When *just enough* is *too much*

mitcho, Sing Summer 2024[1]

1 Introduction

Consider the truth conditions of sufficiency (*enough*) and excessive (*too*) constructions.

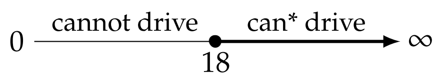
(1) a. Fred is old **enough** to (be able to) drive.

b. Fred is **too** old to (be able to) drive.

(2) Context: In this municipality, people can drive (i.e., are allowed to get a license to drive legally) from age 18 to 70, but not outside of this range.
(Range of legal driving ages = $[18, 70]$)

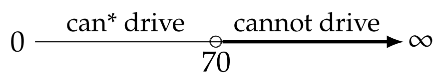
(3) Ages for Fred that make *Fred is old enough/too old to (be able to) drive* true:

a. *old enough* (1a):



* = limiting our attention to ≤ 70

b. *too old* (1b):



* = limiting our attention to ≥ 18

Many (most?) prior works on these constructions share the following intuition:

(4) **A Common Claim:**

a. Sufficiencies claim that the measured degree *meets or exceeds* some threshold (≥, eq.-like).

b. Excessives claim that the measured degree *exceeds* some threshold (>, comparative-like).

Put another way, again for (1a,b) above:

(5) a. The set $\mathcal{D}$ of ages that make *old enough* (1a) true is a *lower-closed* interval, $[18, \infty)$.

b. The set $\mathcal{D}$ of ages that make *too old* (1b) true is a *lower-open* interval, $(70, \infty)$.

In particular, Nelson 1980 and Meier 2003 suggest the following:

(6) a. sufficiency = meeting the minimum:
Fred's age *meets or exceeds* (≥) the *minimum* age for being able to drive.

b. excessive = exceeding the maximum:
Fred's age *exceeds* (>) the *maximum* age for being able to drive.

Today:

- ► **The Common Claim in (4) is incorrect.**
  - Certain sufficiency and excess examples have truth conditions that counterexemplify (4).
  - And yet, interestingly, the claim seems to be right most of the time. *Why?*

[1] This talk is based on my recent manuscript, "On the role of causation in sufficiency and excess," available upon request. I thank Chris Kennedy and Dean McHugh for detailed comments on the manuscript, as well as Bob Beddor, Tom Grano, Prerna Nadathur, and Anne Nguyen for related discussion. Both errors are mine.

I advocate instead for an approach to the semantics of sufficiency and excess that puts *causation* front and center, building on intuitions in Schwarzschild 2008 and Grano 2022. Informally, I claim:

(7) a. sufficiency = the measured degree makes the consequence obtain:
There is an age d such that, because Fred's age meets or exceeds d, Fred *is* able to drive; and Fred's age meets or exceeds d

b. excess = the measured degree makes the consequence *not* obtain:
There is an age d such that, because Fred's age meets or exceeds d, Fred *is not* able to drive; and Fred's age meets or exceeds d

2 Two approaches

2.1 Background

I assume a semantic ontology that includes *degrees* (type d) (Cresswell, 1976; von Stechow, 1984). Gradable predicates such as *tall* have denotations of type $\langle d, et \rangle$.

(8) $[\![\text{old}]\!]^w = \lambda d \,.\, \lambda x \,.\, \text{AGE}_w(x) \geq d$ (type $\langle d, et \rangle$)

In general, we can treat degree scales as (isomorphic to) the non-negative real numbers, $\mathbb{R}_{\geq 0}$. (I discuss contexts that motivate departing from this assumption below.) In some cases, I will indicate units.

Following Heim 2000, Meier 2003, and others, I assume simplified LFs of the form in (9) below. *Enough* and *too* form a constituent with a (possibly implicit) *consequence* clause Q.

