Sufficient and Necessary Conditions for a Non-Unified Analysis of Causation*

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1. Introduction

Causative linguistic constructions, for our purposes, are linguistic constructions, which can be divided into three parts:

i) a cause (c);
ii) the effect of the cause (e); and
iii) the dependency (D) between (c) and (e): [c] D [e]

In studying the nature of (D), one should examine whether a one, all-encompassing, causative meaning component underlying the diverse linguistic phenomena is a justifiable position (cf. e.g. McCawley 1968, Copley et al. 2015), or rather different ones should be distinguished for the various causative constructions.

In other disciplines such as philosophy and cognitive psychology, a pluralistic notion of causation has been recently advocated. Within philosophy, see for instance, Hitchcock (2003), Hall (2004), Psillos (2009), who argue in favor of theories of causal pluralism, allowing the co-existence of different notions of causation; within cognitive studies Waldmann & Hagmayer (2013), inter alia, also indicate that people have a pluralistic conception of causation. As for linguistics, it has been proposed by Lauer (2010), Lauer & Nadathur (2017) and Martin (2017) that the semantic content of (D) is different in various constructions, tracing whether the main verb encodes a necessary or a sufficient condition.

This paper expands on this latter line of thought by focusing on the types of conditions underlying the dependency relation encoded within three verbal constructions in Modern Hebrew, paying particular attention to whether these dependencies are asserted and/or presupposed. The constructions are (i) those featuring an overt causative verb (e.g. *garam* 'cause/make');[1] (ii) those featuring a lexical causative verb encoding a change of state (e.g. *patax* 'open'); and (iii) those featuring a lexical causative verb encoding a caused activity, absent from English (e.g. *hirkid* 'dance.CAUSE').[2]

The structure of the paper is as follows: in §2 we lay out the distinction between sufficient and necessary conditions within the framework of Lewis's counterfactual analysis of causation. In §3-4 we compare the different causative constructions in Hebrew considering the way they may describe various relations between events. The picture that emerges from this comparison is that the (D) of the overt causative verb requires only that (c) is a necessary condition for the occurrence of the (e), whereas lexical causative verbs encode other types of dependencies and combinations thereof. Furthermore, the constructions also differ as to the way they pattern in negative statements, a fact that supports the claim that the semantics of the lexical causative verbs involves various presuppositions. Based on this

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[1] The Modern Hebrew overt lexical causative verb *garam* is a close equivalent of the English verb *cause*, but seems to present also some properties of English *make* (cf. Lauer & Nadathur 2017). A further elaboration will require a close comparison between the overt causative verbs in the two languages.

[2] See, for instance, Doron (2003) for an analysis of the morphological and lexical semantic properties of Modern Hebrew modern Hebrew verbs.

comparison we will propose in §5 an analysis for the semantics of lexical causative verbs and define their presuppositions. The examination of the semantic properties of these three causative constructions, leads us to argue in favor of a non-unified semantic analysis for (D), as summarized in the concluding section (§6).

2. Theoretical background

In this section we begin with a formal counterfactual definition for necessary and sufficient conditions. Our starting point is Lewis' (1973a, b) counterfactual analysis of causation (1), which is, in his own terms, a definition for a necessary condition.

(1) $\sim Oc \ \Box\!\!\rightarrow \sim Oe$ ('had the cause not occurred, the effect would have not occurred').

It is possible to define a sufficient condition, within the Lewisian framework of possible worlds, if we rely on von Wright's (1974: 7) insight about the interdefinable relation between sufficient and necessary conditions (2).

