (see (15a)), PREVENT-type verbs (see (15b)), and ENABLE-type verbs (see (15c)) (Wolff & Song, in press; Wolff et al., 2002).

- (15)
- a. *cause, bribe, compel, convince, drive, have, impel, incite, induce, influence, inspire, lead, move, persuade, prompt, push, force, get, make, rouse, send, set, spur, start, stimulate*
 - b. *bar, block, constrain, deter, discourage, dissuade, hamper, hinder, hold, impede, keep, prevent, protect, restrain, restrict, save, stop*
 - c. *aid, allow, enable, help, leave, let, permit*

Periphrastic causative verbs have both syntactic and semantic criteria (Shibatani, 1976). Syntactically, periphrastic causative verbs can be used as the matrix verb of a sentence containing an embedded clause (Baron, 1972; Cole, 1983; Kozinsky & Polinsky, 1993; Radford, 1988; Wolff & Gentner, 1996; but see Kemmer & Verhagen, 1994). Semantically, periphrastic causative verbs encode the notion of cause, broadly construed (e.g. *caused* in (16a)), while the verb in the embedded clause encodes a particular result (e.g. *heel* in (16a)). The fact that these components of meaning are encoded by different verbs is reflected in the term “periphrastic”, which expresses the idea that two or more words are used to express a single meaning rather than a single inflected form.

- (16)
- a. The blast caused the boat to heel.
 - b. The rain prevented the tar from bonding.

Periphrastic causative verbs entail or strongly imply the occurrence of a result, or, in the case of PREVENT-type verbs, the non-occurrence of a change of state or location that would have occurred without intervention (e.g. see (16b)). We can say that a verb implies a result if negating its implied endstate leads to a contradiction.

- (17)
- a. ?The blast caused the boat to heel, but the boat didn't heel.
 - b. ?The rain prevented the tar from bonding, but the tar bonded.
 - c. Mary begged Bob to marry her, but he didn't marry her.

While negating the endstate in (17a) and (17b) does indeed lead to a contradiction, negating the endstate in (17c) does not. Thus, the verbs *cause* and *prevent* qualify as periphrastic causative verbs, but *beg* does not: although it can appear as the matrix verb of the sentence, it does not necessarily imply the occurrence of a result.

Although ENABLE-type periphrastic causative verbs such as *let* have traditionally been classified as periphrastic causative verbs, the entailment criterion doesn't strictly hold in their case, especially with sentient patients (cf. *Mary let Bob leave, but he didn't leave*, which is acceptable, and *Mary let the water seep into the floor, but the water didn't seep into the floor*, which is a contradiction). It might be, for these verbs, that the occurrence of a result is a strong implicature rather than an entailment. Essentially the same observation is made by Goldvarg and Johnson-Laird (2001).

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