

Cause and Burn*

[forthcoming in *Cognition*]

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[Hume] confidently challenges us to “produce some instance, wherein the efficacy is plainly discoverable to the mind, and its operations obvious to our consciousness or sensation”.... Nothing easier: is cutting, is drinking, is purring not ‘efficacy’? (Anscombe 1987, p. 137)

One prominent set of philosophical accounts of causation appeals centrally to dependence relations. There are several different kinds of dependence theories (e.g., Mackie, 1965; Lewis, 1973; Reichenbach, 1956), but they all share the common idea that causation is to be explicated in terms of dependence between cause and effect. Perhaps the most familiar version is a counterfactual theory of causation according to which we should understand causal relations in terms of counterfactuals like *if C hadn't occurred, then E wouldn't have occurred*. The primary rivals to dependence theories are *production* theories that hold that causation involves some process (typically a physical process) that connects cause and effect. Production views often characterize the causal contribution in terms of *oomph* or *biff*. There are also several kinds of production theories (e.g., Salmon, 1984; Dowe, 2000; Wolff, 2007), but they all oppose dependence views. As Dowe writes, “Biff theories do not include any theory that appeals to counterfactuals or regularities” (MS p. 3). Of course, if C produces E, this might provide the basis for true counterfactual statements. But the counterfactual statements themselves don't capture the causal relation, according to production theories.

One virtue that dependence theories have is that they don't appeal to metaphysically controversial posits like *oomph*. Humean views of the universe generally eschew such metaphysical commitments, and in contemporary philosophy of science, many think that a naturalistic worldview has no place for causal *oomph*. Here, for instance, is a comment from James Ladyman: “The preoccupation with the search for ‘genuine causal *oomph*’ or ‘*biff*’ to settle the competition between different levels of reality derives from this conception of causation and microbanging. This is profoundly unscientific and does not fit with contemporary physics” (Ladyman 2008, 753; see also Schaffer 2004). Dependence theories, by contrast, do not appeal to these kinds of metaphysically controversial causal connections. Indeed, dependence theories can remain silent on which mechanisms, if any, are involved in one thing causing another.

In recent years, there has been a fluorescence of experimental work on lay judgments of causation (e.g., Fraser and Knobe, 2008; Hitchcock and Knobe, 2009; Alicke, Rose and Bloom, 2011; Alicke and Rose, 2012; Rose and Danks, 2012; Sytsma, Livengood and Rose, 2011;

* Acknowledgements: We are grateful to David Danks, Tobias Gerstenberg, Heidi Harley, Paul Henne, Rachana Kamtekar, Josh Knobe, Lavaris McCellion, Kevin Reuter, Carolina Sartorio, Jonathan Schaffer, Justin Sytsma, and two anonymous referees for comments on previous drafts.

Livengood and Rose, 2016; Livengood, Sytsma and Rose, 2017; Danks, Rose and Machery, 2014; Kominsky, Phillips, Gerstenberg, Lagnado and Knobe, 2015; Rose, 2017; Kominsky and Phillips, 2019; Gerstenberg and Icard 2019). Some of this work seems to favor the hypothesis that ordinary people use the word *cause* in a way that corresponds to a production notion (e.g., Mandel 2003; Walsh & Sloman 2011; Wolff 2007). For instance, some of this work has explored judgments about “redundant causation”, which, as philosophers have noted, poses a problem for simple dependence accounts of causation (see, e.g. Hall 2004; Godfrey-Smith 2010). Imagine that Suzy and Billy each throw a rock at the same bottle, and Suzy’s rock smashes the bottle a second before Billy’s would have. In that case, the bottle’s breaking didn’t depend on Suzy’s throw, since the bottle would have broken from Billy’s throw if Suzy hadn’t thrown. Despite this, people tend to say that Suzy’s throw caused the bottle to break and Billy’s did not (e.g., Shultz, 1982; Mandel 2003; Walsh & Sloman 2011). In addition, in work at the intersection of psychology and linguistics, Phillip Wolff has defended a theory of causal verbs that broadly fits with a production notion of causation (e.g., Copley & Wolff 2014).

Thus, some work suggests that the ordinary notion of cause is a production notion rather than a dependence notion. However, more sophisticated dependence theories of causation seek to accommodate examples of redundant causation without reverting to production (e.g. Lewis 2000). Moreover, much of the work on causal judgment suggests that the way people ordinarily use the word *cause* corresponds to a dependence notion of causation (e.g., Hitchcock and Knobe, 2009; Kominsky, Phillips, Gerstenberg, Lagnado and Knobe, 2015; Icard, Kominsky and Knobe, 2017; Kominsky and Phillips, 2019). Some of this work has focused on the role of norm violations—both prescriptive and statistical—in causal judgment, which is then taken to be explained by people operating with a dependence notion of causation (see Willemsen and Kirfel, 2018 for a review). As Kominsky and Phillips (2019) put it, “the impact of both statistical and moral norms is best explained by changes in the relevance of counterfactual possibilities” (p. 2; see also Hitchcock and Knobe, 2009; Halpern and Hitchcock, 2014; Icard, Kominsky and Knobe, 2017; though see Samland and Waldmann, 2016). For instance, Phillips, Luguri and Knobe (2015) find that when people are given a case where a professor is not allowed to take pens from the receptionist’s desk but administrative assistants are, when Professor Smith and an administrative assistant both take pens and then the receptionist doesn’t have one to write an important message, the extent to which people agree with the statement that “Professor Smith caused the problem” is mediated by judgments about whether things would have been different had Professor Smith not taken a pen.

The foregoing work indicates that people’s use of the word “cause” is deeply sensitive to counterfactual alternatives in ways suggesting that people operate with a dependence notion of causation. Danks (2017) summarizes the situation as follows:

At a high level, the results of these types of vignette-based experiments are largely consonant with the more sophisticated difference-making accounts of singular causation. That is, people’s singular causal judgments seem to be sensitive to the truth of particular focal counterfactuals that can be derived from (i) causal graphical model representations of the general causal relations, and (ii) facts about the specific situation, including defaults or “normal” values (p. 210).

The focus on norm violations has been especially crucial in providing support for the view that people operate with a dependence notion of causation. As Phillips and Kominsky (2019) put it: Collectively, the evidence...demonstrates that norm violations affect the relevance of counterfactual alternatives, and the relevance of counterfactual alternatives affects causal

judgments. This relationship holds across variations in the nature of the candidate cause and variations in the nature of the norm violation, suggesting that these effects arise from general features of causal reasoning, rather than some domain-specific way of reasoning about intentional agents, morality, or the intended meaning of the word “cause.” (p. 33)

One particularly significant finding in vignette studies on causal judgment concerns absences. Production theories of causation tend to hold that absences are not causes (e.g., Beebe, 2004; Dowe, 2004; but see Wolff et al. 2010). For instance, on one prominent production theory of causation, causation requires a transfer of conserved physical quantities, e.g., momentum, from one object or event to another (Dowe 2000). But an absence doesn't have any conserved physical quantity to exchange. As a result, on this view, absences are not causes (Dowe 2000). Sara Bernstein writes:

Those who hold oomph or process theories of causation cannot accommodate causation by omission¹, since there is no thing or event from which energy can be transferred.

Counterfactual theorists, on the other hand, generally endorse causation by omission, for omissions easily fit into counterfactuals of the form “If I hadn't failed to water the plant, the plant wouldn't have died.” (2016, p. 2579).

Although production theories tend to maintain that absences are not causes, as several philosophers have pointed out, there are many cases in which an absence does seem to be a cause (e.g., Schaffer 2000, 2004). For instance, in the example of the plant dying mentioned by Bernstein above, it seems plausible to say that *the lack of water* caused the plant to die. And empirical work demonstrates that people tend to think that absences can count as causes (e.g., Clarke et al., 2013; Henne, et. al., 2017; Henne et. al., 2019; though see e.g., Livengood and Machery, 2007).

These findings have been extended in important ways. For instance, judgments about *which* absences are causes are impacted by norm violations. To take one example, Clarke et al., (2013) gave participants the following case:

Two cars, one driven by Greta and the other driven by Rachel, were approaching an intersection. Greta had a green light. Rachel had a red light, but she wasn't paying attention. The lights stayed that way. Unaware of each other, neither driver stepped on the brakes. Both cars collided.

They found that participants were more inclined to judge that Rachel's, as opposed to Greta's, not stepping on the breaks was one of the causes of the collision. The pattern of findings appears best explained by dependence theories (see also Henne et al 2017, 2019 for further evidence). Norm violations appear to guide the selection of counterfactuals even when considering absences. The fact that norm violations guide counterfactual selection whether we are considering non-absence or absence cases suggests that we operate with a thoroughgoing dependence notion of causation (e.g., McGrath 2005; Bernstein 2014).

