A rating task: modal force in Wh-infinitivals

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1. Introduction. Expressions of modality have been identified in a wide array of lexical items, spanning several syntactic categories, and are even attested in sub-lexical linguistic units, such as morphemes. There are modal auxiliaries (e.g., *might*, *must*, *should*, *could*), modal adverbs (*possibly*, *definitely*, *maybe*), and modal morphemes (e.g., *-able* as in *crushable*). Modal meanings have also been identified in a number of constructions, such as imperatives (Kaufmann 2012), infinitival relative clauses (Bhatt 1999/2008, Hackl & Nissenbaum 2012), and infinitival Wh-complements (Bhatt 1999/2008), i.e., *Wh-infinitivals*. In such cases, the modal is not tied to any particular lexical item and is considered *covert*. Though the properties of overt modals have been characterized in great detail, the nature of covert modality is relatively under-explored. Certain aspects of covert modals seem to differ by construction, and also differ in surprising ways from overt modals. This paper is meant to broaden and precisify certain empirical observations initially made in Bhatt (1999/2008) about the modal interpretation in Wh-infinitivals. To achieve this, I conduct a web-based study that asks for native English speakers' judgements on modal interpretation across a range of different contexts involving Wh-infinitivals.

1.1. BACKGROUND. In the influential work of Kratzer (1991), the basic function of a modal is characterized in the following way: the context provides facts about the world (i.e., the modal base), and facts about what worlds are the best (i.e., the ordering source). Relevant facts and relevant ordering sources differ context to context, but one thing that is hard coded into the semantics of the modal is the modal's force: universal or existential. If the modal is universal, the proposition (p) that the modal combines with will necessarily hold in *all* the best worlds picked out by the ordering source. If the modal is existential, p is compatible with at least one of the best worlds.

Overt modals often constrain the modal meaning in a particular way. For example, the modal adverb *possibly* specifies the modal flavor as *epistemic*—what is known—and specifies the force as existential. The modal auxiliary, *must*, on the other hand, is not specified for flavor; e.g., it may be *epistemic* or *deontic*[1], but is fixed in terms of universal force. Though English overt modals are always fixed for force, covert modals in both Wh-infinitivals and infinitival relatives have been identified as varying in force (Bhatt 1999/2008, Hackl & Nissenbaum 2012). Bhatt provides the following example, where the force of the covert modal depends on elements of the context.

(1) Context: The speaker's goal is to get gas.
I know where to get gas.
=I know where we ***could*** *get gas.*

(2) Context: The speaker's goal is to get gas from some ethically commendable source.
I know where to get gas.
=I know where we ***should*** *get gas.*

[1] I use *deontic* to draw a contrast with *epistemic* flavors, but a more apt term for the relevant non-epistemic flavor might be *priority* (Portner 2009)—a more general term that covers more fine-grained flavor distinctions that are similar in nature to *deontic* flavors.

In (1), the speaker's goal is explicitly referenced in the Wh-infinitival—the goal is to get gas from any location that provides it. Bhatt (1999/2008) observes that this amounts to a reading best paraphrased with *could*, a modal with existential force. In (2), the speaker's goal is not made entirely explicit in the Wh-infinitival—the context provides additional considerations on the location. Uttered in the context of (2), Bhatt (1999/2008) observes that the Wh-infinitival is best paraphrased with the universal force modal *should*.

Despite this variability, Bhatt argues that there is one modal operator underlying in both (1) and (2). This covert modal operator of Wh-infinitivals is existential in force, and is goal-oriented in terms of its ordering source—worlds where some agent's goal is met are ranked as better than those where the goal isn't met. Bhatt's modal is composed of two conjuncts. The first conjunct mirrors that which is typically seen for possibility, or existential modals under the Kratzerian approach. The second conjunct imposes a strong relationship between p and the agent's goals, such that if p is true, then the relevant goal is necessarily satisfied.