(2) Necessary (p, q) ≡ Sufficient (~p, ~q)

Thus, the two types of conditions can be defined one via the other with the negation operator. Accordingly, it follows from (2) that (3) captures a sufficient condition:

(3) $Oc \ \Box\!\!\rightarrow \ Oe$

In terms of the truth conditions, (4) (based on (3)), indicates the logical relations between (c) and (e) in sufficient conditions:

(4) In all worlds accessible from w' ($w \in W \ R(w, w')$): $\sim Oe \models \sim Oc$

In Lewis' terms, everything else being equal, possible worlds in which the inference in (4) holds are closer to the actual world than those in which it does not hold. Importantly, Lewis (1973a: 563) notes that if (c) and (e) actually occur, then (3) is automatically true. However, for our analysis, it is (4) which is crucial, as the cases in which the (e)s do not occur are those which define the sufficient conditions. See further discussion in §5.

Before concluding this section, two remarks are in order. First, Baglini & Francez (2016), Lauer & Nadathur (2017) and Martin (2017) propose a different definition for these conditions, based on the Structural Equation Framework for causation (Pearl 2000, Woodward & Hitchcock 2003 and Schultz 2011). For the purposes of this paper, however, it is possible to use their definitions as well, as both analyses capture the basic intuition that the non-occurrence of (e) would necessitate the non-occurrence of the sufficient condition, the (c). A fuller comparison between the two frameworks, clarifying the reasons behind our choice of the Lewisian framework, is beyond the scope of the current paper.

Second, Lewis (1973a) aimed at proposing (1) as capturing the notion of causation. Consequently, the counterfactual theory of causation served as anchor for many linguistic analyses of causative construction (Shibatani 1976 and see also Comrie 1981, Dixon 2000, Talmy 2000, Neeleman & van de Koot 2012 and Escamilla 2012). To a large degree, it was adopted whole-sale from philosophers without engaging in a fundamental discussion (but see Dowty 1979:106-109, Eckardt 2000). However, for Lewis, like for most philosophers the object of investigation is "the world" – as causal relations are between real entities in the world. Therefore, the metaphysics of causation, generally speaking, depicts the structure of the world itself, so that it will be one that hosts such causal relations. Often the object of such a conceptual inquiry is the intuition, which is to a large extent, the "folk theory of causation" implicitly held by everyone (inter alia Lewis 1973a: 558, Psillos 2009 and Thomason 2014). In other words, it is an attempt to provide a conceptual account, in non-causal terms, that covers all and only cases in which we have an intuition to assert correctly that: "c is the/a cause of e". Crucially, however, while their account may capture the semantics of such sentences, it is not necessarily the semantics of all the

linguistic causative constructions. In the rest of this paper, we would like to demonstrate how, in fact, the notion of sufficient condition combined with that of necessary condition, is also relevant for capturing the semantics of some of the verbal causative constructions.

3. Change of state causatives vs. causative verbs

While literature on the differences between lexical change of state causatives (verbs such as *open* and *boil*, where the subject is perceived as being (part of) the (c),[3] the event responsible for bringing about the state denoted by the VP, conceived as the (e)), and overt causatives (such as *cause*) reaches a long way back, debating mainly whether the two differ with respect to the directness of the causation (*inter alia* Fodor 1970, Katz 1970, Shibatani 1976, Levin & Rappaport Hovav 1995, Neeleman & van de Koot 2012), we would like to demonstrate that the two types of verbs differ as to the way they can be used to describe causal relations (cf. Martin 2017). In other words, each involves a different (D).

Consider the following two states of affairs: A and B in (5), in which (c) is the warm temperature in the room, and (e) is the opening of the window (cf. Thomason 2014).

(5) **A**: It is hot in the room. To let some air in, someone opens the window.
B: The heat in the room created such pressure that the window opened by itself.

State of affairs A is designed to portray warm temperature as a necessary (non-sufficient) condition for the opening of the window, whereas B portrays the warm temperature as both a sufficient and a necessary condition for this result. The following sentences demonstrate that overt causatives (6) can describe both states of affairs, whereas change of state verbs (7) only the one in B:

(6) ha-xom **garam** le-ptixat ha-xalon ☑ A ; ☑ B
the-heat caused/made to-opening the-window
'The heat caused the opening of the window.'