A second class of examples, involving *double prevention*, also suggests that people operate with a dependence notion of causation. Consider a situation in which two airplanes are on a collision course, but the air traffic controller is about to rectify the situation when he is tackled by a crazed coworker, with the result that the airplanes collide. Thus, the crazed coworker was a double-preventer; he prevented the air traffic controller from preventing the collision. In a case like this, many philosophers have thought that the crazed coworker caused the collision, even though the coworker did not directly produce the collision (Godfrey-Smith 2010; Hall 2004). The empirical results on prevention are somewhat complex (e.g., Walsh & Sloman

¹ In the philosophical literature, “omission” is often used instead of “absence” (see, e.g., Hall and Paul, 2013, p. 4)

2011; Lombrozo 2010). But under conditions relevantly similar to the crazed coworker case, participants tend to affirm that double-preventers are causes (e.g., Lombrozo 2010, study 1).

Thus, much of the recent work suggests that common sense thought and talk about causation is best explicated in terms of dependence, and is entirely neutral about which if any processes hold between a cause and effect. However, one striking feature of almost all the experimental work on causal judgment is that it is conducted using the word “cause”. Here are some representative examples of the sentences that subjects are asked to evaluate in studies on causal judgment:

“Professor Smith caused the problem” (Knobe and Fraser, 2008)

“Did Sam cause the bottle to fall off the wall?” (Walsh and Sloman, 2011)

“Lauren caused the system to crash” (Livengood, Sytsma and Rose, 2017)

“The attending doctor’s decision caused the patients recovery” (Hitchcock & Knobe 2009)

“Alice caused the music to start” (Lombrozo 2010)

“Billy caused the motion detector to go off” (Kominsky and Phillips 2019)

“Turnbull caused Poole’s death” (Alicke, Rose and Bloom 2011)

From a certain perspective, it’s hardly surprising that studies have been conducted using the word “cause”. That, after all, is the notion that we’re trying to understand. However, as Anscombe (1987) observed, much of our causal discourse is not expressed using the term “cause” (which she characterizes as “highly general”), but instead with more *special* causal terms like “scrape”, “burn”, and “knock over” (p. 137). Moreover, it’s plausible that when children learn causal notions, they get at least as much exposure to these special causal verbs as they do to “cause”. A standard reference source on word frequencies, the Corpus of Contemporary American English (COCA), suggests that some special causal verbs are more common in everyday speech than “cause”. Indeed, “break” all by itself is more common than “cause”.

Our hypothesis is that many special causal concepts will diverge in systematic ways from the concept CAUSE. Classic work in linguistics on direct versus indirect causation suggests that there are important differences, e.g., between “kill” and “cause to die” (e.g., Fodor 1970, Katz 1970, but see Neeleman and Van de Koot 2012). While the word “cause” might well fit with a dependence notion of causation, one that is deeply sensitive to normative considerations, special causal verbs like “burn” might fit better with a production-based notion of causation. Absences have been used as a critical test case to distinguish dependence from production notions of causation. So absences provide a particularly good source for testing special causal verbs. As a result, our first study focuses on whether people are less likely to treat absences as special causes.

For all of our studies, we wanted to present participants with minimal pairs that ask about the same event targeting a special causal concept (e.g., *burn*) or a closely matched question that uses *cause*. Fortunately, linguists have articulated a large set of verbs that allow for this alternation. In particular, English has numerous labile causative/inchoative verbs, including *burn* and *break*. With these verbs, embedding the intransitive alternant inside a periphrastic causative (e.g., caused to break) yields a meaning close to the causative alternant (e.g., broke). As Levin and Rappaport Hovav (1994) put it, “the meaning of the transitive use of a verb V can be roughly paraphrased as ‘cause to V-intransitive’” (p. 35; see also Levin, 1993, pgs. 26-27). For example, 1a can be paraphrased as 1b:

1a. Antonia broke the vase

1b Antonia caused the vase to break (pgs. 35-36)

Levin & Rappaport Hovav (1994) dub such verbs “causative alternation” verbs (p. 36). Thus, for a verb like “burn”, we can frame causal statements with the simple form of the causative, e.g., *X burned Y*, or we can frame the statement periphrastically with the word “cause”, e.g., *X caused Y to burn* (see e.g., Dixon 2000 for a general discussion of periphrastic causatives).

Study 1:

For this first study, we wanted to compare judgments about causal statements where the candidate cause (1) either does or does not involve an absence and (2) is expressed either with the simple form of a causative or periphrastically with the word “cause”. Our hypothesis is that for many special causal verbs, people will be less inclined to judge absences to be special causes, when presented with the simple form of the verb. We hasten to note that we are not claiming that all special causal verbs will behave this way. But we did try to get a range of different special causal verbs that allow for causative alternations.

If “cause” typically corresponds to a dependence notion of causation then we should expect people to be similarly inclined to accept periphrastic causal statements that explicitly use the word “cause” regardless of whether the causal candidate involves an absence. By contrast, if a special causal verb like “burn” corresponds more closely to a production-based notion of causation then people should be less inclined to accept the causal statements about absences when the statements are phrased with the simple form of the causal verb.

Methods

One hundred and fifty-two participants (aged 18-61 years, mean age = 30 years; 81 females) were recruited from Amazon Mechanical Turk and tested in Qualtrics.

Materials

Participants read four different cases, presented in random order. After reading each case, participants were shown four statements, randomized using a Latin square, that varied in whether the statement was framed using the periphrastic or simple form and in whether the causal candidate involved an absence. All statements were presented on an initial screen, and then presented again on new single screen for rating (cf. Lombrozo, 2010). Here is an example:

Burn: Jane is spending the afternoon at the beach. Typically, she wears sunscreen when she is on the beach but today she forgets to bring any. As a result, her skin becomes burned.

You will next be asked to rate the extent to which you agree with the statements below. Before making your rating on the next page, please carefully read all of the statements below.

- The lack of sunscreen caused Jane’s skin to burn.
- The lack of sunscreen burned Jane’s skin.
- The sun caused Jane’s skin to burn.
- The sun burned Jane’s skin.

Participants were then taken to a new screen that included only the statements in the same order they appeared when initially encountered. Ratings for each statement were made on a 7-pt Likert scale ranging from strongly disagree to strongly agree.

The other three cases and corresponding statements are below:

Crack: In a dry climate concrete will crack unless a coat of sealant is applied on top. Harry lives in a dry climate and forgets to apply a sealant to his concrete driveway. As a result, the concrete cracks.

The lack of sealant caused the driveway to crack.

The lack of sealant cracked the driveway.

The dry climate caused the driveway to crack.

The dry climate cracked the driveway.

Melt: NASA is testing a rocket which typically has a heat shield surrounding its engine. One day the heat shield falls off and as a result a rubber gasket melts.

The lack of a heat shield caused the rubber gasket to melt.

The lack a of heat shield melted the rubber gasket.

The heat from the engine caused the rubber gasket to melt.

The heat from the engine melted the rubber gasket.

Flood: Jim's basement window usually prevents water from getting into the cellar. But the basement window is being replaced. While his basement window is absent, there is a huge storm and the cellar floods.

The lack of a basement window caused the cellar to flood.

The lack of a basement window flooded the cellar.

The storm caused the cellar to flood.

The storm flooded the cellar.

Results

Data is available online (<https://osf.io/29syb/>). The overall pattern, collapsing across all cases, is presented in Figure 1 below.

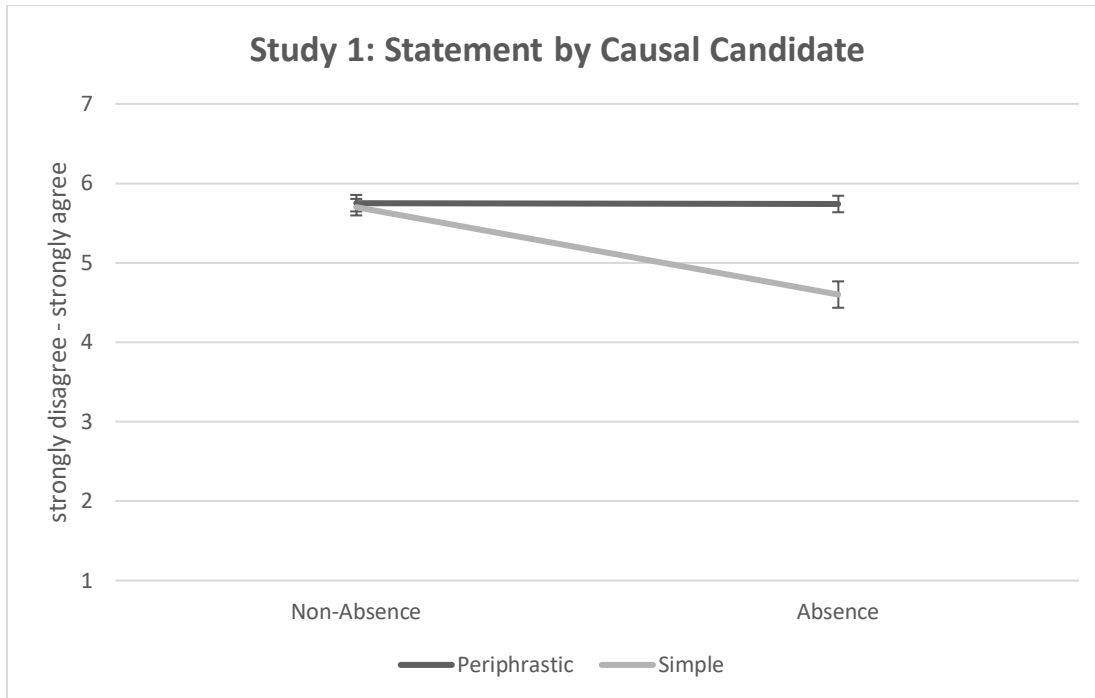


Figure 1: Overall Effect of Statement (Periphrastic, Simple) by Causal Candidate (Non-Absence, Absence) with 95% Confidence Intervals.