(3) Covert modal in Wh-infinitivals (Bhatt 1999/2008)
$\diamond_{\mathrm{D},\rightarrow}(p) = 1 \iff \exists w'[w' \in \mathit{Goal}(w) \wedge p(w')]$
$\wedge\, \forall w'[[w' \in \mathit{Rel}(w) \wedge p(w')] \rightarrow w' \in \mathit{Goal}(w)]$

When the goal is explicitly encoded in the prejacent as in (1), the second conjunct above is rendered trivial and yields the existential interpretation, i.e., *could*. The *should* interpretation is contextually derived whenever p is the *only* way of achieving goals.[2]

Bhatt only considers whether the operator in (3) is appropriate for Wh-infinitivals that are embedded under the predicate *know*. There are several different predicates that may, in principle, embed Wh-infinitivals, and it is not yet clear whether the modal in (3) is empirically justified with embedding predicates other than *know*. That said, Bhatt does make some initial observations about the effect of certain embedding predicates on modal interpretation. Similarly, he also makes observations about the effect of Wh-word. The following study is meant to begin painting a more detailed empirical picture of modal meanings across a range of Wh-infinitivals, sorting out what features affect the interpretation and in what way. This work should both serve as a comparison to Bhatt's initial observations and should pave the way for evaluating the modal in (3) across a broader range of Wh-infinitival contexts.

To this end, the present study uses naturally occurring Wh-infinitivals found in a corpus of spoken dialogue together with its preceding context and asks native English speakers to judge the interpretation of the Wh-infinitival on a Likert scale of 1-7. The 1-side corresponds to a strong *could* interpretation, and the 7-side corresponds to a strong *should* interpretation. Ratings in the middle, e.g., 4, mean both *should* and *could* are plausible readings in the given context.

1.2. PREDICTIONS AND OBSERVATIONS. Bhatt's analysis of the covert modal predicts that there should be certain contexts that favor *could*; namely, if the goal is included in the Wh-infinitival itself. There should also be cases that favor *should*, i.e., where the goal is implicit and the p of the Wh-infinitival is taken to be the only way of achieving one's goals. It may be that, in some

[2]In some cases a *should* interpretation does seem to be possible even if there are multiple ways of achieving one's goals in the relevant context. If this is an empirically accurate statement, then Bhatt's modal does not cover all cases where the *should* interpretation is observed.

cases, the context is rather under-specified such that participants cannot choose between *should* and *could*—in such cases, we expect to see ratings of 4, or we expect to see other elements of the Wh-infinitival favor one modal force over the other.

Bhatt makes the following observations about how Wh-word and embedding predicate affect the interpretation of modal force in Wh-infinitivals, detailed in Table 1 below.

Property	Example	Favored modal interpretation
Wh-word	how, where	could
	who, when, which N, how many N, how Adj/Adv, whether	should
Embedding predicate	Verbs of retaining knowledge (e.g., *know*) Verbs of acquiring knowledge (e.g., *figure out*)	could
	Opinion verbs (e.g., *not sure*) Verbs of one-way communication (e.g., *tell*) Verbs of cogitation (e.g., *studied*) Inquisitive verbs (e.g., *wonder*)	should
Goal-included?	yes	could
	no	should

Table 1: Observations from Bhatt (1999/2008) about which aspects of Wh-infinitivals favor which modal interpretations.

Since the present study relies on naturally occurring data, not all elements of the table above could be found. For example, the corpus consulted contained no examples of *which N*, *how many N*, *how Adj/Adv*, or *whether* in infinitival contexts. The corpus also provided more observations than are accounted for in the above table, e.g., certain embedding verbs identified do not clearly fit in to the categories outlined above. The following section details the features of the Wh-infinitivals identified in the corpus.

2. The experiment and corpus.

2.1. THE DATABASE. This study relies on a corpus developed in Moyer & Degen (2021) that looks at Wh-questions across various structural contexts from the Switchboard corpus (Godfrey et al. 1992). The corpus was developed using TGrep2 (Degen & Jaeger 2005) and was coded for various features using TGrep2 Database Tools (Degen & Jaeger 2011). The features of the Wh-question included, but were not limited to, the Wh-word, whether it was root or embedded, finite or non-finite, and the embedding verb (if there was one).

