3

Expressing Causation in English and Other Languages

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Causal knowledge underlies our ability to explain the past, exert control, and predict future outcomes. It is a central topic of current research in psychology, linguistics, and philosophy. Although causal knowledge is not thought to depend on language per se, much of what we know about causal reasoning is based on intuitions about the acceptability of linguistic strings. For example, as many have noted, we can say "lightning causes fire" but usually not "oxygen causes fire." Indeed, the philosopher Mackie (1974) has asserted, "Of course, we may, or rather must, accept the use of causal language as a rough guide to what we are to take as causal relationships..." (p. 1). Beyond recognizing the role of language in the study of causation, Mackie's statement discloses a certain degree of unease with this approach. Reflecting this unease, numerous linguists have taken pains to distinguish the concept CAUSE from the verb *cause* (Cruse, 1972; Dowty, 1979; Fodor, 1970; Lakoff & Johnson, 1999) because the verb *cause* might include other abstract components of meaning besides CAUSE in its representation or might differ from CAUSE in terms of its presuppositions (Dowty, 1979).

In this chapter we will show that the linguists' and philosophers' concerns about using language to study causation are at least partially justified. For one, we will show how English, like other languages, provides many ways of talking about causal relations. Crucially, we will show that these various ways of encoding causation are not fully interchangeable. This observation should give researchers of causation pause because it implies that focusing on different kinds of causal expressions could lead to different conclusions about the nature of causation. Psychologists, in particular, should pay heed to this finding given that the vast majority of experiments in causal reasoning and induction have relied on linguistic dependent measures. If we do not know how people use and interpret causal expressions, then it may be difficult to determine whether departures from normative models of causality are due to computational errors in information processing (e.g., weighting and combination

of covariational data), as is often assumed, or to the subtle but significant influence of the linguistic code.

Although the various ways of talking about causation differ in meaning, they are also related in important ways. A second major goal of this chapter is to explain how the various kinds of causal expressions are organized in an underlying semantic system. In particular, we will show that the various expressions differ in terms of their inclusion of a core set of semantic components, which gives rise to an inclusion hierarchy of causal expressions. We will further argue that the system of meaning underlying these expressions can be understood, in part, in terms of distinctions specified by the *force dynamic model of causation* (Wolff, 2003; Wolff & Song, 2003; Wolff, Song, & Driscoll, 2002). The force dynamic model represents a particular approach to causation that specifies the basic dimensions of meaning associated with various causal concepts such as CAUSE, ENABLE, and PREVENT. We will refer to these basic dimensions, or components, of meaning as the structural aspects of causal meaning. We propose that various causal expressions can be classified according to their encoding of these structural components of meaning as well as the encoding of other, more specific aspects of causal situations.

The third major goal of this chapter will be to examine causal expressions across several languages. Examining categories of expressions across languages may reveal which aspects of experience are conceptually salient. To the extent that we find commonalities across languages, we will have evidence for a shared framework for conceptualizing causal relationships.

The Force Dynamic Model

Our approach is based on a theory of causation proposed by Talmy (1988) known as *force dynamics* (see also Jackendoff, 1990; Kemmer & Verhagen, 1994; Pinker, 1989). From a force dynamic perspective, the concept of CAUSE belongs to a family of concepts that includes ENABLE and PREVENT, among others. Differences among the concepts are captured in terms of various patterns of tendency, relative strength, rest, and motion between an *affector* and *patient*. An affector is the entity that *acts on* another entity, and the patient is an entity that is *acted on* by another entity (Table 3.1).

In Wolff and Song (2003; Wolff et al., 2002), we introduced our version of Talmy's theory, the force dynamic model. This model defines the concepts of CAUSE, ENABLE, and PREVENT with respect to three binary dimensions:

Table 3.1. Representations of CAUSE, ENABLE, and PREVENT

	Patient tendency for result	Affector–patient concordance	Occurrence of result
CAUSE	N	N	Y
ENABLE	Y	Y	Y
PREVENT	Y	N	N

(a) the patient's intrinsic tendency for the result, (b) whether the affector and patient act in concordance, and (c) occurrence of the result. The sentences in (1) illustrate how these dimensions interact.

(1) a. Strong winds caused the bridge to collapse.
b. Vitamin B enables the body to digest food.
c. Corn oil prevents butter from burning.

In a CAUSE situation (see 1a), for example, the tendency of the patient (the bridge) is not for the result (i.e., not to collapse), but the affector (strong winds) does not act in concordance with this tendency and the result occurs. In an ENABLE situation (1b), the tendency of the patient (the body) is for the result (to digest food); the affector (Vitamin B) acts in concordance with this tendency, even assisting in its realization, and the result occurs. In a PREVENT situation (1c), the tendency of the patient (butter) is for the result (burning), the affector (corn oil) is not in concordance, and the result does not occur.