(9) LF: [[enough/too [$_Q$ PRO to (be able to) drive]] [$_D$ λd . Fred is d-old]]

a. $D = \lambda w \,.\, \lambda d \,.\, \text{AGE}_w(\text{Fred}) \geq d$

b. $Q = \lambda w \,.\, \exists w' \in \text{Acc}(w)\, [\text{drive}_{w'}(\text{Fred})]$

Q is a proposition, type $\langle s, t \rangle$. D will be an intensionalized degree description, type $\langle s, dt \rangle$.

2.2 The classic accounts

As noted above, many previous accounts ("the classics") share the intuition that sufficiencies are "equative-like" and excessives are "comparative-like." From Nelson 1980: 108:

> When we hear a sentence such as *Tom is too young to vote*, we understand *Tom's age is less than age X*, where the value of X may be filled in by our knowledge of the world; specifically, by our knowledge of how old one has to be in order to vote. So we understand *Tom's age is less than 18.*[16] A statement with *too* is in this sense comparative. If Tom's age falls *far* short of 18, it might be said that he is *far too young* or *much too young to vote*, but there is nothing incorrect about simply saying *Tom is too young to vote*.
>
> If Tom is eighteen years old, he is *old enough to vote*. He is also old enough if he is nineteen, twenty-three, or ninety-seven. If he is *well* past the age of eighteen we might, to be informative, say he is *more than old enough* to vote, but it is not inappropriate to use *old enough* without qualification. So *enough* indicates an age that *equals or exceeds age X*.
>
> In sum: (We abbreviate here, using mathematical symbols and substituting *for P* for the complement.)
>
> (113) a. Tom is too young for P. = b. Tom's age $<$ age X.
> (114) a. Tom is old enough for P. = b. Tom's age $\geq$ age X.

Meier 2003 — apparently unaware of Nelson 1980 — arrives at the same basic description, formalized:

(10) ***Enough* and *too* in the style of Meier 2003:**

a. sufficiency = meeting the minimum:
$[\![\text{enough}]\!]^w = \lambda Q_{\langle s,t\rangle} \,.\, \lambda D_{\langle s,dt\rangle} \,.\, \max(D(w)) \geq \min\, (\lambda d \,.\, \text{if } [\lambda w' \,.\, D(w')(d)] \text{ is true, } Q \text{ is true})$

b. excessive = exceeding the maximum:
$[\![\text{too}]\!]^w = \lambda Q_{\langle s,t\rangle} \,.\, \lambda D_{\langle s,dt\rangle} \,.\, \max(D(w)) > \max\, (\lambda d \,.\, \text{if } [\lambda w' \,.\, D(w')(d)] \text{ is true, } Q \text{ is true})$

From Meier 2003: 92:

> Constructions with *too* differ from constructions with *enough* in only two respects. First the comparison relation 'greater than or equal to' is replaced by 'greater than'. And second, the actual extent that an object has is not compared to the *minimal* extent that satisfies the corresponding conditional, but to the *maximal* extent.

See also von Stechow, Krasikova, and Penka 2004 for an alternative approach to how the threshold degree is computed based on D and Q. Nelson 1980, Meier 2003, and von Stechow et al. 2004 all share the following intuition about the truth conditions of sufficiencies and excessives:

(4) **The Common Claim:** (repeated)

a. Sufficiencies claim that the measured degree *meets or exceeds* some threshold (≥, eq.-like).

b. Excessives claim that the measured degree *exceeds* some threshold (>, comparative-like).

2.3 The causation account

In a short review paper, Schwarzschild (2008: 316–317, 325) offers a very different, semi-formal description for excessive *too* as in (12a), based on the BECAUSE operator in (11). Grano (2022: 131–134) notes the potential extension of this approach to sufficiencies as well, as in (12b).

(11) **BECAUSE from Schwarzschild 2008: 325:**
$\text{BECAUSE}_w(p)(q)$ is true iff (i) p is a reason for q and (ii) p and q are true in w.