There were roughly 1,426 total embedded Wh-questions in the Moyer & Degen (2021) database; 135 of these were Wh-infinitivals (9.5%). Thus, Wh-infinitivals are relatively rare overall compared to their finite counterparts. These 135 Wh-infinitivals constituted the naturalistic stimuli for the following rating task. One item from the corpus was excluded due to ungrammaticality—there was no verb following the the infinitival *to*, which resulted in 134 total items.

The overall distribution of Wh-words skewed heavily towards *how*, which made up 75% of all

Wh-infinitivals extracted. Table 2, below, shows the counts of all Wh-words.

HOW	WHAT	WHERE	WHO	WHEN	TOTAL
100	25	5	3	1	134

Table 2: Wh-word distribution in Wh-infinitivals

Notably, this distribution does not match that found in embedded finite contexts, where *what* is the most frequent Wh-word, and *how* is the second most frequent.

The most frequent embedding verb was *know*, making up most of the data at 55%. The full distribution of embedding verb is shown in Table 3, below.

Embedding verb	Count
know	75
learn	19
teach	12
figure out	7
tell	6
not sure	3
show	3
decide	2
forget	2
debate	1
remember	1
wonder	1
read	1
penetrate	1

Table 3: Embedding verb distribution in Wh-infinitivals

Lastly, I coded each Wh-infinitival for whether it made explicit reference to the agent's goal. In (4-a) below, it is clear that the goal isn't only to cope with one's life, but to cope with it by some metric judged as 'better,' as explicitly used by the speaker. In (4-b), however, the goal is implicit in the context—namely, the goal is not just to do anything with the agent's garden, but do something with it that likely *improves* upon its current status.

(4) a. ...but i don't know if they really had significant effects in the places where they went, in teaching the people **how to cope with their lives better**. GOAL-INCLUDED

b. ...i just i like to read gardening books and things like that—just to tell me **what to do with my garden**. GOAL-NOT-INCLUDED

The corpus yielded 12 examples similar in nature to (4-a), and 122 examples similar in nature to (4-b).

2.2. METHODS.

2.2.1. PARTICIPANTS.

141 participants U.S. native English speakers were recruited on Prolific. All participants were paid at a rate of $15/hour.

2.2.2. PROCEDURE AND MATERIALS.

Participants first saw two practice trials, which were meant to orient them to both sides of the scale. The first example biased them toward a SHOULD-reading by using the semi-modal *have to*, while the second example used *be able to*, meant to bias them towards the COULD-reading. Participants could not move beyond the example sentences unless they chose a rating corresponding to the intended reading (i.e., 1-3 for the COULD-reading and 5-7 for the SHOULD-reading).

On each trial, participants saw five lines of dialogue between Speaker #1 and Speaker #2 extracted from the Switchboard corpus, and then the target sentence containing the crucial Wh-infinitival in red. Participants were then asked: *Which sentence best expresses the meaning of the sentence in red?* They were then presented with a Likert scale from 1-7. On the left and lower end of the scale, the COULD-reading was provided, and on the higher end of the scale, the SHOULD-reading was provided. Participants were instructed to choose 4 if they considered both paraphrases appropriate in the given context. An example of preceding context and the target Wh-infinitival in red is provided below.

(5) Speaker #2: yeah,
Speaker #1: most of the time.
Speaker #2: but the politics, the politics gets worse in the small towns sometimes.
Speaker #1: oh man, in dallas you don't even know who's in, in administration, there's so many of them.
Speaker #2: you don't even know **who to payoff**, huh?

The following paraphrases were then offered on either end of the scale:

(6) a. You don't even know who you **could** payoff, huh? COULD-reading
b. You don't even know who you **should** payoff, huh? SHOULD-reading

Participants were required to choose a number on the scale on each trial, but they also had the option of checking a box that said 'Both sentences sound strange.'

The 134 grammatical Wh-infinitivals uncovered from the Wh-questions database were split into seven lists: five lists had 20 items, one list had 19 items, and one list had 15 items, totaling 134 items. The lists weren't completely balanced given the unbalanced nature of the corpus data, but there was an attempt to evenly distribute by Wh-word. The lists with 20 and 19 items all had 15 items with *how*. The additional slots were filled randomly with any non-*how* Wh-word. The seventh list with only 15 items was split in the following way: 10 items with *how*, 2 with *what*, 2 with *where*, and 1 with *who*. Each list was randomly assigned to 20 participants. There was one list that 21 participants saw, totaling 141 participants.

