Ability Modals as Causal Modals*

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Abstract

Can and *be able to* can be used to describe what is possible in light of a subject's abilities. These modals give rise to several logical anomalies, which have led to analyses that stray far from standard Kratzer-style treatments (see [2], [10], [19] a.o.). I suggest that the source of the anomalies is a presupposition sitting on top of a standard existential semantics. The resulting account is both more conservative and more successful at accommodating the data than the alternatives. The presupposition of *S can/is able to* A states (roughly) that a state of S is causally sufficient for A. Interestingly, this account diverges from many existing account in that it does not invoke a notion of agency.

1 Introduction

Can and *be able to* can be used to describe what is possible in light of someone's abilities. Modals of this flavor (which I call 'modals of ability', or MoA for short) give rise to several logical anomalies. These anomalies have led to analyses that stray far from standard Kratzer-style treatments: in particular, they have been analyzed as involving a metalanguage conditional (see [19], a.o.) or a double layer of modal quantification, in which a possibility modal scopes over a necessity modal (see [2], [10], a.o.).

In this paper, I have two goals. First, after reviewing some of the logical anomalies generated by MoA, I argue that these anomalies mark the presence of a presupposition. Second, I suggest that the relevant presupposition states the existence of a causal connection between the subject of the modal and the event picked out by the prejacent. Specifically, the presupposition requires that a state of the subject is causally sufficient (in a way to be made precise) for the prejacent. A Kratzer-style existential semantics, supplemented with this presupposition, captures all the data. Notably, this analysis divorces MoA from a notion of agency, contrary to many accounts in the literature.

I proceed as follows: I describe some of the main puzzles about MoA in §2, give some motivation for a causal account in §3, and develop my analysis in §4.

2 Modals of ability and logical anomalies

2.1 The target of the analysis

My target are occurrences of *can* and *be able to* that track ability, as in (1a) and (1b).

(1) a. Ava can/is able to hit the bull's eye on the next throw.
b. Ben can/is able to join the conference virtually.

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I assume that, in the sentences in (1), *can* and *be able to* express what is possible in light of the abilities of a subject. Hence, in line with the literature on MoA, I assume that there is a dedicated modal flavor that tracks ability.Moreover, I assume that *can* may be used to express a variety of modal flavors (ability, circumstantial, dentic), but *be able to* lexicalizes the ability flavor. In support of this assumption, notice that (2a) can be uttered in a situation where Ava is a first time dart thrower (and hence, presumably, the *can* occurring in it expresses a non-ability modal flavor). But (2b) can't.

(2) a. Ava can hit the bull's eye on this throw—sometimes beginners are lucky!
b. # Ava is able to hit the bull's eye on this throw—sometimes beginners are lucky!

Again in line with the literature, I also assume that MoA have **specific** and **generic** occurrences. Specific occurrences, exemplified by (3a), describe a specific event that is possible in the light of the subject's abilities. Generic occurrences, exemplified by (3b), describe what is possible in general for a subject, given their abilities.

(3) a. Ava is able to hit the bull's eye on this next throw.
b. Ava is able to hit the bull's eye when playing darts.

I assume that specific uses are basic and I will focus on them throughout the paper.

2.2 Logical anomalies

On a classical Kratzer-style analysis ([14], [15], [16]), MoA are treated as existential modals with a realistic modal base (for all w, $w \in f(w)$). The schematic truth conditions of an ability report are:

(4) $[\![S \text{ can/is able to } \mathsf{A}]\!]^{w,f} = 1$ iff $\exists w' \in f(w)$ such that $[\![S \ \mathsf{As}]\!]^{w',f} = 1$

This simple analysis is challenged by several logical puzzles. Here I rehearse two.

Puzzle 1: variable strength. MoA appear to be stronger than (4) in positive contexts, but exactly as strong as (4) under negation.

The argument for strength in positive contexts comes in two steps. First, MoA are stronger than standard circumstantial modals. Consider (5) (adapted from [19]):

Jim and Jo are playing darts; Jo's child Susie, who is quite bad at darts, exclaims:

(5) # Let me take the shot! I can/am able to hit the bull's-eye on this throw.