In a test of the force dynamic model, participants sorted 23 verbs expressing various kinds of causation into piles according to their similarity to one another. Multidimensional scaling indicated that these verbs fell into the three causal categories predicted by the model (Wolff et al., 2002; Wolff & Song, 2003). Moreover, their sorts indicated that the similarity relations between the groups corresponded to those predicted by the model. We have also found corroborating evidence for the proposed semantic distinctions in several rating studies (Wolff et al., 2002; Wolff & Song, 2003). Evidence for a computational version of the model—the vector model—is described in Wolff and Zettergren (2002).

Ways of Describing Causation

English, like other languages, provides several different ways of talking about causal relations. The force dynamic model provides a framework for understanding how the various causal expressions in English are related to one another. More specifically, the model allows us to organize causal expressions according to the hypothesized components of meaning. An overview of our proposal is provided in Table 3.2.

As shown in Table 3.2, we propose that a causal construction such as the resultative—on the far right of Table 3.2—entails that the patient undergoes a change and specifies the nature of the endstate, the patient's tendency, affector–patient concordance (or lack thereof), directness of the causation, and the means used by the affector to bring about the result. In contrast, lexical causatives, periphrastic causatives, causal conjunctions and prepositions, and sentences based on *link* verbs contain various subsets of the meaning components encoded in resultatives. In the next section, we provide a detailed description of these causal constructions and their components of meaning, progressing from the most general to the most specific.

Table 3.2. Components of Meaning Underlying an Inclusion Hierarchy of Causal Expressions

Component of meaning	Sentences with *affect* verbs	Sentences with *link* verbs	Causal conjunctives and prepositions	Periphrastic causatives	Lexical causatives	Resultatives
Occurrence of change in patient	√	√	√	√	√	√
Specification of endstate		√	√	√	√	√
Tendency and concordance				√	√	√
Directness of causation					√	√
Means/ mechanism						√

1. **Sentences containing *affect* verbs.** One common way of describing causal relationships is with *affect* verbs (see Lakoff & Johnson, 1999), which include the verbs *affect*, *influence*, *determine*, and *change*. *Affect* verbs imply that an affector brings about a change in the patient, but they do not specify the nature of that change. For example, the meaning of the sentences in (2) and (4) are compatible with the meanings of the more specific sentences in (3) and (5), respectively, containing CAUSE, ENABLE, or PREVENT verbs.

   (2) Forest fires *affect* biodiversity.
   (3) a. Forest fires cause biodiversity.
   b. Forest fires enable biodiversity.
   c. Forest fires prevent biodiversity.
   (4) Age *influences* cancer spread in mice.
   (5) a. Age causes cancer spread in mice.
   b. Age enables cancer spread in mice.
   c. Age prevents cancer spread in mice.

   Although the sentences in (2) and (4) are consistent in meaning with all the sentences in (3) and (5), prior knowledge will bias readers or listeners to interpret an *affect* verb as more compatible with a CAUSE, ENABLE, or PREVENT meaning. For example, when we say *The moon* affects *the tides,* we mean *The moon* causes *the tides*, rather than *The moon* enables (or prevents) *the tides*.
2. **Sentences containing *link* verbs.** Another way of expressing causation is with *link* verbs. This category of verbs differs in meaning from *affect* verbs in that they specify that a result is achieved. Thus they distinguish generative causation (CAUSE or ENABLE) from preventive causation (PREVENT). For example, (6a) is compatible with

CAUSE or ENABLE readings (see 6b) but not PREVENT (6c). The same holds for (7a) and (8a).

(6) a. An earthquake in North America was *linked to* a tsunami in Japan.
b. An earthquake in North America was caused/enabled by a tsunami in Japan.
c. *An earthquake in North America was prevented by a tsunami in Japan.

(7) a. America's intelligence failures *led to* September 11.
b. America's intelligence failures caused/allowed September 11.
c. *America's intelligence failures prevented September 11.

(8) a. Success *depends on* growth.
b. Growth is caused/enabled by success.
c. *Growth is prevented by success.

The fact that both CAUSE and ENABLE interpretations are possible suggests that the distinction between the concepts is not encoded in the semantics of the *link* verbs themselves but rather is determined by world knowledge.

3. **Causal conjunctives and prepositions.** Causal conjunctives, including conjunctive adverbs, and causal prepositions are similar to one another in the components of causal meaning specified in Table 3.2. Like the *link* verbs, these types of expressions are used to express generative but not preventive causation (Dancygier & Sweetser, 2000). We will focus first on the category of causal conjunctives, in which we include subordinating and coordinating conjunctions and conjunctive adverbs.

Three types of subordinating conjunctions can be used to talk about causal relations: causal (*because, since*), temporal (*after, when*), and conditional (*if*). In all cases, the main clause expresses the result and the subordinate clause expresses the cause. Causal subordinating conjunctions explicitly assert a causal relation (broadly construed).[1] Examples are provided in (9).

(9) a. There's a hole in the screen door *because* I tripped over the cat.
b. I made it on time *because* the traffic lights changed just in time.[2]
c. *Since* John was exhausted by the time he arrived, he went straight to bed.