We conducted a 2(Statement: Periphrastic Simple) x 2(Causal Candidate: Non-Absence Absence) x 4(Case: Burn, Crack, Melt, Flood) repeated measures ANOVA. There was a main effect of Statement, $F(1, 151)=126.714, p<.001, \eta^2=.456$ and Causal Candidate, $F(1, 151)=62.830, p<.001, \eta^2=.294$ but no effect of Case, $F(3, 151)=.921, p=.431, \eta^2=.006$. There was also a significant two-way interaction between Statement and Causal Candidate, $F(1, 151)=140.825, p<.001, \eta^2=.483$; Statement and Case, $F(3, 151)=3.161, p<.05, \eta^2=.021$; and Causal Candidate and Case, $F(3, 151)=3.581, p<.05, \eta^2=.023$ as well as a three-way interaction between case Statement, Causal Candidate and Case, $F(3, 151)=3.206, p<.05, \eta^2=.021$. Descriptive statistics for individual cases are in Table 1.

Table 1: Study 1 Descriptive Statistics

Case	Statement	Causal Candidate	Mean (SD)	95% CI
Burn	Periphrastic	Non-absence	5.88 (1.31)	[5.67, 6.09]
		Absence	5.66 (1.40)	[5.44, 5.89]
	Simple	Non-absence	6.06 (1.07)	[5.88, 6.23]
		Absence	4.46 (1.97)	[4.14, 4.77]
Crack	Periphrastic	Non-absence	5.80 (1.25)	[5.60, 6.00]
		Absence	5.76 (1.31)	[5.55, 5.97]
	Simple	Non-absence	5.30 (1.51)	[5.06, 5.54]
		Absence	4.61 (2.02)	[4.28, 4.93]
Melt	Periphrastic	Non-absence	5.73 (1.41)	[5.59, 6.01]
		Absence	5.80 (1.30)	[5.50, 5.95]
	Simple	Non-absence	5.71 (1.33)	[5.49, 5.92]
		Absence	4.82 (1.91)	[4.51, 5.12]

Flood	Periphrastic	Non-absence	5.58 (1.41)	[5.35, 5.80]
		Absence	5.71 (1.40)	[5.48, 5.93]
	Simple	Non-absence	5.74 (1.27)	[5.53, 5.94]
		Absence	4.55 (1.93)	[4.24, 4.86]

The crucial finding, depicted in Figure 1, is that causal judgments are similar for the causal candidate that does not involve an absence but different for the causal candidate that involves an absence. More specifically, the important two-way interaction between Statement and Causal Candidate indicates that for the non-absence causal candidate, causal judgments are similar whether people are considering the periphrastic (e.g., the sun caused Jane’s skin to burn) or simple statement (e.g. the sun burned Jane’s skin). But for the causal candidate involving an absence, people are less inclined to agree with the simple causative statement (e.g., the lack of sunscreen burned Jane’s skin) than the periphrastic causative (e.g., the lack of sunscreen caused Jane’s skin to burn). Thus, in these cases, periphrastic causal statements that explicitly use the word “cause” are accepted regardless of whether the causal candidate involves an absence. And this fits with familiar dependence theories of causation, which maintain that even absences can be causes. But when the special causal verb is used in its simple form, the situation is very different. In those cases, absences are less likely to be treated as causes. This fits with familiar production theories of causation which deny that absences are causes.² Further, the three-way interaction we found suggests that the type of verb, in particular the type of verb in the simple statements, behave similarly though somewhat differently. But the important point is that people are much less inclined to apply them to absences in comparison to “cause”.

As we documented above, much of the experimental work on causal attribution supports the view that we operate with a thoroughgoing dependence notion of causation. But that, we suggest, is because the previous studies had a strictly limited budget of causal verbs. Once we take in a wider range of causal verbs we get a much different take on causal cognition, which is that production-based notions do play an important role in causal judgment.

Study 2

The findings from study 1 support our hypothesis that many special causal concepts will diverge in systematic ways from the concept CAUSE. More specifically, we find that for many special causal verbs, people are less likely to judge absences to be special causes. In study 1, we selected the special causal verbs ourselves. We did this because we wanted an existence proof for the idea that at least for some special causal verbs, absences would be less likely to be treated as causes. Again, we would emphasize that we are not proposing that no special causal verbs will allow absences as causes. For instance, “kill” is a special causal verb that might permit absences as causes, as in the sentence “the lack of water killed the plants”.

² To check for individual differences, we took the difference between absence and non-absence for both periphrastic and simple statements. We then took the difference of these two resulting differences and plotted a histogram to check whether the distribution might be multimodal. The resultant distribution was instead a normal distribution. We thank an anonymous referee for urging us to check this here and in subsequent studies.

Although we are not making universal claims about special causal verbs, in study 2 we wanted to test a sample of special causal verbs that we didn't handpick. To this end, we assembled all of the causative/inchoative alternation verbs from Levin's (1993) extensive list. This resulted in a list of 311 verbs. We then obtained frequency information on the use of each verb from COCA and ordered the list of verbs by frequency.³ Including "cause" for reference, here are the top twelve verbs ordered by frequency:

Table 2: Causal Verb Frequencies from Levin (1993)

Verb	Frequency
turn	477668
move	430324
change	327637
grow	248803
open	247043
break	213364
cause	170629
increase	137709
close	136431
drop	134220
fill	125249
worry	119256
improve	94764

Excluding "cause", we then randomly selected four verbs from the list in Table 2. The verbs that the random selection function returned were: turn, grow, increase and drop. These served as the target verbs in study 2.

A second issue concerning study 1 is the mean responses to cases involving absences. If special causal verbs tap into a production-based notion of causation, then one might wonder why people are overall somewhat inclined to judge absences as special causes in study 1. We emphasize that our hypothesis is that people will be less inclined to accept the simple statement of the special causal verb in cases involving absences. Nonetheless, it is somewhat surprising that people find the simple statement, "The lack of sunscreen burned Jane's skin", even somewhat acceptable, especially since we suspect that for many readers this statement hits the ear like nails on a chalkboard. So what's going on? Pragmatic factors might be leading to some distortion. A principle of charity might incline one to "somewhat agree" to a sentence that is strictly speaking incorrect, but captures something significant about a situation. For instance, suppose you are walking around Manhattan and someone stops you to ask, "Is the Empire State Building in Fifth Avenue?". Only a jerk would say "no". Instead, we suspect that your likely response will be "yes", even while knowing full well that the Empire State Building is *on* Fifth Avenue, not *in* Fifth Avenue. In order to encourage stricter evaluation of the sentences, in study 2 we framed the question as a query from someone trying to learn English. We anticipated that such a context might lead to a tightening up of standards. In addition, to reduce the potential effects of repeated

³ Some verbs on the list e.g., volatilize, vitrify, lignify, turned up no frequency data in COCA.

exposure to these unusual constructions, each subject only saw one vignette. Thus, using our new stock of causal verbs, in study 2 we investigate whether people are less inclined to view absences as special causes when considering a single case in a context where they are judging the accuracy of statements in response to queries from an English learner.

Methods

Two hundred and forty-three participants (aged 18-61 years, mean age = 26 years; 101 females) were recruited from Prolific and tested in Qualtrics.

Materials

Participants completed a survey in which they were randomly assigned to read one of four cases. After reading the case, participants were shown four statements, randomized using a Latin square, that varied in whether the statement was framed using the periphrastic or simple form and in whether the causal candidate involved an absence. On the same screen, they then rated the appropriateness of each statement presented in the same order. Here is an example:

Turn: Joan's robotic vacuum has a built-in controller that keeps it from falling down stairs. It works by detecting where the floor ends and then activating a motor which moves the wheels to the left. The vacuum approaches the stairs. The controller detects that the floor has ended and activates the motor. As a result, the vacuum turns away from the stairs.

Imagine someone is trying to learn English from you and asks you to indicate how accurate each of these statements is:

The lack of floor turned the vacuum.
The lack of floor caused the vacuum to turn.
The controller turned the vacuum.
The controller caused the vacuum to turn.