2.3. RESULTS.

2.3.1. EXCLUSIONS. Items that were marked as strange by 40% of participants were excluded from the following analyses. This resulted in 13 total exclusions (9.7% of all experimental items).

2.3.2. DATA ANALYSIS. We will focus here on three factors that Bhatt (1999/2008) observes to have an effect on modal interpretation: the effect of Wh-word, the embedding verb, and the explicit inclusion of the goal within the infinitival prejacent.

These questions were addressed by conducting mixed effects ordinal regression analyses that predict rating from fixed effects of Wh-word (reference level: *how*), embedding verb (reference level: *tell*), and what I'll refer to as 'goal-inclusion.' The model included by-participant and by-item random intercepts justified by the design.

We do find a main effect of Wh-word on modal interpretation: *what*, *when*, and *who* are all more likely to be given a higher rating than *how*.

	β	SE	p
what	.69	.25	$< .01$**
when	2.9	1.2	$< .05$*
who	1.4	.64	$< .05$*
where	.45	.5	.37

Table 4: Predicted β coefficient, standard error SE, and p value, with reference level *how*.

The only Wh-word that is not significantly distinct from *how* is *where*. This is consistent with the observation from Table 1, based on Bhatt (1999/2008), that *how* and *where* pattern together to the exclusion of other Wh-words.

How had the lowest mean rating (4.25) compared with other Wh-words. From Figure 1 below, it would seem that SHOULD-readings were never categorically excluded on the basis of Wh-word.

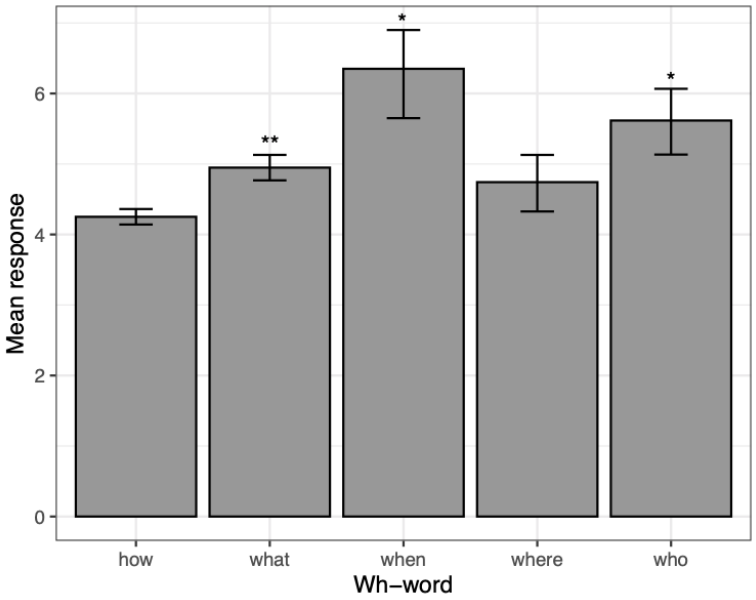

Figure 1: Mean response by Wh-word

Although *how* and *where* are comparatively lower than the other Wh-words, they do not necessarily favor a COULD reading, as suggested in Bhatt (1999/2008).

A main effect of embedding verb is also observed in Table 5, such that *wonder*, *not sure*, *read*, *learn*, *know*, and *figure out* are all more likely to have lower ratings than the reference level predicate, *tell*. In a sense, this finding runs counter to the observation from Bhatt (1999/2008) that *tell* should pattern together with *wonder*, and *not sure* in favoring SHOULD-readings. Figure 2 shows that ratings for *wonder* were, on average, below 4, corresponding to a preference for COULD-readings.

	β	SE	p
debate	-1.2	1.1	.28
decide	-1.2	.84	.15
figure	-2.5	.58	$<$ .001***
know	-1.1	.45	$<$ .05*
learn	-1.5	.5	$<$ .01**
penetrate	-2	1.1	.07
read	-3.1	1.1	$<$ .01**
remember	-1.1	1.1	.32
show	-.11	.73	.87
not sure	-1.4	.73	$<$ .05*
teach	-1	.52	.05
wonder	-3.1	1.1	$<$ .01**

Table 5: Predicted β coefficient, standard error SE, and p value, with reference level *tell*.