Causal subordinators typically introduce a clause that might be best characterized as expressing a *reason*. Although the precise connection between causes and reasons has not yet been fully articulated, we

[1]Recently, there has been a surge of interest in how certain subordinators can be used to encode both causation in the world (*The street was flooded because of the storm*), and events and/or facts that lead to certain observations or conclusions—epistemic causation—(*My wife loves me, because she puts honey in my tea*) (see Lagerwerf, 1998; Louwerse, 2001; Pander Maat & Sanders, 2000; Sanders, Spooren, & Noordman, 1992; Sweetser, 1990). However, a discussion of this very interesting distinction is beyond the scope of this chapter.

[2]We thank Eve Sweetser for this example.

assume, along with Lakoff and Johnson (1999), that reasons can be conceptualized, in an extended sense, as causes (see also Sweetser, 1990).

The temporal conjunctions, *after* and *when*, are exemplified in (10).

(10) a. Ralph left the Republican Party *after* George W. Bush was nominated.
b. Sarah stopped the car *when* she saw the runaway goose.
(11) George W. Bush was nominated *before* Ralph left the Republican Party. (? CAUSE)

Clark and Clark (1977) make the interesting observation that the subordination relation is critical in implying a causal reading. If the result is subordinate to the cause, as in (11), the sentence loses its causal interpretation, even though it describes the same sequence of events as in (10a). According to Talmy (1976), in English and other languages, results are generally construed in terms of causes, not vice versa, and it is for this reason that sentences with *before* do not receive a causal interpretation.

The last type of subordinating conjunction used to express causation is the conditional, *if*, examples of which are shown in (12).

(12) a. *If* you are found guilty, you will go to jail.
b. *If* I win the lottery, I will pay off my debts.

In these sentences, a particular result is understood to be contingent upon a particular cause. *If–then* statements can also be used in counterfactual statements. Conditionals and counterfactuals are closely related, as exemplified by the sentences in (13), which are very similar to those in (12).

(13) a. *If* John had been found guilty, he would have gone to jail.
b. *If* John had won the lottery, he would have paid off his debts.

As noted above, causal expressions containing subordinators specify that a result is achieved but not whether the relationship is one of causation or enabling. For example, the sentence in (14) could be construed as describing either a CAUSE (15a) or an ENABLE (15b) relation, depending on the context.

(14) The stew boiled *after* wood was added to the fire.
(15) a. Adding wood to the fire *caused* the stew to boil.
b. Adding wood to the fire *enabled* the stew to boil.

For most cases, we assume that the particular type of generative causation can be deduced given general world knowledge. For example, (9a) could be paraphrased with a CAUSE verb, as in *My tripping over the cat caused a hole in the screen door.* On the other hand, the sentence in (9b) is more appropriately paraphrased with an ENABLE verb, as in *The timing of the traffic lights allowed me to arrive just in time.*

[3] *By* phr
with ph
tence (u

Coordinating conjunctions make up the second major category of causal conjunctives. The coordinators most closely associated with causation are *and* and *so*. *So* explicitly asserts a causal relation of some sort, whereas *and* can imply causation in certain contexts (see sentences in [16]).

(16) a. Eat well *and* live to be 100!
b. Ralph totaled the car *and* his father went ballistic.
c. He ate a lot of ice cream during the heat spell *so* he gained weight.

In causal descriptions containing coordinators, the order of the causing and resulting events is fixed: the cause must precede the result. Again, coordinating conjunctions do not specify whether the relation is causal or enabling. For example, (16a) is best paraphrased with an ENABLE verb (*Eating well enables you to live to 100*) and (16b), with a CAUSE verb (*Ralph's totaling of the car caused his father to go ballistic*).

The final type of causal conjunctive includes conjunctive adverbs (e.g., *consequently, thus, therefore, as a result, in response*) and lexical cues phrases (e.g., *that's why*) (Pander Maat & Sanders, 2000).

(17) a. Ralph totaled the car. *As a result,* his auto insurance rates increased.
b. John drank a lot of coffee. *That's why* he stayed awake.

As with the other conjunctives, the interpretation of conjunctive adverbials and lexical cue phrases is open to either a CAUSE or ENABLE reading. For example, (17b) could be used to describe either a CAUSE or ENABLE situation, depending on whether John wanted to stay awake or not.

Causal prepositions (*because of, as a result of, in response to*) are paired with causal conjunctives because their meanings are very similar—that is, they specify generative but not preventive causation. Causal prepositions also include *from, by,* and *with*. Here we focus on *from* phrases.[3] As highlighted in the force dynamic model, causes bring about their effects *from a particular direction or source* (see Clark & Carpenter, 1989a, 1989b; Lakoff & Johnson, 1999; DeLancey, 1984). This association appears to motivate the use of *from* phrases as ways of describing causes (see [18]).

(18) a. Darryl likely died *from* a blocked coronary artery.
b. He got rich *from* his investments (adapted from Lakoff & Johnson, 1999).
c. She was tired *from* her day in the shoe shop.

[3]*By* phrases often simply name the agent (or causer) in a passive causal construction whereas *with* phrases typically name the instrument used by the causer mentioned elsewhere in the sentence (usually in subject position).