Participants then rated each statement on a 7-point scale ranging from completely inaccurate to completely accurate. As a comprehension check, participants were then taken to a new screen where they were asked to evaluate a false statement. The story remained at the top of the page and they were asked:

Now imagine the person trying to learn English from you asks you to indicate how accurate this statement is:

The metal casing caused the vacuum to turn.

Ratings were made on the same 7-point scale.

Here are the other three cases and their accompanying statements:

Grow: For a science project, Susie needed to produce mold. She decided to use bread to do this. She lives in a humid climate so that will help, but it takes too long. So she

decides to put the bread in a drawer where there is no light. As a result, within two days, mold grows on the bread.

The lack of light grew the mold.

The lack of light caused the mold to grow.

Susie grew the mold.

Susie caused the mold to grow.

Comprehension check: The drawer handle caused the mold to grow.

Increase: The water pump kicks on when water levels in the pool drop. Water flow is regulated by a valve that plugs the pump hose. So that water can flow from the pump into the pool, the valve automatically releases the plug when enough pressure builds. One day, water pressure from the pump builds and the valve releases the plug. As a result, the water level in the pool increases.

The lack of a plug increased the water level.

The lack of a plug caused the water level to increase.

The pump increased the water level.

The pump caused the water level to increase.

Comprehension check: The diving board caused the water level to increase.

Drop: Mark is flying his hot air balloon, which has four sandbags that he can release when he wants to gain altitude. Each sandbag is held by a small platform jutting out from the basket. The sandbags are released by pressing a button that retracts the platform into the basket. There is only one sandbag left, and Mark wants to go even higher, so he presses the button. As a result, the platform is retracted into the basket and the sandbag drops.

The lack of a platform dropped the sandbag.

The lack of a platform caused the sandbag to drop.

Mark dropped the sandbag.

Mark caused the sandbag to drop.

Comprehension check: The sky caused the sandbag to drop.

Results

Data is available online (<https://osf.io/zt87f/>). The overall pattern of findings are shown in Figure 2. Here we include the overall pattern of results including all participants and only those participants who passed the comprehension question.

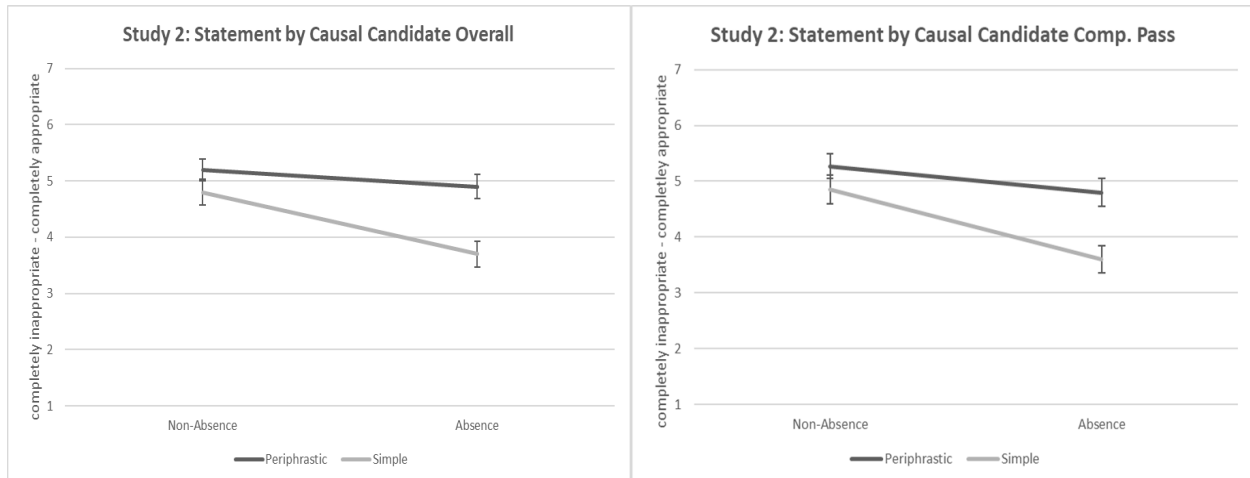


Figure 2: Overall Effect of Statement (Periphrastic, Simple) by Causal Candidate (Non-Absence, Absence) with 95% Confidence Intervals Including All Participants (Left) and Only Those Who Passed the Comprehension Question (Right)

We conducted a 2(Statement: Periphrastic, Simple) x 2(Causal Candidate: Non-Absence, Absence) x 4(Case: Turn, Grow, Increase, Drop) mixed ANOVA with Statement and Causal Candidate as within-subjects factors and Case as a between-subjects factor. There was a main effect of Statement, $F(1, 239)=75.263, p<.001, \eta^2=.239$ and Causal Candidate, $F(1, 239)=35.180, p<.001, \eta^2=.117$ but no effect of Case, $F(3, 239)=.502, p=.681, \eta^2=.006$. There was also a significant two-way interaction between Statement and Causal Candidate, $F(1, 239)=14.753, p<.001, \eta^2=.058$; Statement and Case, $F(3, 239)=4.275, p<.05, \eta^2=.051$; and Causal Candidate and Case, $F(3, 239)=12.012, p<.001, \eta^2=.131$ as well as a three-way interaction between case Statement, Causal Candidate and Case, $F(3, 239)=2.998, p<.05, \eta^2=.036$. We found that ratings for the false statements were overall very low ($M=1.95, SD=1.46$), suggesting that people were attentive and understood the dependent measure. Removing those who gave a 4 or higher in response to the false statements, we end up with a very similar model.⁴ Descriptive statistics for individual cases— including all participants and excluding those who gave a 4 or higher on the comprehension check—are in Table 3.

Table 3: Study 2 Descriptive Statistics for All Participants (Overall) and Only Those Who Passed the Comprehension Question (Comp. Pass)

Case	Statement	Causal Candidate	Overall	95% CI	Comp. Pass	95% CI
			Mean (SD)		Mean (SD)	
Turn	Periphrastic	Non-absence	5.07 (1.61)	[4.68, 5.45]	5.19 (1.68)	[4.75, 5.63]
		Absence	5.17 (1.38)	[4.73, 5.60]	5.23(1.48)	[4.72, 5.75]

⁴ Forty-two participants gave a rating of 4 or higher on the false statements. Analyzing data from the remaining 201 participants, the results from the mixed ANOVA are as follows: There was a main effect of Statement, $F(1, 197)=69.091, p<.001, \eta^2=.260$ and Causal Candidate, $F(1, 197)=33.390, p<.001, \eta^2=.145$ but no effect of Case, $F(3, 197)=.481, p=.696, \eta^2=.007$. There was also a significant two-way interaction between Statement and Causal Candidate, $F(1, 197)=17.747, p<.001, \eta^2=.083$; Statement and Case, $F(3, 197)=4.103, p<.01, \eta^2=.059$; and Causal Candidate and Case, $F(3, 197)=12.105, p<.001, \eta^2=.156$ as well as a three-way interaction between case Statement, Causal Candidate and Case, $F(3, 197)=2.905, p<.05, \eta^2=.042$.

	Simple	Non-absence	4.60 (1.83)	[4.15, 5.05]	4.70 (1.89)	[4.18, 5.23]
		Absence	3.47 (1.79)	[3.02, 3.92]	3.19 (1.60)	[2.69, 3.68]
Grow	Periphrastic	Non-absence	4.82 (1.58)	[4.44, 5.20]	5.19 (1.68)	[4.39, 5.21]
		Absence	5.73 (1.36)	[5.29, 6.16]	5.74 (1.35)	[5.26, 6.22]
	Simple	Non-absence	4.32 (1.85)	[3.88, 4.77]	4.33 (1.88)	[3.84, 4.82]
		Absence	4.16 (1.63)	[3.72, 4.60]	4.09 (1.66)	[3.63, 4.56]
Increase	Periphrastic	Non-absence	5.24 (1.47)	[4.85, 5.63]	5.14(1.51)	[4.61, 5.61]
		Absence	4.21 (2.02)	[3.76, 4.65]	4.21 (2.14)	[3.67, 4.75]
	Simple	Non-absence	4.97 (1.65)	[4.51, 5.43]	4.93 (1.77)	[4.37, 5.49]
		Absence	3.95 (1.89)	[3.49, 4.40]	3.85 (1.86)	[3.34, 4.38]
Drop	Periphrastic	Non-absence	5.84 (1.38)	[5.47, 6.22]	5.95 (1.33)	[5.55, 6.34]
		Absence	4.29 (1.99)	[3.86, 4.71]	4.19 (2.04)	[3.73, 4.65]
	Simple	Non-absence	5.29 (1.76)	[4.85, 5.73]	5.40 (1.77)	[4.92, 5.87]
		Absence	3.40 (1.73)	[2.96, 3.83]	3.28 (1.74)	[2.83, 3.72]

Thus, we replicated the overall pattern of findings in study 1 using a new stock of special causal verbs.⁵ Moreover, in contrast to study 1 where we found that participants were somewhat inclined to agree with the simple statement concerning absences, here we found that people were somewhat inclined to regard those statements as inaccurate. By switching to a single case and having participants evaluate statements in response to queries from an English learner it seems that we were able to reduce some pragmatic pressures present in our initial study that may have led to an overall inflation in responses.