(12) ***Enough* and *too* in the style of Schwarzschild 2008:**

a. $[\![\text{enough}]\!]^w = \lambda Q_{\langle s,t\rangle} \,.\, \lambda D_{\langle s,dt\rangle} \,.\, \exists\theta_d \,.\, \text{BECAUSE}_w(\lambda w' \,.\, D(w')(\theta))(Q)$

b. $[\![\text{too}]\!]^w = \lambda Q_{\langle s,t\rangle} \,.\, \lambda D_{\langle s,dt\rangle} \,.\, \exists\theta_d \,.\, \text{BECAUSE}_w(\lambda w' \,.\, D(w')(\theta))(\neg Q)$

How does this approach compare to the classical accounts? From Grano 2022: 133:

> [19]There is also a sense in which the second strategy is, as it stands, incomplete, because it relies on a meta-language operator BECAUSE that is not formally defined. A reduction of BECAUSE to more familiar theoretical terms, perhaps using possible worlds, might enable a more careful investigation of what is at stake in the choice between the two hypotheses.

► Following Nadathur and Lauer 2020 and related work on the semantics of causal relations, I argue that the relevant notion is *causal sufficiency*.

Informally, A is causally sufficient for B if, reasoning based on knowledge of causes and effects relevant to the situation at hand, the truth of A guarantees the truth of B.

(13) **Proposal (compact, to be expanded):**

a. $[\![\text{enough}]\!]^w = \lambda Q_{\langle s,t\rangle} \,.\, \lambda D_{\langle s,dt\rangle} : \exists d\, [(\lambda w' \,.\, D(w')(d)) \rhd_w Q] \,.\, D(w)(d)$

b. $[\![\text{too}]\!]^w = \lambda Q_{\langle s,t\rangle} \,.\, \lambda D_{\langle s,dt\rangle} : \exists d\, [(\lambda w' \,.\, D(w')(d)) \rhd_w \neg Q] \,.\, D(w)(d)$

where $A \rhd B$ indicates that A is *causally sufficient* for B. The consequence Q contains a modal (possibly a covert possibility modal) if nonfinite (see Grano 2022).

<u>Some support for the causal sufficiency view:</u>

(14) They were {*lucky/smart/rich/famous*} *enough* to get away with murder.

Some high degree of luck makes it possible to get away with murder, but so does a high degree of intelligence, or fortune, or fame. There are many different ways to get away with murder (or so I've been told). Each is causally sufficient. No one particular quality requires a high degree.

(15) The sun is *too hot* to touch. From Schwarzschild 2008: 317:

> this amounts to saying that the sun's temperature makes it impossible for us to touch it. In fact, other factors prevent us from touching the sun, such as its distance from the earth.

<u>Restating causal sufficiency:</u>

- A common formalization of causal relations including causal sufficiency makes use of *causal models* — in particular, so-called *structural equation models*; see Pearl 2000 and Schulz 2011.
- Kaufmann (2013) describes a technique for translating causal models into modal semantic terms. Causal sufficiency is then treated as a variety of conditional necessity (Nadathur 2019: 305, 2023: 180):

  p is *causally sufficient* for q in w ($p \rhd_w q$) iff $\forall w' \in \textsc{Caus}(w)[p(w') \to q(w')]$

  where $\textsc{Caus}(w)$ is the contextually-determined set of causally optimal worlds accessible from world w, which do not predetermine the truth or falsity of propositions p and q.

(16) **Proposal (expanded):**

a. $[\![\text{enough}]\!]^w = \lambda Q_{\langle s,t\rangle} \,.\, \lambda D_{\langle s,dt\rangle} : \exists d\, [\forall w' \in \textsc{Caus}(w)\, [D(w')(d) \to Q(w')]] \,.\, D(w)(d)$

b. $[\![\text{too}]\!]^w = \lambda Q_{\langle s,t\rangle} \,.\, \lambda D_{\langle s,dt\rangle} : \exists d\, [\forall w' \in \textsc{Caus}(w)\, [D(w')(d) \to \neg Q(w')]] \,.\, D(w)(d)$

where $\textsc{Caus}(w)$ is the contextually-determined set of causally optimal worlds accessible from world w. The consequence Q contains a modal (possibly a covert possibility modal) if nonfinite.