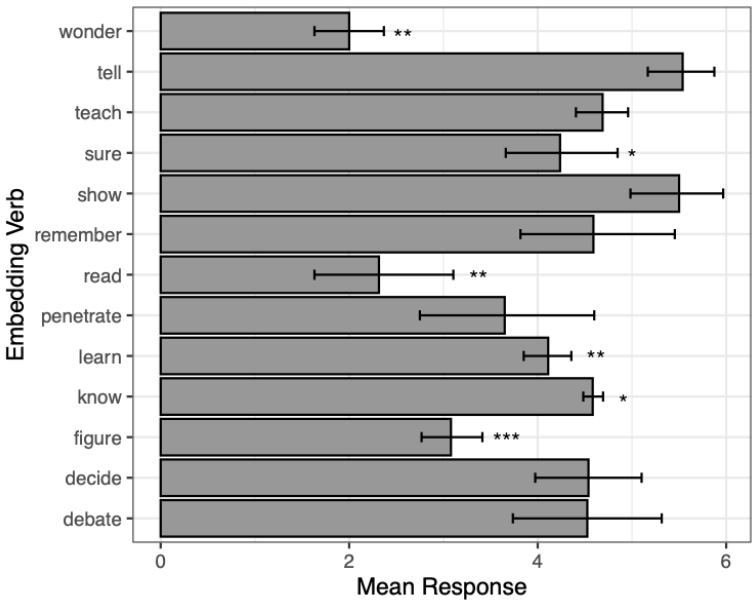

Figure 2: Mean response by embedding verb

Mean ratings for *tell* are definitively in SHOULD territory, and though *not sure* and *tell* differ significantly from one another, mean ratings for *not sure* are just above 4, signifying that SHOULD-readings are not categorically excluded; in this broader sense, then, these embedding verbs do pattern together. More discussion of results as they relate to Bhatt's original observations will be provided in the following section.

Finally, we observe a main effect of including the goal in the infinitival clause itself such that ratings for GOAL INCLUDED are more likely to be lower than cases where the goal is not included.

	β	SE	p
GOAL INCLUDED	-.7	.35	.04*

Table 6: Predicted β coefficient, standard error SE, and p value, with reference level GOAL-NOT-INCLUDED.

Mean ratings for GOAL INCLUDED and GOAL-NOT-INCLUDED show that on average, participants judged those where the goal was included as being in COULD territory—that is, below 4.

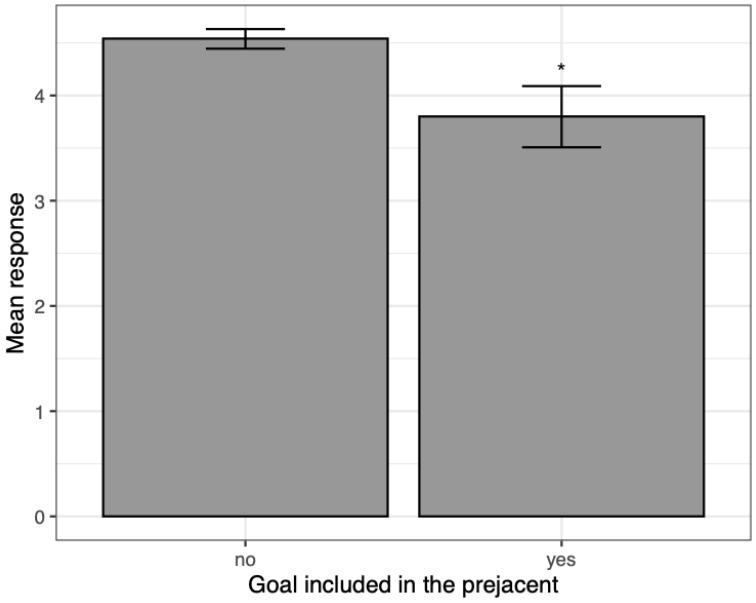

Figure 3: Mean response by goal inclusion

This finding is consistent with Bhatt's prediction about how the covert modal of Wh-infinitivals should interact with properties of the prejacent.

