Deriving indirectness and questioning entailment for epistemic \textit{must}\footnote{Thanks to Chris Potts for advising this project, Anastasia Giannakidou for the seminar that gave rise to it, Peet Klecha for discussion, and the Stanford SemPrag Group for comments. Any errors are my own.}

(1)  
\textbf{Epistemic \textit{must}}  
\begin{quote}  
It \textit{must} be raining.  
\end{quote}  
\textbf{Breakdown} \textit{must}(\phi); here, \(\phi = \text{it is raining}\) (also called the prejacent)

1 Two observations

1. \textit{Must} requires \textbf{indirect evidence}: (1) is only okay if we see people coming inside with wet umbrellas, not if we are standing in the downpour

\begin{quote}  
Also, other strong epistemic modals \textbf{work the same way}, in English \textit{(has to, gotta)} and other languages \textit{(devoir} in French, \textit{bu de bu} in Mandarin)  
\end{quote}

2. \textit{Must} often sounds \textbf{tentative/hedged} (Karttunen (1972))

\begin{quote}  
But \textit{must} is also used in mathematical proofs where the prejacent is necessarily true  
\end{quote}

2 Three questions

1. \textbf{Indirectness}: Why does \textit{must} require indirect evidence? How should we capture this generalization throughout English and across languages?

2. \textbf{Entailment}: What is the logical relationship between \textit{must}(\phi) and \(\phi\)?

\begin{quote}  
\textbf{Weak \textit{must}}: \(\phi \Rightarrow \text{must}(\phi)\)? (Karttunen (1972), Kratzer (1981))  
\textbf{Strong \textit{must}}: \textit{must}(\phi) \Rightarrow \phi\)? (von Fintel & Gillies (2010))  
\end{quote}

\begin{quote}  
Or are they apples and oranges?  
\end{quote}

3. How does \textbf{indirectness} relate to \textbf{entailment}?

\begin{quote}  
Should we derive \textbf{weak \textit{must}}'s logical weakness from indirectness?  
Or are indirectness and entailment independent? (von Fintel & Gillies (2010))  
\end{quote}
2.1 Game plan

- Overview one prominent analysis from each side:
  
  Kratzer’s **weak must**
  von Fintel and Gillies’ **strong must**
  Suggest that neither is fully satisfactory

- Show that Kratzer’s analysis can be tweaked to be consistent with **weak, strong or neither**
  
  By defining epistemic *must* parallel to deontic *must*

- Suggest that the question of **strong/weak must** is not coherent
  And mull over how assertions relate to truth

3 Some representative answers

3.1 Kratzer

<table>
<thead>
<tr>
<th>Anatomy of a modal (from Kratzer (1977))</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Parameters</strong></td>
</tr>
</tbody>
</table>
| **Lexical parameter:**  
  ∀ (for, e.g., *must*; necessity) or ∃ (*might*; possibility) |
| **Contextual parameters:**             |
| **Modal base**, \( W \): the set of worlds being quantified over  
  Circumstantial modal base = all worlds consistent with the circumstances  
  Epistemic modal base = all worlds consistent with what is known, etc. |
| **Ordering source**, \( g \): ranks the worlds in \( W \)  
  by how well they conform to some contextual criteria |
| **General frame for** *must*(\( \phi \))  
  \[ \forall w' \in W \text{ such that } w' \leq_{g(w)}, [\phi(w')] = 1 \] |
| **Prose:** In all worlds in the modal base and ranked above some standard by the ordering source, the prejacent is true. |

Kratzer’s analysis of epistemic *must*:

It must be raining.

*Prejacent:* It is raining

*Contextual parameters:*

\( W \): what is known
3.1.1 Upshot

*Must* is weak because the ordering source allows unreliable information

*Must* needs indirectness because the ordering source allows indirect information

Unreliable/indirect ordering source gives rise to both indirectness and weakness

3.2 von Fintel and Gillies

3.2.1 Key claims:

Indirectness is INDEPENDENT of weakness (against Kratzer’s analysis)

*Must* is strong:

(2) $x$ is an integer and $x/2$ is even: therefore, $x$ must also be even

(3) It must be raining but it might not be.

(4) **Bonnie** (seeing people’s wet umbrellas): It must be raining.