3 Comparing the truth conditions of the two accounts

The advantage of the classical accounts is that, because they assume the Common Claim (4), we immediately know the "shape" of their truth conditions. From Meier 2003: 105:

> Whereas constructions with *so* and *enough* express a 'greater than or equal'-relation, construction with *too* express a 'greater than'-relation. In this respect the former pattern with genuine equatives and the latter with genuine comparatives.

As Grano notes, it's less immediately obvious what a causation-based account predicts.
From the proposal in (16) above, we can describe the sets $\mathcal{D}$ that make a sufficiency or excessive construction felicitous and true:

(17) a. $\mathcal{D}_{enough} = \{d \mid \forall w' \in \textsc{Caus}(w)\,[D(w')(d) \rightarrow Q(w')]\}$
b. $\mathcal{D}_{too} = \{d \mid \forall w' \in \textsc{Caus}(w)\,[D(w')(d) \rightarrow \neg Q(w')]\}$

► For sufficiency and excessive constructions that are contingent (not always true or always false), we can prove that the sets $\mathcal{D}$ in (17) are intervals that are bounded on only one side.

Gradable predicates have a *monotonicity* property (Heim, 2000). For instance, ⟦old⟧ is *downward-scalar*.[2]

(8) $[\![\text{old}]\!]^w = \lambda d\,.\,\lambda x\,.\,\textsc{age}_w(x) \geq d$

(18) A function G of type $\langle d, et\rangle$ is *downward-scalar* iff $\forall x\,\forall d\,\forall d'\,[(G(d)(x) \wedge d' < d) \rightarrow G(d')(x)]$

The downward-scalar property of ⟦old⟧ also makes the corresponding degree description D downward-scalar on its degree argument, too:

(9a) $D = \lambda w\,.\,\lambda d\,.\,\textsc{age}_w(\text{Fred}) \geq d$

(19) **Theorem:** For D downward-scalar, $\mathcal{D}_{enough}$ for a contingent sufficiency construction is a lower bounded, upper unbounded interval: $\mathcal{D} = (\theta, \infty)$ or $[\theta, \infty)$ for some θ.
<u>Proof sketch:</u> $\mathcal{D}_{enough} = \{d \mid \forall w' \in \textsc{Caus}(w)\,[D(w')(d) \rightarrow Q(w')]\}$

a. <u>$\mathcal{D}$ is upper unbounded:</u>
Suppose $d \in \mathcal{D}_{enough}$. Any $d' > d$ will also be in $\mathcal{D}_{enough}$. For any world $w' \in \textsc{Caus}(w)$:
– $D(w')(d) \rightarrow Q(w')$ (because $d \in \mathcal{D}_{enough}$) and
– $D(w')(d') \rightarrow D(w')(d)$ (because D is downward-scalar),
– therefore $D(d')(w') \rightarrow Q(w')$
This guarantees $\forall w' \in \textsc{Caus}(w)\,[D(d')(w') \rightarrow Q(w')]$, and so the higher $d' \in \mathcal{D}_{enough}$.

b. <u>$\mathcal{D}$ has a lower bound:</u>
– Notice that the reasoning in (a) does not apply in the other direction: given $d \in \mathcal{D}_{enough}$, we cannot guarantee that a lower degree ($d' < d$) will also be in $\mathcal{D}_{enough}$.
– As the construction is contingent, $\mathcal{D}_{enough}$ is neither $\emptyset$ nor the full scale S: there is some $d \in S$, $d \notin \mathcal{D}_{enough}$. d is a lower bound for $\mathcal{D}_{enough}$. <u>end sketch</u>

[2] Although this definition is based on Heim 2000: 216, Heim as well as Nouwen (2011) refer to the property simply as monotonicity on the degree argument. I choose to follow works such as Abrusán and Spector 2011: 110 and Beck 2012: 238, 2013: 6 in using the more descriptive term "downward-scalar," introduced as a formal property of predicates of degrees or numbers of type $\langle d, t\rangle$ in Beck and Rullmann 1999: 257.