Clark and Carpenter (1989a, 1989b) have observed that children often use *from* before they use *by* and *because* in naming causers, often resulting in sentences that are ungrammatical for adults (e.g., *These fall down from me, He's really scared from Tommy*). Clark and Carpenter suggest that these uses of *from* might result from children's initial conceptualization of causes as sources.

4. **Periphrastic causatives.** Periphrastic causatives (also called *analytic, overt,* or *auxiliary causatives*) express causal relationships (broadly construed) with two or more predicate terms, one each associated with the cause and result. Often, periphrastic causative constructions are composed of a matrix verb that takes an embedded clause (or predicate) as a complement (Baron, 1977; Radford, 1988; Wolff & Gentner, 1996; but see Kemmer & Verhagen, 1994). For example, in the sentence in (19), the matrix verb (i.e., *cause*) expresses the notion of CAUSE while the embedded verb (i.e., *open*) expresses a particular endstate or RESULT.

(19) Alison *caused* the door to *open.*

As previously discussed, sorting experiments have confirmed that periphrastic causative verbs fall into the three basic categories of causation posited by the force dynamic model: CAUSE-type verbs (see 20a), PREVENT-type verbs (20b), and ENABLE-type verbs (20c; Wolff et al., 2002; Wolff & Song, 2003).

(20) a. *bribe, cause, 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*

Thus, in contrast to the types of constructions discussed in the preceding sections, the periphrastic causative verbs can distinguish not only between generative and prohibitive causation but also between CAUSE and ENABLE. As evidence, note that the verb *cause* in (21a) cannot be replaced by the verb *enable* (21b), nor can *enable* (21c) be replaced by *cause* (21d).

(21) a. The blast caused the boat to heel violently.
b. ?The blast enabled the boat to heel violently.
c. The vitamin B complex enables the body to make full use of the food.
d. ?The vitamin B complex causes the body to make full use of the food.

According to the force dynamic model, generative and prohibitive causation are distinguished in terms of whether a result occurs. The force dynamic model further distinguishes the notions of CAUSE and

5.

Table
Verbs

	C
1	Inf
2	Ba
3	No
4	Pre inc
5	No
6	Pa

[a]Althou
can in (

ENABLE in terms of the patient's tendency for an endstate and the affector's concordance with the patient. In specifying all three dimensions of the force dynamic model, periphrastic causative constructions can be said to be *structurally* complete.

Prototypically, the complement of a periphrastic causative verb is an embedded clause, as in (21a). However, as noted by Baron (1977), such verbs can also appear selectively with a range of other kinds of complements, as shown in Table 3.3. Different verbs take different sets of complements. Moreover, the complement-taking properties of periphrastic causative verbs differ across languages.

5. **Lexical causatives.** One of the most common ways of expressing causal relations is with a lexical causative (also known as covert, or underived, causatives). Lexical causatives (e.g., *break, melt, sink*) are verbs that imply an external CAUSE and explicitly encode a particular RESULT. With a lexical causative, it is possible to describe a causal event within a single clause. For example, the lexical causative *break* in the sentence in (22a) encodes a particular RESULT (i.e., breaking) and that it was brought about by an external CAUSE (i.e., William). As shown in (22b), the verb *break* can also be used intransitively; in this case, the verb merely encodes the RESULT without specifying whether the CAUSE was internal or external. The sentences in (22) exemplify the causative alternation (Levin, 1993). The causative alternation is a conservative test for determining whether a verb is a lexical causative.

(22) a. William *broke* the clock.
b. The clock *broke.*

The class of lexical causative verbs includes many phrasal verbs (e.g., *turn off, knock down*) that participate in the causative alternation. There also appear to be a few verbs that do not participate in this alternation (e.g., *destroy, extinguish*) but that nevertheless indicate an

Table 3.3. Range of Complements That Can Be Found With Periphrastic Causative Verbs

	Complement type	Example
1	Infinitive phrase	The blast caused the boat *to heel.*
2	Base form	The wind made the window *shudder.*
3	Noun phrase	Electrical shock sometimes causes *the onset of diabetes.*
4	Prepositional phrase including *from*	The colonel got the soldiers *in his office within the hour.* A plate with a slight rim prevents food *from sliding over the edge.*
5	Noun clause	He caused *that the school was closed.*[a]
6	Participle phrase	Jay set the pendulum *swinging.*

[a]Although noun clauses cannot be complements of periphrastic causative verbs in English, they can in German, Spanish, and Arabic.

externally caused change of state and hence are often considered lexical causatives.