Using a new selection of special causal verbs, we continue to find evidence suggesting that while “cause” might express dependence, special cause verbs might express production relations. The crucial two-way interaction between the Statement and Causal Candidate supports this. And, as in study 1, we also found a three-way interaction. Yet while each special causal verb might behave somewhat differently, they each behave similarly in that people are much less inclined to apply them, in comparison to “cause”, in cases involving absences.

Study 3

Our first two studies looked at judgments involving putative causation by absence. Philosophers have invoked causation by absence as undermining production theories of causation. And psychologists have found that participants are quite happy to allow causation by absence. This is then taken to suggest that ordinary judgments of causation are guided by a dependence notion rather than a production notion. Although causation by absence is the most prominent case brought against production theories, another important alleged counterexample, as noted above, involves double prevention. It seems that the crazed coworker caused the collision of the

⁵ We again checked for individual differences in the same way we did in study 1 (see fn 3) and found that the resulting histogram was normally distributed.

airplanes by preventing the air traffic controller from preventing the collision. Lombrozo's (2010) work corroborates this intuition. In cases where a person intentionally prevents someone from preventing an outcome, Lombrozo finds that people endorse causation by prevention. Here is one of the cases she tests:

Alice, Bob, and Carol have spent the afternoon juggling and listening to music. At the moment, Alice is juggling and the music is not playing. Alice wants to listen to music, so she deliberately throws a juggling ball, which heads straight for the stereo's 'on' button. But while Alice's ball is in the air, Bob starts pulling on the power cord connecting the stereo to the outlet. If Bob unplugs the cord, it will prevent Alice's ball from turning on the stereo and starting the music. However, Carol wants the music to play, so she deliberately steps on the power cord just before Alice's ball hits the 'on' button, preventing Bob's pull from unplugging the stereo. As a result of these events, the music starts to play.

After reading the case, participants are asked to rate the propriety of statements like "Alice caused the music to start" and "Carol caused the music to start".

As Lombrozo (2010) explains, "in this scenario, the outcome (the music starting) depends on both the actions of Alice (the "transference" cause) and on the actions of Carol (the "dependence" cause). Thus according to a dependence theory, both Alice and Carol can appropriately be judged causes of the outcome. However, only Alice's actions transfer a force or quantity to the stereo. On a transference [i.e., production] theory, Alice is the only cause of the outcome." (p. 311). Lombrozo finds that in the case above, where both Alice and Carol act intentionally, people are inclined to judge both of their actions as causes of the music starting. And this fits with the view that people are applying a dependence-based notion of causation, at least under conditions of intentional action.

We offer a different proposal. Lombrozo's task solicited causal judgments about periphrastic causal statements like "Carol caused the music to start". We suspect that this phrasing plays an essential role in facilitating propriety judgments that appear to support the view that people operate with a dependence-based notion of causation under conditions of intentional action. By contrast, if participants were presented with the simple form of the statement featuring the special causal verb – in this case "start" – we predict that people will be less inclined to judge that Carol started the music. Such a finding would cohere with our proposal that special causal verbs often express a production-based notion of causation.

Methods

Forty-nine participants (aged 18-63 years, mean age = 29 years; 22 females) were recruited from Prolific and tested in Qualtrics.

Materials

Participants were presented with the above case featuring Alice, Carol and Bob.⁶ After reading the case, participants received the same prompt as they did in study 2 where they were asked to

⁶ Lombrozo's study 1 also included another vignette, involving submitting an order for pens. But the relevant verbs in that vignette don't allow causative alternation, and so we focused on the music vignette.

imagine an English learner asking about the accuracy of various statements. This appeared as follows:

Imagine someone is trying to learn English from you and asks you to indicate how accurate each of these statements is:

Carol started the music.
Carol caused the music to start.
Alice started the music.
Alice caused the music to start.

Participants then rated each statement on a 7-pt Likert scale ranging from completely inaccurate to completely accurate. Lastly, they were then taken to a new screen with the story remaining at the top and were asked the following comprehension question:

Who stepped on the cord? (Alice/Bob/Carol)

Results

Data is available online (<https://osf.io/t3r67/>). We conducted a 2(Statement: Periphrastic Simple) x 2(Causal Candidate: Alice, Carol) repeated measures ANOVA, excluding the three people who missed the comprehension question.⁷ There was a main effect of Statement, $F(1, 45)=4.218$, $p<.05$, $\eta^2=.086$ and an effect of Causal Candidate, $F(1, 45)=10.520$, $p<.01$, $\eta^2=.189$. There was also a significant two-way interaction between Statement and Causal Candidate, $F(1, 45)=11.711$, $p<.01$, $\eta^2=.207$. The results are shown in Figure 3.

⁷ Including those who failed the comprehension question in the data analysis produces the same basic results: there is a main effect of main effect of Statement, $F(1, 48)=4.639$, $p<.05$, $\eta^2=.088$, an effect of Causal Candidate, $F(1, 48)=12.284$, $p<.01$, $\eta^2=.204$ and a significant two-way interaction between Statement and Causal Candidate (Alice Periphrastic: $M=5.00$, $SD=1.89$; Alice Simple: $M=5.33$, $SD=1.94$; Carol Periphrastic: $M=4.51$, $SD=2.00$; Carol Simple= 3.24 , $SD=1.96$), $F(1, 48)=11.164$, $p<.01$, $\eta^2=.189$.

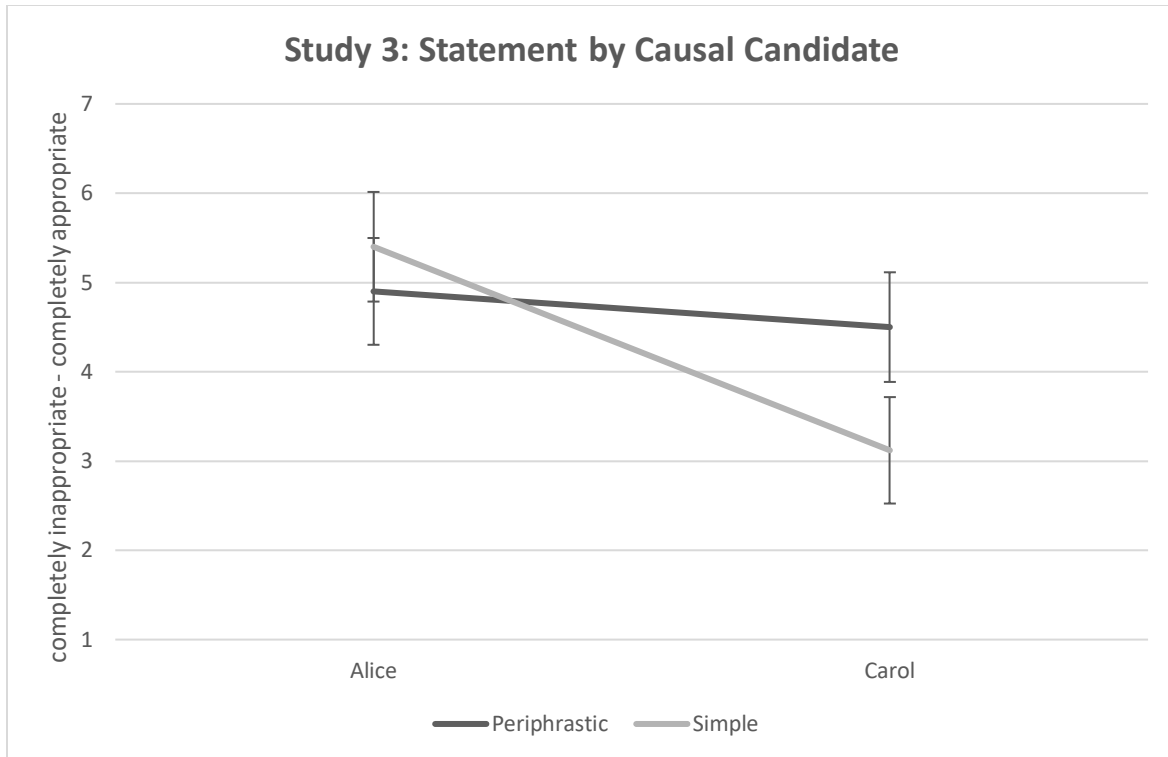


Figure 3: Effect of Statement (Periphrastic, Simple) by Causal Candidate (Alice, Carol) with 95% Confidence Intervals.

Here we replicate Lombrozo’s (2010) finding that when both Alice and Carol act intentionally, people are inclined to judge that they caused the music to start. But this only obtains when evaluating the periphrastic statement that explicitly features the word “cause”. When considering the simple form of the statement featuring only the special causal verb “start”, the situation is very different. People are inclined to judge that the non-production causal candidate, Carol, did not start the music.⁸ Thus, just as people are disinclined to regard absences as causes for many special causal verbs, here we find people disinclined to regard double preventers as causes. As with the results of the previous experiments on causation by absence, the results of this study fit with our proposal that special causal verbs often express production-based notions of causation.