The proof also goes through with $\mathcal{D}_{too}$. The results for non-downward-scalar D are left as an exercise.

Summary

- The monotonicity property of gradable predicates ensures that the causation-based semantics in (16) derives truth conditions *very similar* to that of the classical accounts.
  - For contingent sufficiency and excessive constructions with D downward-scalar: $\mathcal{D}$ will be $(\theta, \infty) = \{x \in S \mid \theta < x\}$ (lower-open) or $[\theta, \infty) = \{x \in S \mid \theta \leq x\}$ (lower-closed), where S is the relevant scale and θ is the greatest lower bound of $\mathcal{D}$.
  - But importantly, **the causation-based view does *not* entail that any $\mathcal{D}$ will be lower-closed or lower-open,** contrary to the Common Claim (4).

4 Open sufficiencies and closed excessives

- There *are* in fact sufficiencies with lower-open $\mathcal{D}_{enough}$ ($> \theta$, "comparative-like") and excessives with lower-closed $\mathcal{D}_{too}$ ($\geq \theta$, "equative-like"), contrary to the Common Claim (4).

(4) **The Common Claim:** (repeated)
  a. Sufficiencies claim that the measured degree *meets or exceeds* some threshold ($\geq$, eq.-like).
  b. Excessives claim that the measured degree *exceeds* some threshold ($>$, comparative-like).

Here I give mathematical examples involving real numbers as well as examples based real world facts. I also give their corresponding $\mathcal{D}$ intervals. All degree descriptions D are downward-scalar.

(20) **Sufficiencies that have no minimum true degree:**
  a. [r is a positive real number.]
  The value of r is large enough that the function $y = r^x$ is increasing. $\mathcal{D} = (1, \infty)$
  b. [The Lufthansa baggage policy specifies that, "a piece of baggage is considered to be excess baggage when it weighs more than 23 kg," and that excess baggage incurs an additional fee.[3] We do not know the precision of the scale used to weigh the luggage.]
  Your box is heavy enough to incur a fee. $\mathcal{D} = (23\text{kg}, \infty)$

(21) **Excessives that have a minimum true degree:**
  a. [r is a positive real number.]
  The value of r is too large for the geometric series $\sum_{n=0}^{\infty} r^n$ to converge. $\mathcal{D} = [1, \infty)$[4]
  b. [The rules of the Paws 'n Play dog park in Lansing, Michigan specify that "Large dogs (26 lbs and above) are not allowed in the small run area. Small dogs (under 26 lbs) are not allowed in the large dog run area."[5] We do not know the precision of the tools they would use to determine a dog's weight in any context of potential enforcement action.]
  Your dog is too heavy to be in the small run area. $\mathcal{D} = [26 \text{ lbs}, \infty)$

[3] From https://www.lufthansa.com/us/en/excess-baggage, accessed May 14, 2024.
[4] For any $|r| < 1$, the series converges to $1/(1 - r)$. For any $|r| \geq 1$, the series diverges.
[5] From https://www.lanoakparkdistrict.org/paws-n-play/paws-n-play-rules/, accessed May 14, 2024.

► **The Common Claim is incorrect!** Therefore the various, influential, classical accounts which more or less explicitly bake the Common Claim into their semantics — i.e., Nelson 1980, Meier 2003, von Stechow et al. 2004, and works based on them — are incorrect!

We instead need (something like) the causation-based semantics proposed here.