(5) seems not true, even though there is a circumstantial possibility where Susie hits the bull's-eye out of sheer luck. Second, in positive contexts MoA are stronger in a further way: the truth of *S As/will A* is insufficient for the truth of *S is able to A*. Several authors have produced arguments for this point ([13], [1][1]). Here is a quick and simple one. Suppose that *S As/will A* does entail *S is able to A*. Then, since (6a) entails (6b), it also entails (6c).

(6) a. Maria will hit the target out of sheer luck on this throw.

[1] Boylan's position comes with a twist: he argues that ⌜*S* As⌝ does not entail ⌜*S can A*⌝ when A has a present or a future reference time, but that it does when the A has a past reference time. I don't have space here to engage with Boylan's position. Let me just say that I think that the data Boylan exploits is complicated by the interactions between modals and aspect: in particular, all root modals give rise to so-called actuality entailments (see [7]) when they combine with perfective aspect. This might have a crucial effect on the judgments.

b. Maria will hit the target on this throw.

c. Maria is able to hit the target on this throw.

From this, given minimal assumptions about conditionals, it follows that (7) should be a logical truth. But (7) is not a logical truth, and in fact it sounds pretty awkward.[2]

(7) If Maria will hit the target out of sheer luck on this throw, Maria is able to hit the target on this throw.

At the same time, MoA appear as weak as (4) predicts in negative contexts. Consider again Susie's case, and suppose that Susie's mom, Jo, responds to her by saying:

(8) No, you're not able to/you can't hit the bull's eye on this throw. You're not good enough.

(8) is the negation of Susie's original claim (5). And like the latter, it seems defective. Susie might get lucky and hit the bull's eye just on this throw. This seems enough to make (8) unassertable.

A second mark of weakness is that the truth of *S cannot A* seems sufficient for the truth of *S does not A/won't A*. To see this, notice that conjunctions like (9) are contradictory:

(9) # Susie is unable to hit the dartboard on this throw, but she will hit the dartboard on this throw (by sheer luck).

In sum, MoA appear to vindicate the following two principles.

Actuality does not entail ability.	$A \nvDash \Diamond A$	*S* will A $\nvDash$ *S* is able to A
Inability entails inactuality.	$\neg\Diamond A \vDash \neg A$	*S* is unable to A $\vDash$ *S* won't A

This combination is puzzling, since the two principles are contrapositives of each other.

Puzzle 2: failure of DoD. Kenny ([13]) famously presents the following case:

> **Context.** Clem is a somewhat experienced dart player. She's good enough to reliably hit the board when she throws, but she is still unable to control what section of the board she hits.

(10) a. Clem is able to hit the top or the bottom part of the board. ✓

b. Clem is able to hit the top part of the board. ✗

c. Clem is able to hit the bottom part of the board. ✗

These judgments violate Distribution over Disjunction, which is valid on standard semantics:

Failure of Distribution over Disjunction (DoD). $\Diamond(A \vee B) \nvDash \Diamond A \vee \Diamond B$

2.3 The mark of presupposition

The first puzzle suggests that MoA involve a presupposition of sorts. The reason is that notions of entailment that track presupposition, like Strawson entailment ([5]), don't contrapose (see [3] for related discussion). To see this, notice that the inference in (11a) is valid on a notion of Strawson-entailment, but its contrapositive in (11b) clearly is not.

(11) a. Ben doesn't know that Clem won. $\vDash$ Clem won.

b. Clem didn't win. $\nvDash$ Ben knows that Clem won.

[2]The argument relies on the following assumptions: (i) conditionals of the form *If A, then A* are logical truths, and (ii) if B^+ entails B, *If A, then* B^+ entails *If A, then B*. Both are fairly uncontroversial.

3 Evidence for a causal analysis

A further feature of MoA is that their complement seems subject to a 'no-chanciness' requirement. Suppose that Ava has bought a ticket for a fair lottery, which she has a genuine chance to win. Both sentences in (12) are infelicitous.

(12) a. ?? Ava is able to win the lottery.
b. ?? Ava is unable to win the lottery.

To accommodate cases like (12) (and, sometimes, as part of an account of DoD failure), several analyses ([19], [6], [25] a.o.) link MoA to a notion of agency. Roughly, the idea is that MoA track possibilities that an agent may bring about by acting in one of several ways. If this was on the right track, it might be used to rule out cases like (12a) and (12b), since winning the lottery (or losing it) is not an action, and not something an agent has control over.