Study 4

Studies 1 through 3 indicate that in many cases, special causal verbs do not conform to the predictions of dependence theories of causation. Previous work on absences and double prevention indicate that people will assent to “X caused Y to ϕ ” when X is an absence or a double preventer. We replicated this familiar result for a wide range of special causal verbs, but also showed that while people assented to “X caused Y to ϕ ”, they were less inclined to assent to “X ϕ -ed Y”. This shows a characteristic pattern of failure of entailment. The fact that *X caused Y to break* doesn’t seem to entail that *X broke Y*, in cases of absences and double preventions.

⁸ We again checked for individual differences in the same way we did in our previous studies and found that the resulting histogram was normally distributed.

A natural idea is that the notion of cause is a more general notion which captures something common among all the special causal verbs. Indeed, Anscombe (1987) seems to treat the situation in this way: when she considers “cause” in contrast to the special causal verbs, she maintains that “the word “cause” itself is highly general” (p. 137). The idea would be that there’s some abstract relation that is shared across all the special causal verbs and is represented by “cause”. So, even though our earlier studies show that there is a failure of entailment from “X caused Y to ϕ ” to “X ϕ -ed Y”, one might expect entailments in the other direction. On this view, if *X broke Y* holds, then so should *X caused Y to break*. However, another possibility is that “cause” is a verb that is special in its own way, shaped by a variety of human interests, and that it doesn’t have a pure general content that is common across all of these different special causal verbs.

In the recent empirical literature on causal judgment, some have proposed that the verb “cause” is distinctively tied to responsibility (e.g., Livengood, Sytsma and Rose, 2017; Sytsma et al, 2019). Summing up some of this research, Hitchcock (2007), writes:

These results, if taken at face value, suggest that causal attribution is not conceptually prior to the evaluation of moral responsibility, but is in fact more tightly bound up with judgments of moral responsibility: we are more strongly inclined to judge that an agent’s actions caused some negative outcome when we judge the agent to be blameworthy in other respects. In this regard, ordinary causal attributions are not purely objective, since they depend, in part, upon our value judgments (p. 513).

A related idea comes from ancient philosophy, where it is suggested that the notion of cause (*aition*) deployed in ancient Greek philosophy means *responsible for* and is closely associated with legal contexts (e.g., Sedley, 1988, p. 115). If that’s so, then we might find cases where participants accept a statement that uses a verb like “crack” in its simple form (*X cracked Y*), while being less inclined to accept a statement that uses the periphrastic alternant (*X caused Y to crack*) (because responsibility is absent). Thus, in this next study, we wanted to see whether there are cases in which participants would agree to the simple causative statement but not to the corresponding periphrastic statement using “cause”.

We designed this study with the role of responsibility in mind and so created cases where there is a causal chain leading to a bad outcome.⁹ The chain involved a distal agent and a proximal agent and ultimately the bad outcome. We made it so that it is intuitively plausible that the distal agent is responsible for the outcome, but the proximal agent is not. We predict here that since the distal agent would be viewed as responsible, participants would be more inclined to affirm the periphrastic form of the causal statement, “X caused Y to ϕ ” for the distal agent as compared to the proximal agent. By contrast, when the causal statement is made with the simple form of the verb, “X ϕ -ed Y”, the situation is different. For many of these special causal verbs, including the verbs we have been investigating, we suspect that the specified relation requires proximity between the cause and the effect.¹⁰ As a result, we predict that when presented with a statement using the simple form of the causal verb (e.g., “X cracked Y”), participants will think

⁹ We emphasize that we are not committing ourselves to the view that responsibility captures everything there is about causal attribution using the word “cause”. Rather, we’re drawing on the earlier work primarily as a basis for generating materials to test for a dissociation between “cause” and special causal verbs.

¹⁰ This means that we do not expect these causal relations to be transitive. This fits with classic views about direct causal verbs (see, e.g., Shibatani 1976). While some theorists have maintained that causal relations are transitive, this is not an essential commitment of production theories of causation (see, e.g. Hall and Paul 2013, p. 220).

that the relation holds between the proximal agent and the outcome, but not between the distal agent and the outcome.

Methods

One hundred and forty-two participants (aged 18-64 years, mean age = 31 years; 65 females) were recruited from Amazon Mechanical Turk and tested in Qualtrics.

Materials

As in study 1, participants read four different cases, presented in random order. After reading each case, participants were shown four statements, randomized using a Latin square, that varied in whether the statement was (1) framed with the simple form of the causative or periphrastically with “cause” and in whether (2) the causal candidate was an initiating or intermediary factor. Again, after reading each statement, they were then taken to a new screen where they rated agreement with the statements on a 7-pt Likert scale ranging from strongly disagree to strongly agree. Here are the cases with the 4 different statements (which we represent here with a 2 x 2 table, but the participants just got the statements):

Crack: Gus is drunk. He almost fell as he stood up from his stool, but grabbed the coat sleeve of Billy and Billy fell into a painting. As a result, the frame of the painting cracked.

	Distal	Proximal
Periphrastic	Gus caused the frame to crack	Billy caused the frame to crack
Simple	Gus cracked the frame	Billy cracked the frame

Bend: A blue car hit a red car, propelling it into a street sign. As a result, the street sign bent.

	Distal	Proximal
Periphrastic	The blue car caused the sign to bend	The red car caused the sign to bend.
Simple	The blue car bent the sign.	The red car bent the sign.

Spill: Suzy sneaks up on Andy and blasts a loud air horn as a practical joke. A startled Andy jumps. As a result, the drink he was holding spills.

	Distal	Proximal
Periphrastic	Suzy caused the drink to spill.	Andy caused the drink to spill.
Simple	Suzy spilled the drink.	Andy spilled the drink.

Break: A cyclist is speeding around a turn on a path and hits a pedestrian who then falls into a railing. As a result, the railing breaks.

	Distal	Proximal
Periphrastic	The cyclist caused the railing to break.	The pedestrian caused the railing to break.
Simple	The cyclist broke the railing.	The pedestrian broke the railing.

Results

Data is available online (<https://osf.io/gyzun/>). The overall pattern across cases is shown in Figure 4.

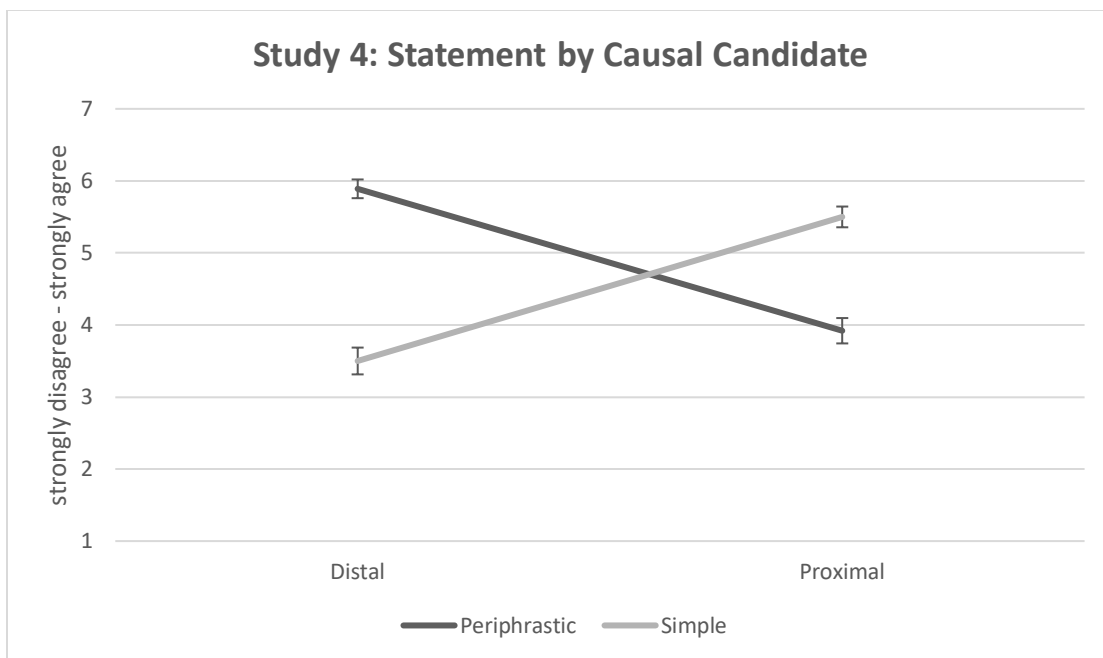


Figure 4: Overall Effect of Statement (Periphrastic, Simple) by Causal Candidate (Distal, Proximal) with 95% Confidence Intervals.