But interestingly, the Common Claim seems to be right most of the time. *Why?* I've thought about two possible factors:

1. (Im)precision and discrete scales

- Recall that I described (as is standard) the scale of degrees S as (isomorphic to) the non-negative real numbers, $\mathbb{R}_{\geq 0}$. An important property of the real numbers is that it is *dense*:

(22) An ordered set S is *dense* iff for any two values $a, b \in S$ where $a < b$, there is another value $c \in S$ such that $a < c < b$.

- But most real life contexts have a relevant level of (im)precision, identifiable from the context or else reasonably inferred (see e.g. Lasersohn, 1999; Klecha, 2018). So in practice, scales may be *non-dense* (cf 22), or *discrete* (*pace* Fox and Hackl, 2006).

► With S discrete, a sufficiency with no logical minimum true degree can be restated as a sufficiency *with* a minimum true degree.

(23) **Sufficiency that invites a precise, minimum degree:**
[The current world record for the largest lake trout by weight is 32.65kg.[6] These records are based on weights rounded to two decimal places.]
This lake trout is heavy enough to set a new world record! $\mathcal{D}$ = [32.66kg, ∞)

- Hypothetically, if such world records cared about differences of arbitrary precision, $\mathcal{D}$ = (32.65, ∞). But because we know that relevant measures are rounded to the nearest hundredth, the descriptively "equative-like" interpretation with $\mathcal{D}$ = [32.66, ∞) counts as faithful here.

- Notice: if the scale S does not include any values that fall between 32.65 and 32.66, the intervals (32.65, ∞) and [32.66, ∞) are equivalent over S.

This gives us a hint as to what made the counterexamples in (20–21) special:

- In the *baggage policy* (20b) and *dog park* (21b), I specified that "We do not know the precision of the scale/tools...", to emphasize an *exact* interpretation, where no discernible difference is ignorable. (Maybe this is unusual, but not impossible.)

- In the mathematical examples, I explicitly specify $S = \mathbb{R}_{>0}$, which is dense. In such mathematical discussions, no pragmatic slack is allowed (see e.g. Lasersohn, 1999: 524).

[6] From `https://igfa.org/member-services/world-record/common-name/Trout,%20lake`, accessed May 14, 2024 — and still true when I checked today!

2. Conceptualizing consequences

- ► I hypothesize that there is a communicative preference for discussing consequences Q so that the threshold degree θ is associated with the truth of Q.
  - For instance, if we are discussing ages associated with voting or heights associated with being the thief, etc., it is most natural to describe these acceptable values themselves by describing minimum and maximum bounds which are included in the corresponding degree extension.
  - If the degrees for D that are causally sufficient for Q is a closed interval $[A, B]$, the causation-based view indeed predicts $\mathcal{D}_{enough} = [A, \infty)$ and $\mathcal{D}_{too} = (B, \infty)$, corresponding to degrees of D that are causally sufficient for Q or $\neg Q$.
- • The examples in (20) and (21) above show that this preference is not absolute.

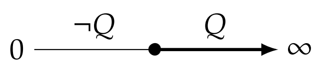
I hypothesize that these two pressures, while not in force in all contexts, together conspire to make it so that sufficiencies generally are compatible with "equative-like" ($\geq$) interpretations and excessives generally are compatible with "comparative-like" ($>$) interpretations.