Lexical causatives can be divided into three main subclasses according to the type of result they encode: change of state (23a), change of location in a particular manner (23b), and certain kinds of light or sound emission (23c; Bowerman, 1996; Levin & Rappaport Hovav, 1994; Pinker, 1989; Smith, 1970).[4]

(23) a. *awake, balance, bend, break, burn, capsize, change, chill, clog, close, collapse, crack, crumble, decompose, decrease, deflate, defrost, degrade, dissolve, divide, drain, enlarge, expand, explode, flood, fold, freeze, hush, ignite, increase, 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*
c. *shine, beam, buzz, jingle, ring, rustle*

Like periphrastic causative verbs, lexical causatives are fully specified with respect to the structural components of meaning. However, their meanings are restricted to the concept of CAUSE; no lexical causative verb can be said to encode the concept of ENABLE or PREVENT. For example, (22) could be paraphrased as *William caused the clock to break* but not *William enabled the clock to break.*

Lexical causatives differ most prominently from periphrastic causatives with respect to the notion of direct causation. Whereas periphrastic causatives can be applied to causation that is either direct or indirect, lexical causatives are restricted to direct causation (e.g., Comrie, 1985; Dowty, 1979; Levin & Rappaport Hovav, 1994; Pinker, 1989; Shibatani, 1976; Wierzbicka, 1988; Wolff, 2003; among others). To illustrate this difference, consider the sentences in (24).

(24) a. Sara *opened* the door. (lexical causative)
b. Sara *caused* the door to *open.* (periphrastic causative)

Both sentences in (24) could be used to describe direct causation—for example, a situation in which Sara turns a doorknob and pushes the door open. However, only the periphrastic causative sentence in (24b) can be used to describe indirect causation—for example, a situation in which Sara opens a window, a breeze enters the room, and the door opens. If the door did indeed open when Sara opened a window, it would sound odd to say, *Sarah opened the door.*

6. **Resultatives.** Resultative constructions are exemplified by the sentences in (25).

[4]A fourth possible class of lexical causatives are the so-called subject-initiating, implicit causality verbs or stimulus-experiencer verbs such as *amaze, amuse, bore, charm deceive, disappoint, fascinate, frighten, inspire, scare*, and *surprise* (see Au, 1986; Majid, Sanford, & Pickering, 2003; McKoon, Green, & Ratcliff, 1993). These verbs can be given a causative paraphrase (e.g., *She amazed him* implies *She caused him to be amazed*).

(25) a. The children *yelled* themselves *hoarse.*
b. John *hammered* the metal *flat.*

They are defined by both syntactic and semantic criteria. Syntactically, they occur in sentences of the form [NP V NP XP] where the XP is either an adjectival [AP] or a prepositional phrase [PP] naming a resulting state or location.[5] Resultatives can be analyzed as expressing complex events—composed of two subevents—and receive a causative analysis. For example, (25a) describes a yelling event and a becoming hoarse event that are causally related to each other. This causal relationship is made clear in the sentences in (26), which are acceptable paraphrases for the sentences in (25).

(26) a. The children caused themselves to become hoarse by yelling.
b. John flattened the metal (caused the metal to become flat) by hammering it.

Resultatives resemble lexical causatives in several ways. According to Rappaport Hovav and Levin (2001), neither type of construction requires that the causing and the result events be temporally dependent. Another commonality is that both are restricted to describing direct causation (Goldberg, 1995; Rappaport Hovav & Levin, 2001). Yet another important commonality is that, like lexical causatives, resultatives only seem to encode the concept of CAUSE, as opposed to ENABLE.

A key difference between resultatives and lexical causatives is that with resultatives the result is encoded in the XP whereas in lexical causatives it is encoded in the verb. This means that the verb in the resultative construction can encode information about the means (or mechanism) of causation. Thus the resultative construction allows us to specify whether, for example, a house became clean via dusting, vacuuming, sweeping, or mopping, as demonstrated in (27a). This is in contrast to the lexical causative construction in (27b), which leaves the means of causation unspecified.

(27) a. The maid *dusted / vacuumed / swept / mopped* the house *clean.*
b. The maid cleaned the house.
c. The maid cleaned the house by dusting/vacuuming/sweeping/mopping.

Of course, (27b) could be augmented to include information about the manner of causation, as in (27c). It is important to note, however, that the manner phrases in (27c) are optional whereas the verb—encoding information about the means of causation—in the resultative sentence is obligatory.

[5]There are some resultatives with the form [NP V XP]—called "bare resultatives" (Rappaport Hovav & Levin, 2001)—for example, *The gate swung shut* or *The girl danced out of the room.* According to Rappaport Hovav and Levin (2001), bare resultatives are associated with simple event structures in which the causing (e.g., swinging) and resulting subevents (e.g., shutting) unfold together and thus are temporally dependent. As a consequence, bare resultatives are said to refer to situations conceptualized as having a single subevent and thus do not receive a causative reading.

Summary

We have identified six major kinds of causal expressions. Semantic differences among these ways of talking about causation provide evidence for an underlying semantic system organized around several basic components of meaning. Moreover, our analyses suggest that these various ways of talking about causation give rise to an inclusion hierarchy with respect to these components of meaning. Resultatives specify all of the components of meaning that can be encoded in a causal expression; lexical causatives specify a subset of those encoded in resultatives, periphrastic causatives, a subset of those encoded in lexical causatives, and so on to the most general type of causal expression, sentences containing *affect* verbs. The semantic system underlying the various types of causal expressions could have been organized differently. For instance, we can imagine a system in which different expressions encode different subsets of meaning, but no particular subset is necessarily inclusive of another.