We again conducted a 2(Statement: Periphrastic, Simple) x 2(Causal Candidate: Distal, Proximal) x 4(Case: Bend, Crack, Spill, Break) repeated measures ANOVA. There was a main effect of Statement, $F(1, 141)=62.207, p<.001, \eta^2=.306$ but no effect of Causal Candidate, $F(1, 141)=.195, p=.660, \eta^2=.001$ and no effect of Case, $F(3, 141)=1.222, p=.301, \eta^2=.009$. There was also a significant two-way interaction between Statement and Causal Candidate, $F(1, 141)=405.524, p<.001, \eta^2=.742$; Causal Candidate and Case, $F(3, 141)=3.115, p<.05, \eta^2=.022$; but no interaction between Statement and Case, $F(3, 141)=2.169, p=.091, \eta^2=.015$. Lastly, there was a three-way interaction between case Statement, Causal Candidate and Case, $F(3, 141)=7.054, p<.001, \eta^2=.048$. Descriptive statistics for individual cases are in Table 4.

Table 4: Study 4 Descriptive Statistics

Case	Causal Candidate	Statement	Mean (SD)	95% CI
Bend	Distal	Periphrastic	5.56 (1.61)	[5.29, 5.82]

		Simple	3.57 (2.18)	[3.21, 3.93]
	Proximal	Periphrastic	4.58 (2.02)	[4.25, 4.91]
		Simple	5.46 (1.79)	[5.16, 5.75]
Crack	Distal	Periphrastic	5.98 (1.35)	[5.75, 6.20]
		Simple	3.44 (2.00)	[3.11, 3.76]
	Proximal	Periphrastic	3.72 (1.98)	[3.39, 4.04]
		Simple	5.48 (1.75)	[5.21, 5.73]
Spill	Distal	Periphrastic	6.07 (1.24)	[5.86, 6.27]
		Simple	3.18 (2.04)	[2.84, 3.52]
	Proximal	Periphrastic	3.55 (2.04)	[3.21, 3.88]
		Simple	5.83 (1.43)	[5.59, 6.06]
Break	Distal	Periphrastic	5.95 (1.38)	[5.72, 6.18]
		Simple	3.82 (2.13)	[3.47, 4.17]
	Proximal	Periphrastic	3.86 (1.97)	[3.53, 4.18]
		Simple	5.42 (1.67)	[5.14, 5.70]

We find exactly the sharp dissociation we predicted. The crucial two-way interaction between Statement and Causal Candidate indicates that when asked to evaluate the statement that uses the simple form of the causative (e.g., X broke the railing), people were more inclined to agree that the proximal agent was the special cause than that the distal agent was. This fits with the idea that the special causal verb denotes a particular relation, which obtains between the proximal agent and the outcome but not between the distal agent and the outcome. By contrast, when asked to evaluate the periphrastic statement using the word “cause” (e.g., X caused the railing to break), people were more inclined to agree that the distal agent was the cause than that the proximal agent was.¹¹ This fits with the suggestion that the verb “cause” is semantically linked to responsibility, since in all of the vignettes, the distal agent is intuitively responsible for the bad outcome and the proximal agent is not intuitively responsible. Of course, we didn’t directly manipulate responsibility but instead manipulated whether the causal candidate was distal or proximal and whether the special causal verb was used in its simple form or periphrastically with “cause”. But given the range of research suggesting that “cause” is semantically linked to responsibility (e.g., Sytsma, Livengood and Rose, 2011; Livengood, Rose and Sytsma, 2017; Sytsma et. al., 2019), we think it is reasonable to take the current findings, indirect as they are, as building upon that work. However, the more important point for our purposes is that this study shows that the notion of cause is not simply a more general relation that holds for all the specific relations indicated by special causal verbs. In particular, we find that for many special causal verbs, people’s judgments do not respect an entailment from “X ϕ -ed Y” to “X caused Y to ϕ ”.

We also note that here, as in studies 1 and 2, we found a three-way interaction. In particular, this interaction is such that it suggests that while each special verb behaves similarly, each is also somewhat unique. Importantly, our findings together suggest that “cause” and a

¹¹ We again checked for individual differences in the same way we did in the previous studies. The difference here was that instead of taking the difference between absence and non-absence for both periphrastic and simple statements, we instead took the difference between proximal and distal for both of these statements. We then took the difference of these two resulting differences and found that the resulting histogram was normally distributed.

range of special causal verbs are treated differently: “cause” appears largely consonant with a dependence based notion of causation while at the same time being tied into notions of responsibility; special causal verbs look to largely tap into a production based notion of causation, perhaps even, as we suggest below, reflecting a plurality of unique production relations.

General discussion

A range of previous work on causal judgment indicates that the everyday notion of causation coheres with dependence theories of causation. Part of what makes this result philosophically significant is that dependence theories of causation take on fewer metaphysical commitments than production accounts. For instance, the conserved quantity account of causation is hard to apply to causal statements in sciences like biology and psychology, and this is taken to be a serious strike against it (see e.g. Craver & Tabery 2019). And insofar as a production account invokes a metaphysically controversial notion of oomph, this will render such accounts philosophically problematic. By contrast, dependence theories can be broadly neutral about mechanisms that link cause and effect, and so these theories are insulated from such problems. As a result, insofar as the commonsense notion of causation is a dependence notion, commonsense is similarly insulated from problematic commitments.

Our studies suggest that it’s premature to endorse this picture of commonsense causal thought as metaphysically neutral. Previous studies suggest that the relation picked out by “cause” is a relation of dependence rather than production. Most prominently, people judge absences and double preventers to be causes, and this is hard to square with production accounts of causation but is easily accommodated by a dependence theory. However, almost all of these studies on causal judgment examined the issue by asking people for their judgments about causal statements that explicitly use the word “cause”. We expanded the investigation of causal judgment by including special causal verbs like “burn”, “turn”, “crack” and “start”.

In studies 1 and 2, we replicated the basic finding that people will affirm absences as causes, as in “The lack of sunscreen caused Jane’s skin to burn”; but we also found people were less inclined to affirm a closely matched statement “The lack of sunscreen burned Jane’s skin”. In study 3, we replicated Lombrozo’s finding that when asked to evaluate a sentence about a double preventer, “Carol caused the music to start”, participants tended to rate this as accurate; but we also found that people were less inclined to affirm the closely matched simple causal statement, “Carol started the music”. Thus, for absences and double preventers, we found a systematic failure of entailment: across a wide range of special causal verbs people assented to “X caused Y to ϕ ”, but were less inclined to assent to “X ϕ -ed Y”. In our fourth and final study, we looked whether we could find evidence of a failure of entailment in other direction. We found that for a range of cases involving a proximal agent P, people assented to simple causal statements of the form “P ϕ -ed Y” but were less inclined to assent to the periphrastic alternant “P caused Y to ϕ ”. Our strategy for constructing these cases was to draw on the idea that causal attribution is often bound up with attribution of responsibility. In the cases we constructed, it was natural to interpret a distal agent, rather than the proximal agent, as responsible for the outcome. Accordingly, we found that for a distal agent D, people assented to “D caused Y to ϕ ” but were less inclined to assent to “D ϕ -ed Y”. In effect, we find a double dissociation between special causal verbs, like “burn”, and “cause”. For many scenarios, “X caused Y to ϕ ” neither entails nor is entailed by “X ϕ -ed Y”.

Our results are naturally interpreted as indicating that many special causal verbs implicate a production-based notion of causation. Most production accounts of causation deny that absences and double preventers count as causation, and we found that people's judgments about special causal verbs pattern in this way. Of course, we aren't the first to suggest that commonsense fundamentally trades in production-based notions of causation. Perhaps the most prominent advocate is Phillip Wolff, who has developed an analysis of causal terms ("cause", "prevent", and "allow") in terms of forces. For instance, "X caused Y" implies that X (the *affector*) exerted a force on Y (the *patient*) that was counter to the existing tendency of Y (see, e.g. Wolff 2007, Wolff et al. 2010). We resonate with Wolff's enthusiasm for production theories, and our own efforts have been to expand the reach of production theories into special causal verbs. However, there is a critical point on which we diverge from Wolff – the treatment of causation by absence. Although many theorists take causation by absence to be a problem for production theories, Wolff et al. (2010) develop a treatment of causation by absence which they take to be broadly consistent with production theories. On their proposal:

absences are causal when the removal or non-realization of an anticipated force leads to an effect. To illustrate this idea, consider a situation in which a car is held off the ground by a jack. A man pushes the jack aside – removing the force holding up the car – and the car falls to the ground. The situation instantiates a type of causation by absence, as indicated by the acceptability of the description, "The lack of a Jack cause the car to fall to the ground" (p. 193).

In brief, the idea is that the removal of a pre-existing force counts as a cause. A series of studies appears to provide support for this proposal (Wolff et al. 2010; cf. Khemlani et al. 2018).

Wolff and colleagues' account thus attempts to provide a production-like explanation of judgments that absences are causes. Although this has the virtue of being a unified theory of causal judgment, it comes at the cost of rejecting a core intuition behind production accounts: namely, that there can be no causation by absence because absences don't actually produce anything. Our own approach has been to respect the intuition that absences can't be causes. And when we look at special causal verbs, we find that people are more inclined to demur from causation by absence. More importantly, Wolff and colleagues' theory of causation-by-absence doesn't explain why we find differences between judgments of absence causation for simple causal statements and periphrastic ones.