As I argue at greater length in [23], however, agency is way too restrictive to account for the full range of uses of MoA in natural language. There are occurrences of MoA in which the subject is not an agent and/or the complement does not describe an action. Below are some natural examples of this sort.

(13) a. Steel is able to withstand a pressure of 100 tons.
b. This type of coal is able to burn without producing smoke.

(14) a. Ava is able to process sugar very fast now (since she's on a special medication).
b. Ben is able to perceive unusually high frequencies now (since he's on drugs).
c. Clem is able to fight off the virus over the next days.

I suggest that the analysis of MoA should invoke causal rather than agential notions.

4 The Causal Analysis

The causal notion that plays a key role in my analysis is **causal sufficiency**. Here I show how this notion can be defined precisely appealing to the causal models framework ([8], [21], [9], a.o.). I use causal models merely because they are a widespread and fruitful way of capturing causal notions formally; in principle, alternative treatments are possible.

4.1 Defining causal sufficiency

The idea I want to capture is this. Suppose that an expert dart thrower (say, Ava) and an inexpert one (say, Ben) are both about to take a throw. Intuitively, Ava's intention to throw, given appropriate background circumstances (no sudden gusts of wind, no one pushes her, etc) is sufficient to bring about that the target is hit. Not so for Ben. Whether Ben hits the target depends also on other factors, (which, for simplicity, we might identify with chance).

To characterize precisely the relevant notion of causal sufficiency, I use the causal models framework. Causal models are formal models used to charaterize causal processes. Here I understand a causal model as consisting of three elements: a set of **random variables**, a set of **structural equations**, and an **assignment of values** to the variables.

A **random variable** can be thought of as a set of mutually exclusive and jointly exhaustive outcomes for a process. Following standard notation, I represent random variables with uppercase Roman letters, like 'X'. I represent the values of random variables with lowercase Roman letters, sometimes with subscripts, like 'x_i'. Moreover, to say that variable X has value x_i, I

use the notation '$X = x_i$'. Notice that an equation like '$X = x_i$' basically says that a certain event obtains. (For example, using variables from the model below, we can represent the event of a target being hit with the equation '$T = 1$'.)

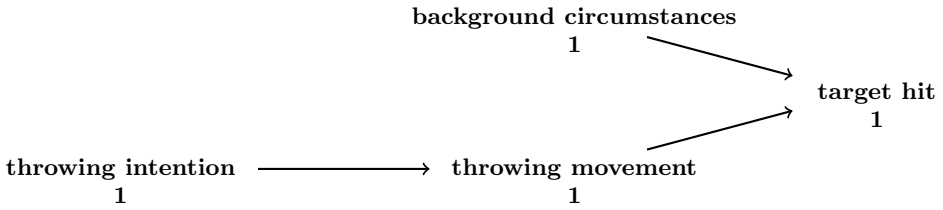
Structural equations are mathematical equations that state the relations between different values of random variables. An **assignment of values** is simply a mapping of each variable in a model to one of its possible values.

Let me go through an example. We can represent the case of an expert dart thrower (say, again, Ava) who is about to throw a dart with the following model:

Random variables			**Structural equations**
C	:	whether the background circumstances are favorable	
I	:	whether Ava has the intention to throw	$M = I$
M	:	whether Ava performs a correct throwing movement	$T = \min(C, M)$
T	:	whether Ava hits the target	

To complete our model, suppose also that all the variables have value 1 (corresponding to 'true') and that hence the target is hit.

Causal models can be can represented via graphs. Here is the graph for our toy model:



Now, against this background, we can define causal sufficiency as follows:

> **Causal sufficiency.** A set of events $\{X_1 = x_1, \ldots X_n = x_n\}$ is **causally sufficient** for an event $E = e$, relative to a set of equations $\mathcal{S}$ and background circumstances $\mathcal{C}$ iff any model that is (i) consistent with $\mathcal{S}$, (ii) consistent with $\mathcal{C}$, and (iii) such that $\{X_1 = x_1, \ldots X_n = x_n\}$, is also a model where $E = e$.