3. Discussion. The modal of Wh-infinitivals argued for in Bhatt (1999/2008) accounts for all cases in which there was a preference for an interpretation involving deontic possibility, i.e., the COULD-reading. We saw this preference under certain conditions; namely, when the goal was explicitly included in the prejacent (see Figure 3), and in the complement of certain embedding verbs (e.g., *wonder*, *figure out*, *read*). This study also reveals that the preference for COULD-readings when the goal is included in the prejacent persists in the domain of other embedding predicates, and isn't limited to *know*.

However, it is also true that there were several cases where deontic necessity, e.g., the SHOULD-reading, was preferred. For example, Wh-infinitivlas with *who* and *when* have average ratings above 5, signifying the preference for a SHOULD-reading. We also see this preference in the complement of certain embedding verbs (e.g., *tell*, *show*). Bhatt's modal in (3) can be informally characterized as meaning *p* is *one way* of achieving one's goal; it does not say that *p* is the *only way*, or the *necessary* way to achieve one's goals. On its own then, the modal in (3) does not account for the SHOULD-readings. If Bhatt is on the right track, and the modal of all Wh-infinitivals is existential, then speakers must be assuming, when they choose a rating corresponding to SHOULD that *p* is both *one way* of achieving one's goals, and the *only* way. If, however, speakers can accommodate a context where there are several ways of achieving one's goal and still prefer a SHOULD-reading, then we do not have an explanation from Bhatt's modal about the preference for SHOULD-readings. This would be unfortunate, since overall, SHOULD-readings were rarely excluded.

This raises a question about how average ratings in the 4-range should be understood: given a particular item, do some speakers have more of a COULD bias and some speakers, a SHOULD bias? Or were ratings generally in the middle of scale at 4? Either scenario is interesting from the standpoint of evaluating the modal in Wh-infinitivals. If it turns out that there was a bi-modal distribution of responses on either end of the scale for particular items that had an average rating around 4, then a follow up study should probe how speakers evaluate the *p* of the Wh-infinitival in context–do they perceive *p* as the only way of achieving one's goal or not? And does that correspond with choosing either the SHOULD or COULD reading? On the other hand, if some items were rated very much in the middle of the scale, at 4, was this because the context lacked crucial information that would bias them either way? Then one might ask, were sparse contexts always given middling ratings or is that only seen under certain conditions? Evaluating this will require surveying more closely the contexts in the corpus.

This study was able to confirm, in a broader sense, that at least two modal interpretations are possible in Wh-infinitivals: *should* and *could*. In some cases, too, neither modal paraphrase was plausible to speakers, suggesting that there may be an additional meaning associated with Wh-infinitivals.

The study also raises larger theoretical questions about *why* properties like Wh-word and embedding verb affect the modal force interpretation in the ways that they do. Is it an artifact of frequency, such that certain embedding verbs occur more often with overt *should* or *could*? Even if this is the case, what underlies that frequency? Are certain embedding verbs used more often in contexts that also favor either *should* or *could*? Asking these questions should shed light on what the analysis of covert modality in Wh-infinitivals ought to be. As a starting point, further analysis of responses should isolate by Wh-word and embedding verb to see the true effect of each on modal interpretation.

Bhatt (1999/2008) provides core insights into the nature of the covert modal in Wh-infinitivial that any analysis offered should preserve; e.g., the real effect of including the goal in the prejacent. However, it is unclear, from the present study, whether it is tenable to assume that the modal in all Wh-infinitivals is always the same, i.e., are SHOULD-readings accounted for? There were few cases where SHOULD was categorically excluded; in most cases, mean ratings tended to hover around 4 or above. What the underlying factors are that give rise to such ratings should provide a

starting point for future work on the interpretive component of this construction.

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Relevant links. The pre-registered hypotheses can be found at: https://osf.io/nb6yx. The Github respository contains the materials and analysis scripts: https://github.com/anissarz/my-project/tree/master/wh-questions.

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