Nothing's wrong with believing (or hoping) whether*

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Abstract Theories of clause selection that aim to explain the distribution of interrogative and declarative complement clauses often take as a starting point that predicates like *think*, *believe*, *hope*, and *fear* are incompatible with interrogative complements. After discussing experimental evidence against the generalizations on which these theories rest, I give corpus evidence that even the core data are faulty: *think*, *believe*, *hope*, and *fear* are in fact compatible with interrogative complements, suggesting that any theory predicting that they should not be must be jettisoned.

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1 Introduction

Some of the most well-developed theories of clause selection aim to explain the distribution of embedded interrogative and declarative clauses—specifically, which lexical properties condition whether a predicate takes only interrogative complements, only declarative complements, or both (Hintikka 1975, Karttunen 1977a, Zuber 1983, Berman 1991, Ginzburg 1995, Lahiri 2002, Egré 2008, George 2011, Uegaki 2015, Theiler et al. 2017, 2019, Elliott et al. 2017, White & Rawlins 2018a; but see Mayr 2018). Following Grimshaw 1979, a canonical contrast in this literature is that between predicates like *think*, *believe*, *hope*, and *fear*—which are often judged worse with interrogative complements than with declaratives (1a) out of context—and *know*—which is often judged fine with both (1b).

(1) a. Jo {thinks, believes, hopes, fears} (*whether) Bo left.
b. Jo knows (whether) Bo left.

This out-of-context contrast, which is corroborated by experimental evidence (White & Rawlins 2016, 2020, White et al. 2018a), forms the basis for various generalizations that authors then attempt to derive. I discuss three major proposals found in the literature, which I lay out in §2. The aim of this squib is to show that these generalizations, and thus their derivations, are not viable, even if heavily constrained.

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I first review prior lexicon-scale experimental evidence against one of these proposals in §3 and adduce further evidence against a second based on existing lexicon-scale datasets. This lexicon-scale evidence leaves open the possibility that the proposed generalizations might be saved by further constraining them. Using examples drawn from two corpora, I suggest in §4 that any such constrained version must jettison the contrast in (1) as supporting evidence. But because the contrast in (1) forms the core data for all of these generalizations, I argue that the generalizations are left so frail without these data that they should be jettisoned altogether.

2 Proposed generalizations

Egré (2008) proposes that a predicate *V* is *responsive*—i.e. takes both interrogatives and declaratives (Lahiri 2002)—iff it is *veridical*—i.e. *X V S* entails *S*.[1] *Think* and *believe* are not veridical—(2a) does not entail (2b)—and thus they should not be responsive. And because they take declaratives, they should not take interrogatives.

(2) a. Jo {thinks, believes} Bo left.
b. Bo left.

Theiler et al. (2017, 2019), following Zuber (1983), propose a generalization with similar consequences: a predicate is *antirogative*—i.e. takes declaratives but not interrogatives—if it is *neg-raising*—i.e. if one tends to infer from *X not V S* that *X V not S*. *Think* and *believe* are therefore also neg-raising—from (3a), one tends to infer (3b)—and thus they should not take interrogatives.

(3) a. Jo doesn't {think, believe} Bo left.
b. Jo {thinks, believes} Bo didn't leave.

Finally, in an attempt to extend Theiler et al.'s proposal, Uegaki & Sudo (2019) propose that a predicate *V* is antirogative if it is nonveridical and *preferential*—i.e. if focus in the scope of the predicate has a truth conditional effect. *Hope* and *fear* are not veridical—(4) does not entail (2b)—but they are preferential (see Uegaki & Sudo's Ex. 11), and thus they should not take interrogative complements.

(4) Jo {hopes, fears} Bo left.

In what follows, I assume what I take to be the most charitable possible interpretation of each generalization: that it concerns inferences (veridicality or neg-raising) drawn on particular uses of a particular predicate sense. Under this assumption, the

1 Egré attributes a similar generalization to Hintikka 1975—a predicate is responsive iff it is factive (see also Berman 1991, Ginzburg 1995). This generalization is not stated outright in that work—though it is a reasonable interpretation. It also predicts that *think* and *believe* are antirogative.

explanation for the contrast in (1) would then be that the default context against which the default senses of *think*, *believe*, *hope*, and *fear* are judged implies antirogativity.