(7) ha-xom **patax** et ha-xalon ☒ A ; ☑ B
the-heat opened ACC the-window
'The heat opened the window. '

This implies that (c) in change of state verbs must be a sufficient condition for (e), while the (c) in the causative verb in (6) does not. Interestingly, a similar distinction holds true also under **negation**. While the negated overt causative can express the negated state of affairs stemming both from A and B (8), the lexical causative can only express a proposition related to B, not to A (9):

(8) ha-xom **lo** **garam** le-ptixat ha-xalon ☑ negating A; ☑ negating B
the-heat NEG caused/made to-opening the-window
'The heat did not cause the opening of the window.'

(9) ha-xom **lo** **patax** et ha-xalon ☒ negating A ; ☑ negating B
the-heat NEG opened ACC the-window
'The heat did not open the window.'

(9) can only convey that whereas there was considerable heat, there was not *enough* pressure to open the window (B); without a focus on *ha-xom* 'the heat', (9) is infelicitous when describing the situation depicted by A, where it was hot in the room but this did not induce opening the window by someone in the room. Conversely, (8) can be used to express both these states of affairs. This observation leads us to conclude that part of the semantics of change of state causatives includes a presupposition of what *could*

[3] It is beyond the scope of the current paper to provide an account about the nature of the relata in causal relations, and how they are represented in the various causative constructions. Since our analysis adopts Lewis' counterfactual analysis of causation, we follow him in taking the dependency to hold between the occurrences of events.

be a sufficient condition, and as such it is projected under negation. We shall return to this notion of possible sufficient condition in the analysis in §5.

4. Caused activities vs. causative verbs

Hebrew unlike English, has a separate class of lexical causative verbs denoting the causation of activities rather than change of states. Among this class one may find *leharkid* 'dance.CAUSE', *lehakpiṣ* 'jump.CAUSE' and *lehaṣxik* 'laugh.CAUSE'. Investigating these constructions expands on previous studies, which took lexical causative verbs to be a homogenous group. We would like to demonstrate that these verbs differ not only in the type of (e) they encode, namely, whether it denotes a change of state or an activity, but also in the (D) they denote. Consider the following two states of affairs C and D in (10), in which (c) is singing by a singer, and (e) is the dancing of the kids, and the consider the ability of (11)-(12) to describe these states of affairs.

(10) **C**: The kids were dancing, when the singer came in and added motivation for their dancing with his singing
[(c) is an event that could be a sufficient cause for the dancing (e), but *de facto* wasn't; also clearly not a necessary condition, as the kids were dancing prior to the singing.]
D: The kids stood still until the singer came in and made them dance with his singing.
[(c) is both the sufficient and the necessary condition.]

(11) ha-zamar **garam** la-yeladim lirkod ☒ C ; ☑ D
the-singer caused/made to.the-children to.dance
≈'The singer caused the kids to dance.'

(12) ha-zamar **hirkid** et ha-yeladim ☑ C ; ☑ D
The-singer dance.CAUSE ACC the-children
≈'The singer made the kids dance.'

The incompatibility of (11) with state of affairs C indicates that the overt causative verb cannot specify a *possible* sufficient condition which is not *de facto* in the actual world, a necessary one (this is consistent with (6)). In contrast to this, a caused activity verb (12) can describe not only state of affairs D but also C. Furthermore, under **negation**, overt causatives (13) can negate only the activity corresponding to the negated state of affairs in D.

(13) ha-zamar **lo** **garam** la-yeladim lirkod ☒ negating C
The-singer NEG cause/made to.the-children to.dance ☑ negating D
≈'The singer didn't cause the kids to dance.'

The singer didn't do the action that was necessary for the kids to dance. Note that (13) can describe the state of affairs in C, when despite the fact that the singer did the relevant action that could be sufficient to make the kids dance, he was not the actual cause, but rather something else was. In other words, this indicates that it (= the singer's singing) was not a necessary condition.