As noted, taken together, our studies suggest that there is a double dissociation between special causal verbs like "break" and "cause" and their periphrastic alternants. While people allow causation by absence and prevention in the case of "cause", they tend to reject these kinds of causation in the case of "break". And study 4 indicated that for some cases people would affirm that an individual broke something while denying that he "caused it to break". We take these results to point towards a pluralist account of causal attribution, since it seems that different criteria are used to evaluate a sentence like "X broke Y" and one like "X caused Y to break". But the kind of pluralism suggested by our results differs from prevailing proposals.

A number of philosophers have promoted causal pluralism where, as Godfrey Smith, notes, the pluralism always seems to amount to $N = 2$ (e.g., Godfrey-Smith, 2010; Hall, 2004; Sober 1984). These proposals, such as Hall's (2004), typically proceed by noting that some cases (e.g., late preemption and overdetermination) seem to support a production-based notion of causation and others (e.g., absences and double prevention) seem to support a dependence-based notion of causation. And having noted the persistent failure to provide a unified treatment,

the proposal is that we have two different concepts that track two fundamentally different kinds of causal relations, a relation of dependence and a relation of production.

In psychology, Tania Lombrozo has developed a somewhat different version of causal pluralism (2010). Lombrozo doesn't pronounce on whether there are two fundamentally different kinds of causal relations. But she concurs with the idea that we operate with two concepts of causation – a production-based concept and a dependence-based concept. Whether one or the other is elicited depends on whether an event is viewed in teleological or mechanistic terms. More specifically, if an event is viewed teleologically—in intentional, goal-directed terms—then people should be more inclined to make causal judgments that fit familiar patterns of dependence than if the event is viewed mechanistically or as accidental. Lombrozo's results on double prevention cases support this claim. When the double preventer is clearly seeking a goal, people are more inclined to say that she was a cause than when the double preventer's contribution to the outcome is accidental (Lombrozo 2010, pgs. 311-313).

Our study 3 replicated Lombrozo's finding that participants tend to say that Carol (a double preventer) "caused the music to start" when Carol acted intentionally. This fits with Lombrozo's pluralist theory according to which people deploy the dependence-notion of causation when the relevant agent acted intentionally. But importantly, in this very same case where Carol acted intentionally, people did not say that Carol "started the music". This suggests that for some special causal verbs—including "start"—people do not think of the causal relation in terms of dependence, even under conditions of goal-directed action.

The word "cause" does seem to be importantly connected to teleology (Lombrozo, 2010; Rose, 2017) and responsibility (Sytsma et al. 2019). We built on these ideas in developing study 4. Insofar as identifying a person as a cause communicates responsibility for the effect, we hypothesized that a person might count as having *broken something* without having *caused it to break*. Conversely, someone might be identified as having *caused the thing to break* without having *broken it*. As noted above, our primary interest in these studies was to confirm a double dissociation between words like "break" and "cause". But the results fit broadly with the hypothesis that "cause" is closely tied to the notion of responsibility. This is not to say that the expression "X caused Y to ϕ " will always communicate greater responsibility for an outcome than "X ϕ -ed Y". For instance, in some cases where we make a simple attribution of a special cause, e.g. "John burned the building to the ground" we are communicating that an action was done intentionally and maliciously, and we are not communicating that in the related periphrastic statement "John caused the building to burn to the ground". Nonetheless, as suggested by Study 4, it can happen that a pedestrian is not regarded as responsible for breaking a railing (since he was knocked into the railing by cyclist) while it's nonetheless hard to deny that the pedestrian broke the railing.

In any case, we're suggesting that part of the reason it has seemed that causal judgment is not about production is because researchers have focused on the word "cause". "Cause" might well track intentions and goals, be prompted by responsibility, and display patterns that looks to reflect dependence. But a stock of special causal verbs operate very differently and in ways that appear to be better captured by a production-based notion.

There is of course a long-standing challenge from research on causal perception against the idea that ordinary notions of causation can be captured in terms of dependence. Michotte found that people's visual impression of causal launching depends on very specific kinds of visual inputs. Schlottman and Shanks (1992) found that people's judgments of perceptual causality (whether it seemed like X caused Y) come apart from their judgments of causal

dependencies (whether X is necessary for Y to happen) (though see e.g., Gerstenberg et al., 2017). This suggests that people operate with a notion of causation that fits better with production theories than dependence theories (see also Bullock 1985; Leslie, 1984; Saxe and Carey, 2006; Saxe, Tenebaum, and Carey, 2005; Saxe, Tzelnic and Carey, 2007). As Woodward (2011) notes, these results might encourage the view that there are two concepts of causation (p. 244).¹² In particular, Woodward suggests that the responses to questions about perceived causality might be taken to reflect a “mechanical” notion of causation that diverges from the dependence notion. He writes, “‘Mechanical’ in this context is not easy to define, but, roughly, it at least includes, at the level of folk physics, those causal relationships which physical objects enter into in virtue of their possession of properties like solidity, rigidity, and impenetrability” (p. 235). This mechanical notion of causation, of course, has a strong affinity to productive notions.

Although the work in causal perception provides a further reason to doubt that commonsense thinking about causation is uniformly dependence-based, Woodward raises an important limitation of extant work on causal perception. It’s possible that when people report their causal perception, they are not reporting anything like a causal judgment. Rather, it’s possible that when participants have an experience of a causal launching that defies known dependencies, they regard their perception of launching as a kind of illusion. When I look at the Muller-Lyer illusion, I register that the two lines appear to be different in length, but my explicit judgment does not conform to that (I know better). Woodward suggests that it’s possible that something similar holds for the relation between causal perception and causal judgment. That is, perhaps people regard their own perceptions of causation as illusory under conditions where dependence fails. Woodward is cautious not to dismiss the causal perception studies on these grounds. But his point exposes a gap between causal perception and causal judgment, suggesting that we would do well to have an additional source of evidence, beyond causal perception, to support the idea that people operate at least partly with a production-based notion of cause.

Our studies using special causal verbs like “crack” and “burn” might provide this kind of additional source of evidence that people do, at least sometimes, operate with production-based notions of causation. In keeping with prior work on causal judgment, we used vignette studies. As a result, our studies aren’t vulnerable to the charge that we are measuring people’s reports of causal appearances or illusions rather than their actual causal judgments. Thus, consonant with the spirit of the causal perception work, our studies reveal that people treat many special causal concepts in ways that fit with production accounts rather than dependence accounts of causation.

The work with special causal verbs reveals a different limitation of the causal perception research. Causal perception represents a very thin slice of causal cognition. Properties like solidity and impenetrability, and causal relations like collisions and launchings are undeniably an important part of our causal world, but they offer a highly circumscribed set of cases. If causal perception provides the only commonsense ground for production theories, dependence theories can take comfort in the fact that most commonsense talk of causation is not tied to immediate causal perceptions. However, by expanding the vignette studies to include special causal verbs, we find a much broader swath of commonsense causal cognition that seems to fit better with a production theory than dependence theories. For special causal verbs are highly heterogeneous. Causal perception studies have focused on collisions. Special causal verbs, of course, include verbs for the relations we see in causal perception studies, like “bump”, “launch”, and “pull”. But they also include verbs that pick out different causal relations than we find in causal

¹² Woodward (2011) is ultimately skeptical that there are two concepts here, but he acknowledges that these results might encourage the view that there are two concepts (p. 244).

perception studies, like “burn”, “melt”, “bend”, “flood”, and “spill”. Indeed when we turn to special causal verbs, we find a rich array of potentially productive causes (see Levin 1993 for an extensive list of such causative verbs).

What does this mean for how many concepts of causation there are? It's unclear how one goes about counting concepts. But our studies suggest that the answer is, *more than one*. For as we saw, the special causal notion “break” doubly dissociates from “cause”. In certain contexts, people will assent to “X broke Y” but not “X caused Y to break”; in other contexts, they will assent to “X caused Y to break” but not “X broke Y”. This also, of course, indicates that “cause” does not simply specify some very abstract relation that holds wherever some special-cause relation holds. “Cause” seems to be special in its own way, perhaps tied to notions of responsibility. But it's not obvious that the plurality of causal concepts ends here. Advocates for production-notions of causation can point to the work on causal perception as evidence that we have a notion of collision that is productive and not merely dependence-based. However, it might be a mistake to focus narrowly on such low-level phenomena. Aristotle, in *On Generation and Corruption*, criticized the atomists for reducing all causation to collisions; for we also observe crucial causal processes, like *growth*, that are not mere collisions. When we examine special causal verbs, a similar lesson suggests itself. Just as “cause” and “break” pick out two different relations, “grow”, “worry”, and “burn” might each pick out additional different causal relations, none of which can be captured in terms of dependencies.

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