To what extent does the semantic system underlying causal expressions reflect our conceptualization of causation? On the one hand, the various kinds of causal expressions might be specific to English (i.e., linguistic in origin). For example, it could be the case that a particular class of expressions was derived from historical or cultural influences that were unique to English. Alternatively, the various kinds of causal expressions might reflect common ways of construing causal situations. If so, we should find similar categories of expressions in other languages. The existence of similar semantic systems for expressing causation across multiple languages would argue for the cognitive significance of the distinctions reflected in the linguistic categories.

Expressing Causation Across Languages

There has been considerable research on the expression of causation in languages other than English (Ammon & Slobin, 1979; Comrie, 1981, 1985; Comrie & Polinsky, 1993; Nedyalkov & Silnitsky, 1973; Shibatani, 1976; Van Valin & LaPolla, 1997; among others). Much of this work has focused on the difference in meaning between lexical and periphrastic causatives. In contrast, there has been little cross-linguistic research on the other kinds of causal expressions. To address this limitation, we conducted a small-scale comparison of four Indo-European languages—English, German, Russian, and Spanish—and one Afro-Asiatic language, Arabic. In particular, we were interested in discovering whether these languages had similar categories of causal expressions that also differed according to the components of meaning hypothesized by the force dynamic model. For our study, we recruited at least three native speakers of each of these languages who were also fluent in English. All of our bilingual consultants had studied through at least high school in their native language.

We focused on the five ways of expressing causation involving verbs: *affect* verbs, *link* verbs, periphrastic causatives, lexical causatives, and resultatives. For each language group, we first asked two bilinguals to translate English

sentences including the various kinds of causal expressions into their native languages and provide English glosses, including sentences containing the 23 periphrastic causative verbs listed in Table 3.5, on page 43. In cases in which the bilinguals felt the original English sentence could not be translated directly into their native language, we asked them to provide near translations. The third bilingual examined the two sets of translations. Disagreements were resolved by discussion and reference to several on-line corpora.[6]

Results

As shown in Table 3.4, languages other than English have *affect* verbs, *link* verbs, periphrastic causatives, lexical causatives, and resultatives. Moreover, the semantics of these verbs are quite similar to those found in English. In Table 3.4, each verb is shown next to three boxes indicating whether that verb can be used in sentences to imply (a) causation, (b) enablement, or (c) prevention.

As expected, the *affect* verbs in the five languages tended to be compatible with all three kinds of force dynamic interactions: CAUSE, ENABLE, and PREVENT. *Link* verbs tended to be compatible with CAUSE and ENABLE situations, but in no language could they be used to describe PREVENT situations. Each periphrastic causative represented only CAUSE, HELP or PREVENT. Finally, lexical causatives and resultatives were compatible with CAUSE situations only. The most noticeable difference was that one of the languages, Spanish, lacked resultatives. We also remain cautious about the existence of resultatives in Arabic.

In sum, the inclusion hierarchy that appears to underlie expressions of causation in English seems to be present in other languages. This finding suggests that the semantic system underlying the expressions of causation in English is not just a quirk of English; rather, it suggests that certain ways of thinking about force dynamic events are conceptually salient enough that the inventory of causal expressions across languages is far more similar than it is different. To determine more closely the extent to which the semantics of causal verbs in other languages mirrored that of causal verbs in English, we focused on the periphrastic causatives present in each language.

The results are shown in Table 3.5. In cases in which the English verb has no direct translation, the relevant entry is left blank. In cases in which the same verb is used in German, Russian, Spanish, or Arabic for two English verbs, the verb is listed twice. Differences in the appropriateness of a translation are indicated by case, with lowercase representing less primary translations.

The results shown in Table 3.5 indicate that a significant number of periphrastic causative verbs are present in all five languages. However, the languages differ in the total number of these verbs. It appears that only about

[6]The corpora included (a) The Russian Corpora at the University of Tübingen (38.5 million words), (b) The Corpus Del Español (100 million words), (c) The COSMA II corpus by the Institute for German Language (128 million words), and (d) The British National Corpus (100 million words).

Table 3.4. Ways of Expressing Causation Across Languages With Associated Semantic Senses