Next, as (14) demonstrates, negating a caused activity verb is different:

(14) ha-zamar **lo** **hirkid** et ha-yeladim. ☑ negating C
The-singer NEG dance.CAUSE ACC the-children ☑ negating D
≈'The singer didn't make the kids dance.'

The only reading of (14) is such that the singer didn't perform the relevant action that *could be* sufficient to make the kids dance, compatible with the negation of both C and D. This not only sharply contrasts with negated overt causative verbs, but also with change of state verbs. The latter are similar to overt causative verbs, with respect to the assertion of (c) being a necessary condition. Therefore, (9) can be

used to describe states of affairs where the heat was *potentially* sufficient for the opening of the window, but something else caused the actual opening of the window before (i.e. (c) is not a necessary condition).[4]

Expressing (14), however, still presupposes the knowledge of what type of activity by the singer could have stimulated dancing or the continuation of the dancing.

5. Analysis

It emerges from the felicity of negating lexical causative verbs, as well as from the use of positive activity caused verbs that these constructions implicate the notion of possible causation / sufficient condition. In this section, we elaborate on this notion.

The interpretations of lexical causative verbs under negation in (9) and (14), especially in light of the contrast with (8), and the ability to express (12) only based on a counterfactual relation, lead us to conclude that using such verbs presupposes world-knowledge of whether some *type* of cause is a member of the set of possible causal factors (c), each sufficient, that *can* bring about the state of affairs described in the VP (e), in a given context (g), all things being equal. The relevant (c) in a given construction must be a token of such a type. (9), for example, could negate the state of affairs in B since certain degrees of warm temperature could be a possible sufficient condition for the opening of the specific window in a given state-of-affairs.[5]

In the case of caused activities, the contrast between (11) and (12) strengthens the claim that there's no available assertion that it is *de facto* (c) which brought about (e), as it can be expressed to describe situations in which (e) precedes (c), namely, such as in state of affairs C. We therefore rely on (4), the definition of sufficient conditions, and propose the formulation in (15) as the content of such presuppositions:

(15) $\{c \mid \sim Oe \vDash \sim Oc\}^{g}$

This definition expresses the fact that part of the lexical content of a given lexical causative verb consists in the type of events which are sufficient for bringing about the results described in the given (e). Thus, (15) states, for a causative verb in a given context, the presupposed knowledge of types of events (c), such that the non-occurrence of (e) necessitates their non-occurrence as well. Given (15), the infelicity of (9) in describing the negation of the state of affairs in A can be explained as follows: since it is possible that it was hot in the room but no one opened the window, then it is not the case that, in the given context, if the window remained closed that it entails that it was not hot in the room – the definition for sufficient conditions.

6. Conclusions

The different types of causative configurations summarized in table 1 advocate for a non-unified semantic analysis for the dependency relation (D) in verbal causatives. As demonstrated throughout this paper, there are two parameters that distinguish between the verbal causative constructions: whether they encode a necessary or a sufficient condition and whether this is only asserted in positive sentences or also can be presupposed in negative ones, presupposing the relevancy of being a potential condition.[6]

[4] The equivalent description for state of affairs C with change-of-state verbs will be something like 'the heat kept the window open.'

[5] Clearly (9) could be expressed only if it was warm in the room but not enough for the pressure to open the window. A future study will have to examine what the conditions are for the negative sentence to be felicitous in a given context. Namely, how close the actual state of affairs should be to those in the alternative worlds in which the sufficient conditions occur and the effect as well.

[6] Lauer & Nadathur (2017) analyze the English verb *make* as asserting a sufficient condition unlike the verb *cause.*

	Asserting a necessary condition	*Presupposing* a potential sufficient condition
Overt causatives	+	-
Change of states causatives	+	+
Caused activities	-	+

Table 1.

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