The idea behind the definition is simple. A set of events $\mathcal{E}$ is causally sufficient for an effect e just in case, holding fixed the equations and background circumstances, any model where the events in $\mathcal{E}$ obtain is also a model where e obtains.[3]

It's easy to check that, on this definition, Ava's throwing intention is causally sufficient for the target being hit, given that favorable background circumstances obtain. I leave it to the reader to verify that the sufficiency condition is not satisfied in a case involving an inexperienced thrower like Ben (where variables other than I contribute to determining the value of M).

4.2 Semantics

I suggest that the semantics of *able* involves reference to a notion of causal sufficiency. Specifically, *S is able to/can* A requires that there is a state of S that, given background circumstances, is causally sufficient for A. For reasons of space, I won't expand on what counts as a 'state' of the relevant sort. What states are relevant is clear enough in all the cases discussed in this paper. For example, in the case of the expert thrower Ava, we can take the relevant state to be the obtaining of a throwing intention ($I = 1$).[4]

[3] In passing, let me notice that this definition is reminiscent of the so-called 'INUS' account of causation, first introduced by [18] and then elaborated by many authors. See [20] for discussion.

[4] In general, states can be identified with sets of events in a causal model.

In the lexical entry of the modal, the causal requirement is encoded in a presupposition. Specifically, I propose that *can* and *be able to* work as existential quantifiers over a set of circumstantial worlds. On top of this existential meaning, a presupposition captures the causal requirement. The content of the presupposition is, roughly:[5]

> Either not-A, or there is a state of S that, given appropriate background circumstances, is causally sufficient for A

I adopt a fairly standard Kratzer-style framework, with one addition. On Kratzer's semantics, the interpretation of modals is relativized to a modal base and an ordering source, both of which are functions from worlds to sets of propositions. I add a third parameter, which specifies a function from worlds to sets of 'background propositions' that are used for assessing causal sufficiency.[6] Following Kratzer, I use 'f' to denote the modal base and 'B' to denote the background parameter. For simplicity, I ignore the ordering source. Here is the semantics:

(15) $[\![S \text{ can/is able to } \mathsf{A}]\!]^{w,f,B} =$

true iff $\exists w' \in \text{CIRCUMSTANTIAL}_{w,f,B}$ such that $[\![S \text{ As}]\!]^{w',f,B} = 1$

defined iff $\forall w' \in \text{CIRCUMSTANTIAL}_{w,f,B}$, either $[\![S \text{ As}]\!]^{w',f,B} = 0$, or $[\![S \text{ As}]\!]^{w',f,B} = 1$ and, in w', there is a state of S that is causally sufficient for A given $B(w)$.

Let me briefly sketch how this semantics accounts for the puzzles in §2.

The strength puzzle. In positive contexts, the presupposition requires (via the right disjunct) that, in every circumstantially accessible world where S As, there is a state of S that is causally sufficient for A. Hence an utterance of *S is able to A* requires that there is a circumstantially accessible world where S As, and in this world some state of S is causally sufficient for A. Conversely, in negative contexts the presupposition is immediately satisfied via the truth conditions (via the left disjunct), so it generates no extra requirements.

DoD failure. Consider again (10a). In a scenario where Clem is about to throw, there is a circumstantial possibility where there is a state of of Clem's (say, her having the intention to throw) that is causally sufficient for her to hit the board. But there are no circumstantial possibilities where Clem's being in that state is causally sufficient for her to hit the top part of the board, or causally sufficient for her to hit the bottom part of the board. Hence (10a) is true, but (10b) and (10c) are undefined.

5 Conclusion

Modals of abilty give rise to several logical anomalies, which have led to analyses that stray far from standard Kratzer-style treatments. In this paper, I have made two suggestions. (i) The source of the anomalies is a presupposition sitting on top of a standard existential semantics. (ii) Roughly, the presupposition requires that there is a state of the subject that is causally sufficient for the prejacent. I have shown how the relevant notion of causal sufficiency can be made precise by appeal to causal models. Causal notions have already turned out to be useful in modal semantics, notably in the semantics of counterfactuals (see [24], [12], [11], [4], [22], a.o.). It is unsurprising that they can also be useful for other flavors of modality.

[5] This presupposition resembles the so-called homogeneity requirement; see [17] for discussion.

[6] As a default, I assume that, for all w, $B(w) \subseteq f(w)$, i.e. the 'background propositions' are a subset of the propositions in the modal base.

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