	English		German		Russian		Spanish		Arabic	
Affect verbs	AFFECT	• • •	WIRKEN	• • _	VOZDEISTVOVAT'	• • •	AFECTAR	• • _	ATHAR	• •
	INFLUENCE	• • •	BEINFLUSSEN	• • •	VLIIAT'	• • •	INFLUIR	• •	YAGGAL	• •
Link verbs	LINK	• • _	VERBINDEN	• • _	SVIAZYVAT'	• • _	UNIR	• • _	ARJAA	• • _
	LEAD	• • _	FUEHREN	• • •	PRIVODIT'	• _ _			ADDA	• • _
	DEPEND	• • _	ABHAENGEN	• • •	ZAVISIT'	• • •	DEPENDER	• • _	YA'ATAMID	• • _
Periphrastic	CAUSE	• _ _	VERURSACHEN	• _ _	VYZYVAT'	• _ _	CAUSAR	• _ _	YUSABIB	• _ _
causative	HELP	_ • _	HELFEN	_ • _	POMOGAT'	_ • _	AYUDAR	_ • _	SAADA	_ • _
verbs	PREVENT	_ _ •	VERHINDERN	_ _ •	PREDOTVRASHCHAT'	_ _ •	PREVENIR	_ _ •	MANAA	_ _ •
Lexical	BREAK	• _ _	ZERBRECHEN	• _ _	RAZBIVAT'	• _ _	ROMPER	• _ _	KASARA	• _ _
causatives	OPEN	• _ _	OEFFNEN	• _ _	OTKRYVAT'	• _ _	ABRIR	• _ _	FATAHA	• _ _
	SINK	• _ _	SINKEN	• _ _	TOPIT'	• _ _	HUNDIR	• _ _	GHARIKA	• _ _
Resultatives	Yes	• _ _	Yes	• _ _	Yes	• _ _	No	_ _ _	Yes	• _ _

Note. • _ _ – CAUSE sense
_ • _ – ENABLE sense
_ _ • – PREVENT sense

Table 3.5. Periphrastic Causative Verbs Present in Different Languages

English	German	Russian	Spanish	Arabic
CAUSE	VERURSACHEN	VYZYVAT'	CAUSAR	YUSABIB
HELP	HELFEN	POMOGAT'	AYUDAR	SAADA
PREVENT	VERHINDERN	PREDOTVRASHCHAT'	PREVENIR	MANAA

Table 3.5. Periphrastic Causative Verbs Present in Different Languages

English	German	Russian	Spanish	Arabic
CAUSE	VERURSACHEN	VYZYVAT'	CAUSAR	YUSABIB GAALTAH
FORCE	ZWINGEN	VYNUZHDAT'	FORZAR	IGBAR
GET	DAZU BRINGEN			
MAKE		ZASTAVLIAT'	HACER	GAAL
SET	ANSETZEN			
START			EMPESAR	SHAGALT
STIMULATE	ANREGEN	STIMULIROVAT'	ESTIMULAR	
ALLOW	ERLAUBEN	POZVOLIAT'	permitir	samah
ENABLE	ERMOEGLICHEN	DAVAT' VOZMOZHNOST' (give an opportunity)	permitir	saad
HELP	HELFEN	POMOGAT'	AYUDAR	SAADA
LET	LASSEN	pozvoliat	dejar	samaha
LEAVE	lassen	OSTAVLIAT'	DEJAR	TARAKA
PERMIT	erlauben	RAZRESHAT'	PERMITIR	SAMAHA
BLOCK				
HINDER	HINDERN	MESHAT'	impedir	manaa
HOLD	abhalten	Sderzhivat'		
IMPEDE	verhindern	PREPIATSTVOVAT'	IMPEDIR	manaa
KEEP	ABHALTEN			
PREVENT	VERHINDERN	PREDOTVRASHCHAT'	PREVENIR	MANAA
PROTECT	BESCHUETZEN	PREDOKHRANIAT'	PROTECTA	HAMA
RESTRAIN		SDERZHIVAT'		
SAVE	BEWAHREN	SPASAT'	SALVAR	YANKUTH
STOP		UDERZHIVAT'		AWKAFA

half of the 23 English periphrastic causative verbs have direct translations in German (N = 14), Russian (N = 16), Spanish (N = 12), and Arabic (N = 12). For all of the non-English languages, it was often the case that a single verb is used for more than one English verb. An exception to this pattern was in Arabic, where the verbs *yusabib* and *gaaltah* both translate as *cause* in English.[7]

As discussed above, to the extent that a word is consistently available across multiple languages, we have an indication of its conceptual importance. In our sample, only two CAUSE verbs appeared in all five languages: *cause* and *force*. The only ENABLE verb found in all five languages was *help*.[8] Finally, the only PREVENT verbs found in all of the languages were *prevent, save,* and *protect*. Examining the availability of words across languages could prove useful in identifying the core components of meaning in groups of related words.

Broader Implications

Our findings have several implications. Among others, they confirm that the various ways of expressing causation within a language are not interchangeable. In particular, we are likely to run into trouble when rephrasing more inclusive expressions in terms of less inclusive expressions. For example, the sentence *Low fat diets are* linked to *good health* is not correctly paraphrased by *Low fat diets* cause *good health*. Although we might say *Low air pressure* caused *the water to boil*, this doesn't mean *Low air pressure* boiled *the water* (adapted from Dowty, 1979). However, our account does predict that it should be possible to rephrase less inclusive expressions with more inclusive expressions. Hence, *Mary* boiled *the water* can also be stated (though not quite as felicitously) as *Mary* caused *the water to boil, Mary's actions* led to *the boiling of the water,* or *Mary's actions* affected *the water*. Most experiments in the psychology literature have measured causal knowledge using periphrastic causatives (e.g., Ahn, Kim, Lassaline, & Dennis, 2000; Lober & Shanks, 2000; Spellman, Price, & Logan, 2001; Mandel & Lehman, 1998; Wasserman, Elek, Chatlosh, & Baker, 1993). However, other studies have used more inclusive causal expressions as dependent measures (e.g., Kao & Wasserman, 1993; Shanks, 1989; Yarlett & Ramscar, 2002). Our analyses should alert researchers to be cautious when comparing studies using different causal expressions as dependent measures.