3 Experimental evidence against the generalizations

Given quantitative measures of responsivity and veridicality, the Egré generalization ($\mathbb{V}$) predicts that one should find a strong (in fact, perfect) positive correlation between these measures across all verbs, and the Uegaki & Sudo generalization ($\mathbb{V}+\mathbb{P}$) predicts that, when subsetting to just the preferential predicates, one should find a reliable (though not necessarily perfect) positive correlation between the measures. Similarly, given quantitative measures of responsivity and neg-raising, the Zuber-Theiler et al. generalization ($\mathbb{NR}$) predicts that one should find a reliable (though not necessarily perfect) negative correlation between the measures.[2]

I first discuss existing quantitative evidence against $\mathbb{V}$ in §3.1. I then turn to a new analysis of existing quantitative data that provides evidence against $\mathbb{NR}$ in §3.2. I state this evidence in terms of *variance explained* and *predictive power* rather than *correlation* because this is how the existing analysis I discuss is stated, but note that one variable's poorly explaining variance in another implies having a weak or nonexistent correlation with that variable by definition.

3.1 Evidence against the Egré generalization

White & Rawlins (2018b) show that the predictions of $\mathbb{V}$ are not borne out. Using a veridicality judgment task to construct their MegaVeridicality dataset, they obtain a quantitative measure of veridicality for all English verbs that are acceptable with a declarative complement—operationalized as an average acceptability judgment of 4 out of 7 or better for (5a) or (5b) in White & Rawlins's (2016, 2020) MegaAcceptability dataset. A total of 517 verbs in MegaAcceptability fit this criterion.[3]

(5) a. Someone {thought, knew, ...} that something happened.
b. Someone was {told, worried, ...} that something happened.

White & Rawlins's veridicality judgment task prompt is exemplified for *know* in (6).

(6) A particular person knows that a particular thing happened.
Did that thing happen? *yes*, *maybe or maybe not*, *no*

2 Because $\mathbb{V}+\mathbb{P}$ and $\mathbb{NR}$ are stated in terms of a conditional, rather than a biconditional, the quantitative predictions of these generalizations are potentially much weaker than $\mathbb{V}$, though for these proposals to have any explanatory power, I assume that some nontrivial, reliable correlation is predicted.

3 White et al. (2018b) substantially expand MegaVeridicality to predicates that take various types of infinitival complement. Since Egré discusses only finite interrogatives, I do not discuss this expansion.

White & Rawlins then derive a measure of responsivity for each verb from MegaAcceptability by (i) taking the maximum average acceptability over both polar (7a) and constituent (7b) interrogatives to obtain a measure of interrogative-taking; and (ii) taking the minimum of that measure and an analogous declarative-taking measure.

(7) a. Someone (was) {thought, told ...} whether something happened.
b. Someone (was) {though, told, ...} which thing happened.

In regressing the responsivity measure on the veridicality measure under 10-fold cross-validation, they find that veridicality predicts only 5% of the variance in the responsivity measure—and even then, not reliably (95% CI = [-2%, 13%]). This finding suggests that $\mathbb{V}$ has effectively no predictive power at the scale of the lexicon.

3.2 Evidence against the Zuber-Theiler et al. generalization

Because there does not exist a database of predicates annotated using Uegaki & Sudo's preferentiality definition, it is not currently possible to test $\mathbb{V}+\mathbb{P}$ using White & Rawlins's methodology; but using this methodology in conjunction with An & White's (2020) MegaNegRaising dataset, it is possible to test $\mathbb{NR}$. An & White derive a measure of neg-raising using a likelihood judgment task, wherein participants are asked to judge how likely a speaker is to mean one thing if they say another. For instance, to assess whether *think* is neg-raising in the present tense with a first person subject, participants were asked to respond to (8) with a slider.

(8) If I were to say *I don't think that a particular thing happened*, how likely is it that I actually mean that *I think that that thing didn't happen*?

After showing that this method tracks neg-raising judgments reported in the literature extremely well (Appendix C), An & White apply their method to all English verbs acceptable with a declarative complement under White & Rawlins's declarative-taking criterion, varying both the subject (*first* v. *third*) and tense (*past* v. *present*).[4]

To use this measure of neg-raising, I take the maximum average neg-raising judgment across all four subject and tense variants for a particular predicate. I then regress White & Rawlins's measure of responsivity on this neg-raising measure under 10-fold cross-validation. This yields an average of 2% of the variance explained (95% CI = [0%, 4%]), suggesting that $\mathbb{NR}$ has even worse predictive power than $\mathbb{V}$.