**Sharese:** You’re wrong! It was raining earlier but it stopped.

**Bonnie:** ??I didn’t say it was raining, I just said it must be raining! Stop picking on me!

They propose the following denotation for a strong *must* that requires indirect evidence independent of logical strength

**Definition:** strong *must* + evidentiality (adapted from von Fintel & Gillies (2010): 372)

**Contextual parameters:** Fix a kernel $K$, which represents direct information in the context, and a modal base $B$, and find the subset of $B$, $B(K)$, which is the modal base minus the kernel of direct evidence.

i. $[[must(\phi)]]^{c,w}$ is defined only if $K$ does not directly settle $[[\phi]]^c$

ii. if defined, $[[must(\phi)]]^{c,w} = 1$ iff $B(K) \subseteq [[\phi]]^c$

**Prose:** *must* $\phi$ is defined only if the direct evidence does not directly settle $\phi$, and true only if the indirect evidence $B(K)$ entails the prejacent.

**Illustration:** *it must be raining* is defined only if the direct evidence does not settle whether it is raining, and true only if the indirect evidence (wet umbrellas) entails that it is raining.
3.2.2 Upshot

Convincing argument that indirectness and logical entailment are separate concepts

But have they really shown that \textit{must} be strong? Or just that it \textit{can} be strong? (as Portner objects in their footnote, p. 16)

Maybe you can conclude that \textit{it must be raining} using unreliable information

but conclude that \textit{x must be even} based on foolproof reasoning

Indirectness is now stipulated; is “non-directly-settled information” (B(K)) a natural class?

Their denotation is

a “\textit{placeholder}”

“for the eventual solution to the \textit{mystery}”

of why this “pairing of epistemic modals with an indirect inference signal”

persists throughout English and across languages

(all quotations throughout p. 368, footnote)

4 My proposal

Modify Kratzer’s proposal to derive indirectness separate from logical strength/weakness

Using:

(5) \textbf{Deontic \textit{must}}

You \textit{must} not litter.

Currently, epistemic \textit{must} is analyzed quite differently from deontic \textit{must}:

<table>
<thead>
<tr>
<th>Modal force</th>
<th>Modal base</th>
<th>Ordering source</th>
</tr>
</thead>
<tbody>
<tr>
<td>epistemic</td>
<td>what is known</td>
<td>questionable assumptions (Kratzer), stereotypicality, or none (von Fintel and Gillies)</td>
</tr>
<tr>
<td>deontic</td>
<td>the circumstances</td>
<td>compliance with a body of rules</td>
</tr>
</tbody>
</table>

4.1 The intuition

Analyzing epistemic and deontic \textit{must} differently obfuscates \textbf{what they share}:

Both epistemic and deontic \textit{must} invoke a body of rules:

Normative rules for deontic \textit{must} – e.g. \textit{do not litter}

Descriptive rules for epistemic \textit{must} – e.g. \textit{wet umbrellas indicate rain}

Analyzing epistemic \textit{must} more like deontic \textit{must} \textbf{derives indirectness requirement independent} of strength/weakness

therefore, compatible with analyzing \textit{must} as \textit{strong}, \textit{weak} or \textit{neither}
4.2 The details

(6) **Definition: rule**
A logical relationship between two sets of worlds

<table>
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<tr>
<th>General form</th>
<th>Example</th>
<th>Prose</th>
</tr>
</thead>
<tbody>
<tr>
<td>( P \implies Q )</td>
<td>wet umbrellas \implies rain</td>
<td>wet-umbrella worlds are rain worlds</td>
</tr>
<tr>
<td>( P(w') \implies Q(w') )</td>
<td>good(w') \implies no-litter(w')</td>
<td>good worlds are non-littering worlds</td>
</tr>
</tbody>
</table>

To capture this similarity, I propose the denotations below:

**Deontic must**
*Contextual parameters:* Fix a circumstantial modal base \( B \) and an ordering source \( g \) selecting all the worlds compatible with some normative rules

\[
[[\text{must} (\phi)] \]_{B,f,w} = 1 \iff \forall w' \in B \leq_{g(w)}, [[\phi(w')]] = 1
\]

**Epistemic must**
*Contextual parameters:* Fix a circumstantial modal base \( B \) and an ordering source \( g \) selecting all the worlds compatible with some descriptive rules

\[
[[\text{must} \phi)] \]_{B,f,w} = 1 \iff \forall w' \in B \leq_{g(w)}, [[\phi(w')]] = 1
\]

A lemma:
There is **no meaningful difference between circumstantial and epistemic modal base**
- Circumstantial: true/known facts; can be restricted in context
- Epistemic: true/known facts; can be restricted in context

**Foreshadowing:**
true/known according to the *speaker* or some other contextually relevant party
Not just true in the actual world

4.3 Deriving indirectness

**Main idea:**
Epistemic *must* involves moving from facts about *this world* to a claim about *all worlds consistent with those facts*
To generalize, one needs a generalization that maps facts to the things that follow from them
The facts only support the prejacent when mediated by this generalization: indirectly.