5 Summary

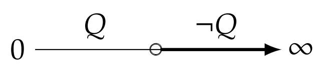
The classic accounts and my causation-based proposal based on Schwarzschild 2008 and Grano 2022 differ in a very subtle way. In number line terms:

(24) **Degrees ensuring felicity and truth, according to the Common Claim of the classical accounts:**

a. $\mathcal{D}_{enough}$:

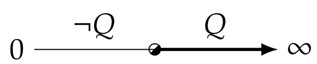


b. $\mathcal{D}_{too}$:

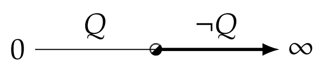


(25) **$\mathcal{D}$ predicted by my causation-based account:**

a. $\mathcal{D}_{enough}$:

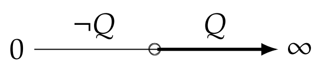


b. $\mathcal{D}_{too}$:

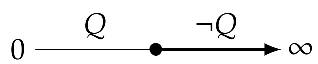


(26) **$\mathcal{D}$ for the counterexamples to the Common Claim in §4:**

a. $\mathcal{D}_{enough}$:



b. $\mathcal{D}_{too}$:



- ► Although the classic accounts offer reasonable descriptions for the semantics of sufficiency and excess in most cases, these counterexamples show that they are incorrect as descriptions for these constructions.

References

Abrusán, Márta, and Benjamin Spector. 2011. A semantics for degree questions based on intervals: Negative islands and their obviation. *Journal of Semantics* 28:107–147.

Beck, Sigrid. 2012. DegP scope revisited. *Natural Language Semantics* 20:227–272.

Beck, Sigrid. 2013. Lucinda driving too fast again: The scalar properties of ambiguous *than* clauses. *Journal of Semantics* 30:1–63.

Beck, Sigrid, and Hotze Rullmann. 1999. A flexible approach to exhaustivity in questions. *Natural Language Semantics* 7:249–298.

Cresswell, Max J. 1976. The semantics of degree. In *Montague Grammar*, ed. Barbara Hall Partee, 261–292. Academic Press.

Fox, Danny, and Martin Hackl. 2006. The universal density of measurement. *Linguistics and Philosophy* 29:537–586.

Grano, Thomas. 2022. *Enough* clauses, (non)finiteness, and modality. *Natural Language Semantics* 30:115–153.

Heim, Irene. 2000. Degree operators and scope. In *Proceedings of SALT 10*, ed. Brendan Jackson and Tanya Matthews, 40–64.

Kaufmann, Stefan. 2013. Causal premise semantics. *Cognitive Science* 37:1136–1170.

Klecha, Peter. 2018. On unidirectionality in precisification. *Linguistics and Philosophy* 41:87–124.

Lasersohn, Peter. 1999. Pragmatic halos. *Language* 75:522–551.

Meier, Cécile. 2003. The meaning of *too*, *enough*, and *so...that*. *Natural Language Semantics* 11:68–107.

Nadathur, Prerna. 2019. Causality, aspect, and modality in actuality inferences. Doctoral Dissertation, Stanford University.

Nadathur, Prerna. 2023. *Actuality inferences: causality, aspect, and modality*. Oxford University Press.

Nadathur, Prerna, and Sven Lauer. 2020. Causal necessity, causal sufficiency, and the implications of causative verbs. *Glossa* 5:1–37.

Nelson, Eric S. 1980. *Too* and *enough*. *Minnesota Papers in Linguistics and the Philosophy of Language* 6:93–132.

Nouwen, Rick. 2011. Degree modifiers and monotonicity. In *Vagueness and language use*, ed. Paul Égré and Nathan Klinedinst, 146–164. Palgrave Macmillan.

Pearl, Judea. 2000. *Causality: Models, reasoning, and inference*. Cambridge University Press.

Schulz, Katrin. 2011. "If you'd wiggled A, then B would've changed": Causality and counterfactual conditionals. *Synthese* 179:239–251.

Schwarzschild, Roger. 2008. The semantics of comparatives and other degree constructions. *Language and Linguistics Compass* 2:308–331.

von Stechow, Arnim. 1984. Comparing semantic theories of comparison. *Journal of Semantics* 3:1–77.

von Stechow, Arnim, Sveta Krasikova, and Doris Penka. 2004. The meaning of German *um zu*: Necessary condition and *enough/too*. Presented at the Workshop on Modal Verbs and Modality, University of Tübingen.