4 An & White additionally follow White et al. (2018b) in collecting similar judgments for predicates that take infinitival complements. Since Theiler et al. only focus on finite interrogatives—and thus it is unclear how to correctly test $\mathbb{NR}$ for infinitival-taking predicates—I focus only on finite declaratives.

4 Corpus evidence against the generalizations

Having established that at least $\mathbb{V}$ and $\mathbb{NR}$ have effectively no predictive power, I now address the possibility that they might be rescued by constraining their statement further—e.g. in the way $\mathbb{V}+\mathbb{P}$ is constrained to preferential predicates. Such a constraint might serve to exclude peripheral classes of predicates, while retaining the core contrast in (1). On the basis of corpus examples, I argue that even this core contrast cannot be retained and that all three generalizations should be jettisoned.

I select examples from two corpora: the Corpus of Contemporary American English (COCA) and the iWeb Corpus. COCA is a corpus that, at the time of my search, contained over 500 million words spread over five genres: spoken, fiction, popular magazines, newspapers, and academic texts; and iWeb is a corpus containing over 14 billion words of web text (blogs, news articles, etc.). To search for examples, I use each corpus' web interface (linked above) to query for *think*, *believe*, *hope*, and *fear* in any morphological form, followed by *whether*—e.g. for *think*: `[THINK] [WHETHER]`.[5] From the results of this search, I select examples that I (a native California English speaker) take to be perfectly acceptable.[6]

I break discussion of these examples into two sections based on which generalizations they are relevant to. In §4.1, I discuss *think* and *believe*, showing that neither $\mathbb{V}$ nor $\mathbb{NR}$ can explain these examples. I then turn in §4.2 to *hope* and *fear*, showing that $\mathbb{V}+\mathbb{P}$ cannot explain these examples.

4.1 *Thinking* and *believing whether*

As discussed in §2, both $\mathbb{V}$ and $\mathbb{NR}$ predict that *think* and *believe* should not take interrogative complements. But *think* is attested with interrogative complements in transcribed speech (9), periodical text (10), and internet text (11).

(9) a. The image of having the members of one branch of government standing up[...]cheering and hollering while the court[...]has to sit there, expressionless[...]is very troubling. And it does cause you to **think whether** or not it makes sense for us to be there.

b. [...]the righteousness is unbelievable and people[...]will have to **think whether** they want four more years of that.

(10) a. When Jan Brown completed her safety briefing for the passengers, she tried to **think whether** she had covered everything.

5 I focus on polar (*whether*) interrogatives because, following Egré, I assume that polar interrogative selection is more constrained than constituent interrogative selection.

6 An anonymous reviewer reports that they find most of the examples cited below acceptable, but that others are not as good for them. An exploration of such idiolectal variation in this area would be interesting, but it is out of scope for the current squib.

b. I'm trying to **think whether** I'd have been a star today or not.

(11) a. [O]ften, when listening to some other players (especially beginners) I start to **think whether** there's an unwritten law for guitarists to never play an interval bigger than the major third.

b. [...]he wanted a domain that was memorable, brandable, keyword-rich, and relatively short. That's tough and he started to **think whether** it was worthwhile to look into other TLDs.

In at least a subset of these examples, one might attempt to save $\mathbb{V}$ by arguing that *think* is in fact veridical or is not in fact neg-raising in these contexts (see Spector & Egré's (2015) approach to predicates like *tell*). For example, *think* in (10a) might be paraphrased using *remember*, and *think* in (10b) might be paraphrased using *figure out*, both of which are neither veridical nor neg-raising. But with respect to veridicality, this move is somewhat suspect for (9) and (11), wherein reasonable paraphrases seem to involve the predicate *consider*. Now, *consider that* may well have a veridical sense—roughly, *consider the fact*, in contrast to *consider the possibility*—but that sense does not appear to be the one active in at least (9b), wherein the speaker seems to be encouraging consideration of a possible desire.