Our analyses further highlight differences in the underlying semantics implicit in various models of causation. For example, the arrows connecting one variable to another in Bayesian networks (see Gopnik et al., 2004; Glymour, 2001; Tenenbaum & Griffiths, 2001) do not specify whether the nature of the influence is one of causation, enabling, or prevention; hence, these links are roughly comparable to the range of situations encoded by sentences

[7]Whereas *yusabib* can be used for most kinds of affectors and patients, *gaaltah* is restricted to affectors and patients that are both sentient.

[8]The widespread availability of the verb *help* is interesting because, in an independent line of research, we speculated that this verb was semantically the simplest of the ENABLE group of verbs (Wolff & Zettergren, 2002).

containing *affect* verbs. Associative models, like those based on the Rescorla–Wagner algorithm (see Baker, Murphy, & Vallée-Tourangeau, 1996; Lober & Shanks, 2000; Wasserman, Eleks, Chatlosh, & Baker, 1993) distinguish generative from preventive contingencies; hence, these models appear to capture the categories of events distinguished by *link* verbs. Several models of causation have been formulated to account for the distinctions among CAUSE, ENABLE, and PREVENT, including the probabilistic contrast model (Cheng & Novick, 1991, 1992), the power PC model (Cheng, 1997), the model theory of causation (Goldvarg & Johnson–Laird, 2001), the force dynamic model (Wolff et al., 2002; Wolff & Song, 2003), and the vector model (Wolff & Zettergren, 2002). This class of models is potentially equipped to distinguish the categories of causation encoded by periphrastic causatives. When comparing models, researchers should keep in mind whether the models are compatible in terms of their underlying semantics.

At the core of our proposal is the idea that the various expressions of causation are related to one another in a series of inclusion relationships. In fact, causal expressions seem to be organized in a hierarchy that resembles the taxonomic organization of certain nominal categories. We doubt that the various causal expressions are represented in the mind explicitly in terms of a taxonomic hierarchy. Indeed, even in the case of domains in which taxonomic organizations are easy to imagine (e.g., animals), it appears that the adjoining IS-A links are often computed rather than stored (see Murphy, 2002). Nevertheless, it is interesting to speculate as to which level we might assign each of the expressions of causation. We have argued that periphrastic causatives are "structurally complete." As such, they provide schemas for the more specific levels of expression. This is precisely what characterizes superordinate categories, according to Markman and Wisniewski (1997). On their account, we might view periphrastic causatives as representing a kind of superordinate level for causal expressions. Right below the periphrastic causatives are the lexical causatives. The lexical causatives show several of the characteristics of a basic level. As with basic level categories in other domains, lexical causatives are clearly more numerous than any other kind of causal expression (see Levin, 1993). Another property of basic level terms is that they tend to be the terms that people use when they spontaneously describe scenes or objects. Indeed, in a naming study by Song and Wolff (2003), participants' descriptions of animated causal events included lexical causatives more often than any other kind of causal expression.

Finally, category labels at the basic level are usually learned before labels at the other levels. Supporting the idea that lexical causatives are at a basic level of sorts, Bowerman (1974, 1982) has documented that children use lexical causatives as early as 15 to 18 months of age, well before they start using periphrastic causatives, between 2 and 3 years of age. The data suggest, then, that the lexical causatives are privileged in some way. Finally, it is easy to imagine resultatives as residing at a subordinate level because they encode relatively fine distinctions. *Affect* and *link* verbs would most likely constitute super-superordinate categories.

Although it may be intriguing, and at times enlightening, to view causal expressions in terms of a taxonomic hierarchy, it is not entirely unproblematic.

The kind of taxonomic structure that descriptions of causation appear to have differs significantly from the kind generally observed in nominal categories (see Miller & Fellbaum, 1987). In particular, the various periphrastic causative verbs do not seem to be associated with different kinds of lexical causative verbs. Thus all of the periphrastic causative verbs appear to be associated with a single subordinate category. In a similar fashion, the various lexical causative verbs do not appear to be associated with different kinds of resultatives. Differences such as these raise questions concerning whether the various expressions of causation reflect an underlying nonlinguistic taxonomic structure. What does seem clear is that the various expressions of causation differ in their level of generality.

Conclusion

English, like other languages, provides many ways to talk about causal relations. Our analyses have shown that these various ways of expressing causation are not interchangeable. In particular, we presented evidence supporting the idea that the various ways of expressing causation reveal an underlying semantic system. Within this system, causal expressions differ in terms of their inclusion of a core set of semantic components, which give rise to an inclusion hierarchy of causal expressions. We found evidence for the same kind of semantic system in languages other than English. Thus it appears that our findings are not unique to English but rather reflect common ways of viewing force dynamic interactions in general.

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