**Felicitous use of must**
1. Know certain facts in the actual world: *see people come in with wet umbrellas*
2. Know a rule mapping these facts to things that always follow from them: *wet umbrellas mean rain*
3. Conclude: in *all worlds* consistent with the facts of *this world*, it is raining.

**Infelicitous use of must**
1. Know certain facts about the actual world: *see raindrops falling from the sky*

2. Know a rule mapping these facts to things that always follow from them
   - *tautological; rain entails rain*

5 What about entailment?

This denotation is compatible with:

**Weak must**, if the descriptive generalizations are fallible

**Strong must**, if the descriptive generalizations are known to be true

Just depends how you define the ordering source

So, which to choose?

**My answer:** Presupposition failure!

5.1 Strong vs. weak *must* is a false dichotomy

(7) **Definition:** Strong claim

Given two claims $P$ and $Q$, the **stronger claim** is the one that is *true in fewer worlds*

(8) **Entailment:** A special kind of strength

If $P \Rightarrow Q$, then $Q$-worlds $\subset P$-worlds

If $P$-worlds $\subset Q$-worlds, then $|P$-worlds$| < |Q$-worlds$|

**Prose:** If $P$ is a subset of $Q$, then $P$ has fewer elements than $Q$

So $P$ is stronger than $Q$

So, to see if $must(\phi)$ is **weaker** or **stronger** than $\phi$, we ask:

$(must(\phi))$-worlds $\subset (\phi$-worlds$)?$

$(\phi$-worlds$) \subset (must(\phi))$-worlds$?

**Problems**

**Circularity**

Have to define $must(\phi)$ to know whether $must(\phi)$ worlds are a subset of $\phi$ worlds

But have to know whether $must(\phi)$ worlds are a subset of $\phi$ worlds to define $must(\phi)$

**Appropriateness vs. truth**

The only data we **really** have is:

contexts where $\text{ASSERT}(must(\phi))$ is appropriate (indirect evidence for $\phi$)

*vs.* contexts where $\text{ASSERT}(\phi)$ is appropriate (direct evidence for $\phi$)

But indirect-evidence worlds and direct-evidence contexts worlds do not overlap

Need subset relationship to assess *strength*

but can’t have a subset relationship if the sets don’t overlap

So *strength* is not meaningful here

**Context-sensitivity**

Epistemic *must* invokes **body of rules** that the speaker **thinks she knows**
It is interpreted relative to the beliefs of some party determined in context.

The strength/weakness dichotomy does not take this into account.

Does \( \text{must}(\phi) \) entail \( \phi \)?

Does \( \text{I know that Barack Obama is the president} \) entail \( \text{Barack Obama is the President} \)?

I think so, but I might be wrong.

Maybe you can say \( \text{must}(\phi) \) when you might be wrong.

But, you can also say \( \phi \) when you might be wrong.

We cannot draw conclusions about actual world based on the speaker’s subjective beliefs.

\( \text{Must} \) invokes the speaker’s subjective beliefs.

So we cannot conclude whether \( \text{must}(\phi) \)-worlds are also \( \phi \)-worlds.

Similarly: “Speakers express a variety of conclusions, some logical, some defeasible. Sometimes they express them using epistemic \text{must}, but the data suggests that this use does not reflect the different logical status of conclusions.” (Stone (1994): 3)

See also: Matthewson et al. (2008), Giannakidou & Mari (2012) for evidence that \text{must} encodes evidentiality, independent of logical strength.

5.2 Upshot

Maybe the entailment question is so controversial and tricky because it is not really a coherent question.

6 Conclusion

Subtly modifying Kratzer’s system – to treat epistemic \text{must} more like deontic \text{must} – derives indirectness.

Turning to strength/weakness:

The proposed analysis is consistent with strong \text{must} AND weak \text{must}.

To choose one (or neither), we must tease apart propositions that are:

true in actual world

believed to be true in some party’s mental world

pragmatically appropriate assertions in the context

References