These examples may be less problematic for $\mathbb{NR}$, since proponents might argue that *think* is not neg-raising in (9)-(11). An example of this sort of argument is laid out by Theiler et al. (2019) for *believe*, which is normally taken to be a neg-raising predicate. They point out (fn. 11) that *believe* can take interrogative complements in certain constructions (12), and when it does, they argue that it is not neg-raising, given that strong negative polarity items (strong NPIs; Zwarts 1998), like *in ages*, cannot occur in the complement (Gajewski 2007).

(12) You won't believe who called (*in ages)!

One issue with this test is that neg-raising never occurs with interrogative complements: why should we expect it to occur here? A proponent of $\mathbb{NR}$ might argue that this data point is another piece of evidence in their favor. But if this data point is indeed evidence for the generalization, it is quite weak, because it does not disassociate a predicate's propensity to license neg-raising in a particular context from other syntactic and semantic factors that might block the inference, such as the form of the complement. With this in mind, I propose that a better test is to minimally modify sentences like (12) to remove any effect of the form of the complement while retaining all other aspects of the context—e.g. by simply converting an interrogative, as in (12), to a declarative, as in (13). When we do this for (12), we get a result consistent with Theiler et al.'s argument: (13) is bad.

(13) *You won't believe that someone called in ages!

I refer to this as the *interrogative-to-declarative test*. Applying this test to corpus examples like (14) yields contexts where both *think whether* and neg-raising *think* are possible: the strong NPI *until...* is fine in (15) with low attachment to *help*.[7]

(14) I was **thinking whether** there was a way to[...]help more than one person.

(15) I wasn't thinking there was a way to help more than one person (at a time) until Jo got back from lunch.

This form of argument is weak, since the *think* in (14) still might be a different *think* from the one in (15), though such a polysemy is otherwise unmotivated. To posit a regular polysemy of this form, it would be necessary to see other predicates showing similar behavior. *Believe* is such a predicate, and it is compatible with interrogative complements—seen in (12) and corroborated by (16).

(16) a. [...]I didn't believe the Bible growing up, I wasn't a Christian growing up, I struggled to **believe whether** I could trust the Scriptures[...]
b. We can choose to **believe whether** the word of God is true[...]or not.
c. I am torn between **believing whether** or not Jagex can detect the RSBot client.

But unlike (12), at least some of these examples pass the interrogative-to-declarative test. For instance, in the context of (17a), the strong NPI *either* in (17b)—analogous to (16b)—is clearly good.

(17) a. We can choose not to believe the teachings of the Buddha are true.
b. We can choose not to believe the word of God is true either.

One property that all of the sentences in (16) share is that, in context, they apparently either do not trigger an *opinionatedness inference*—i.e. the inference that a speaker who uses *NP believe S* endorses $[\![\text{NP}]\!]$ BELIEVE $[\![\text{S}]\!] \vee [\![\text{NP}]\!]$ BELIEVE $\neg[\![\text{S}]\!]$ (Bartsch 1973)—or they only do so vacuously: in (16a), an explicit belief is stated about the trustworthiness of the Bible before the use of *believe whether*, assymetrically entailing the inference; in (16b), a choice of belief has apparently not been made and thus the speaker's cohort is presumably not yet opinionated; and in (16c), in being torn, the speaker explicitly states that they do not have a firm belief.

The opinionatedness inference is implicated in the derivation of the neg-raising inference in some approaches, so this fact could then be used to save $\mathbb{NR}$ by denying that the conditions for neg-raising are met in context. But beyond substantially

7 For those having difficulty obtaining the low attachment reading, consider a context wherein the speaker's manager is questioning why they, as team leader at a help desk, were serving only one customer at a time, when the help desk was staffed with three people.

weakening the predictive power of that generalization, this move is not possible for all sentences. Consider (18).

(18) [...]Richard Stavin, a former veteran federal prosecutor[...]declared[...] "[...]I believe it was an organized, orchestrated effort on the part of certain individuals within Washington, D.C. to keep a hands-off policy towards MCA[...]" **Believing whether** certain individuals within Washington D.C. had an MCA policy is not the same as proving there was such a policy.

Here, the author takes as common ground that Stavin has an opinion, then asserts that having said opinion is not the same as proving that opinion to be true. Beyond being problematic for $\mathbb{NR}$, this example is also problematic for $\mathbb{V}$: the content of (18) draws a contrast between the nonveridicality of belief and the veridicality of proof, and so it would be contradictory to interpret *believe* as veridical in this context.

On the basis of these examples, attesting that *think* and *believe* do indeed take interrogative complements, I argue that we should jettison both $\mathbb{V}$ and $\mathbb{NR}$.

4.2 *Hoping* and *fearing whether*

$\mathbb{V}+\mathbb{P}$ predicts that *hope* and *fear* should not take interrogative complements. Indeed, *hope* and *fear* are two of the central cases discussed as evidence for $\mathbb{V}+\mathbb{P}$ by Uegaki & Sudo. But *hope* is attested with interrogative complements in both speech transcripts (19) and internet text (20).[8]

(19) This Trump/Carson boom really has people like Bush, Walker, Rubio, and others wondering and **hoping whether** history will repeat itself and whether Republicans will return back to focusing on the establishment choices but it's all about outsider candidates right now.

(20) a. I was **hoping whether** you are able to guide me[...]
b. I have done a quite a bit of research on using a Limited Co but was **hoping whether** someone with more experience could confirm my understanding of a few points[...]

A potential worry with at least the sentences in (20) is that they seem paraphrasable using *hope that*—evoking Karttunen's (1977b) observation that declarative and polar interrogative complements appear interchangeable for responsives like *doubt*.

(21) Jo doubts that Bo left. ≈ Jo doubts whether Bo left.

8 I was unable to find examples in COCA's periodical texts. I suspect this has to do with the lower frequency of *hope* compared to *think* as well as the small size of the COCA periodicals corpus.

While such a paraphrase may be available, this availability cannot imply that the interrogative is somehow different from the one found under other predicates: note that, in (19), *hope* is coordinated with *wonder*, which is unambiguously interrogative-taking. Thus, even if one argues that *hope that* and *hope whether* are in some sense interchangeable, this explanation cannot presume that the interchangeability is due to the interrogative embedded under *hope* having a distinct semantics.

Similar examples can be found for *fear*.

(22) a. Interstellar space is so vast that there is no need to **fear whether** stars in the Andromeda galaxy will accidentally slam into the Sun.
b. I **fear whether** this test would run safely on the oxygen sensor as it has a lot of drawback when compared with the others.
c. [...]I **fear whether** I'll have use of my arms/hands by age 55 or 60.
d. I know parents who seriously **fear whether** their children will ever hold a meaningful job.

Example (22a) might be explained under Mayr's (2018) proposal that interrogative embedding for some predicates, like *be certain*, is licensed by downward entailing contexts, since the *no* scoping over *fear* in (22a) creates such a context.

But this move is not available for at least (22b)-(22d), where no downward entailing operators outscope *fear*. Further, running the interrogative-to-declarative test on these cases does not yield veridicality inferences about the content of *fear*'s complement, suggesting that veridicality is not licensing these cases: from (23a), one does not infer that the test would (not) run safely; from (23b), one does not infer that the speaker will not (or will) have use of their arms/hands; and from (23c), one does not infer that the parents' children will (not) ever hold a meaningful job.

(23) a. I fear that this test would run safely on the oxygen sensor as it has a lot of drawback when compared with the others.
b. [...]I fear that I won't have use of my arms/hands by age 55 or 60.
c. I know parents who seriously fear that their children will ever hold a meaningful job.

On the basis of these examples, attesting that *hope* and *fear* do indeed take interrogative complements, I argue that we should jettison $\mathbb{V}+\mathbb{P}$.

5 Conclusion

The proposals discussed here pursue the laudable goal of associating selection with independently motivated lexical properties, such as veridicality, neg-raising, and preferentiality. This means that the generalizations on which these proposals rest are

predictive and thus falsifiable. I have presented evidence from both lexicon-scale experimental data and examples attested in corpora that these generalizations are, if not outright falsified, so frail that they should be jettisoned.

Importantly, though, this finding does not imply that proposals wherein clause selection is a function of semantic selection (Grimshaw 1979) should be abandoned wholesale, as Mayr (2018) argues. It remains a live possibility that some alternative set of lexical properties might be found that predict clause-selection—e.g. as suggested by White & Rawlins (2018a), event structural properties, such as stativity, durativity, and telicity (see also Kratzer 2006, Moulton 2009, Bogal-Allbritten 2016).

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