The *hope-wh puzzle*

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Abstract

Clause-embedding predicates come in three major varieties: (i) *responsive predicates* (e.g. *know*) are compatible with both declarative and interrogative complements, (ii) *rogative predicates* (e.g. *wonder*) are only compatible with interrogative complements, and (iii) *anti-rogative predicates* (e.g. *hope*) are only compatible with declarative complements. It has recently been suggested that these selectional properties are at least partly semantic in nature. In particular, it is proposed that the anti-rogativity of neg-raising predicates like *believe* comes from the triviality in meaning that would arise with interrogative complements. This paper puts forward a similar semantic explanation for non-veridical preferential predicates such as *hope*. In so doing we also aim at explaining the fact that their veridical counterparts such as *be happy* are responsive.

1 Introduction

Clause-embedding predicates can be classified into three types (Grimshaw 1979, Lahiri 2002, Theiler, Roelofsen, and Aloni 2017):

- Responsive predicates can embed both declarative and interrogative complements, e.g. *know*.
- Rogative predicates can only embed interrogative complements, e.g. *wonder*.
- Anti-rogative predicates can only embed declarative complements, e.g. *believe*.

The main question we would like to tackle in this paper is how this variation should be accounted for. One possibility is to assume that each clause-embedding predicate comes with a lexical specification as to what kind of clause it syntactically selects for. This type of explanation, however, is unsatisfactory on its own given the stability and predictability of selectional patterns observed both intra- and cross-linguistically such that predicates that have similar meanings generally exhibit the same selectional properties. For instance, we would like to explain why we do not find a version of *know* that is rogative or a version

*Acknowledgments to be added later.

of *wonder* that is responsive. Considerations like this are taken as evidence that the core selectional properties come from the lexical semantics of the predicates, although idiosyncratic syntactic properties are not necessarily excluded (Grimshaw 1979, Pesetsky 1982, 1991, White and Rawlins 2016).

Recent developments in the area of question semantics have deepened our understanding of the semantic nature of complement selection, but there still are some open issues. In order to illustrate these issues, let us first consider the following type-theoretic approach. One of the standard views of question semantics, championed by Karttunen (1977) and others, holds that declarative and interrogative clauses denote different kinds of semantic objects. Specifically, declarative clauses denote propositions, while interrogative clauses denote sets of propositions. In this setting, anti-rogative predicates like *believe* are analyzed as those whose denotations exclusively select for propositions, and rogative predicates like *wonder* as those whose denotations exclusively select for sets of propositions, as illustrated in (1). Throughout this paper, we write $\hat{\tau}$ for the type of sets of type-τ objects.[1]

(1) a. $[\![\,\mathsf{believe}\,]\!]^w = \lambda p_{\langle s,t\rangle}.\lambda x_e.\ \mathtt{believe}_w(x,p)$
b. $[\![\,\mathsf{wonder}\,]\!]^w = \lambda Q_{\widehat{\langle s,t\rangle}}.\lambda x_e.\ \mathtt{wonder}_w(x,Q)$

This analysis needs to make an extra assumption about responsive predicates, which are compatible with both types of embedded clauses. The most popular take on this is to assume that when they combine with an interrogative clause, the meaning of the interrogative clause is converted to a specific proposition that represents an 'answer' to the question (Heim 1994, Dayal 1996, Beck and Rullmann 1999, Spector and Egré 2015). We will put aside the interesting but complicated issue of what counts as an appropriate answer to a question for the moment (see §4.3), but if any such mechanism that converts sets of propositions to propositions is available, it becomes unclear why anti-rogative predicates cannot combine with interrogative clauses. That is, just like (2-a) means roughly 'John doesn't know the true answer to the question *Who danced?*', (2-b) should be able to mean something like 'John doesn't believe the true answer to the question *Who danced?*'.

(2) a. John doesn't know who danced.
b. *John doesn't believe who danced.

Some recent theories of question semantics do not make a type distinction between declarative and interrogative clauses (Ciardelli, Groenendijk, and Roelofsen 2013, Uegaki 2015, Theiler, Roelofsen, and Aloni 2016). Specifically, on these accounts, both declarative and interrogative clauses denote sets of propositions, which are taken to represent *issues*, and the difference between declarative and interrogative clauses boils down to whether or not the issue is *resolved* (where a resolved issue can be seen as a set of propositions with a unique maximum with respect to entailment). In this setting, rogative predicates can be analyzed as those that exclusively select for unresolved issues, anti-rogative predicates as those that exclusively select for resolved issues, and responsive predicates as those that are insensitive to resolvedness. To be more concrete, these restrictions could be encoded as sortal presuppositions as in (3).

[1]Since the domain of partial functions of type $\langle\sigma,t\rangle$ is not isomorphic to the domain of sets of objects of type-σ (unlike the domain of total functions), we will explicitly distinguish sets and their characteristic functions.

(3) a. $[\![\textsf{believe}]\!]^w = \lambda Q_{\widehat{\langle s,t\rangle}}: \texttt{resolved}(Q).\lambda x_e.\ \texttt{believe}_w(x,Q)$
b. $[\![\textsf{wonder}]\!]^w = \lambda Q_{\widehat{\langle s,t\rangle}}: \neg\texttt{resolved}(Q).\lambda x_e.\ \texttt{wonder}_w(x,Q)$
c. $[\![\textsf{know}]\!]^w = \lambda Q_{\widehat{\langle s,t\rangle}}.\lambda x_e.\ \texttt{know}_w(x,Q)$

For such a theory to be truly explanatory, however, it needs to be able to predict which predicates have what restrictions, but this turns out to be not at all trivial. For instance, *know* and *believe* have very similar meanings, but why is it that the former is insensitive to resolvedness, while the latter is sensitive to it?

Recently, Theiler et al. (2017) and Mayr (2017) propose a partial answer to this question. As originally noticed by Zuber (1982), neg-raising predicates are all anti-rogative (e.g. *believe, think, expect, assume, presume, reckon, advisable, desirable, likely*). To explain this robust generalization, Theiler et al. (2017) and Mayr (2017) put forward semantic accounts, according to which, such predicates give rise to logically trivial interpretations with interrogative complements, due to their neg-raising property. We do not go into the details of these accounts here, but in our view they are conceptually attractive, as they reduce the selectional properties of these predicates to their independently observed semantic property.

One limitation of these accounts, however, is that they only explain a subset of anti-rogative predicates. That is, while neg-raising predicates are all anti-rogative, not all anti-rogative predicates are neg-raising. Concretely, predicates like *hope, wish, fear, deny* and *regret* are not neg-raising but are still anti-rogative.

In sum, it is conceptually appealing to explain anti-rogativity in semantic terms, and some recent accounts achieve this for neg-raising predicates like *believe*. However, the explanations they offer are not applicable to all anti-rogative predicates. This of course does not mean that these accounts should be dismissed. In fact, we think it is not unlikely that different anti-rogative predicates are anti-rogative for different semantic reasons. In this paper, we will develop a semantic analysis of the anti-rogativity of preferential predicates like *hope* and *fear*. If successful, it will complement the analyses of the anti-rogativity of neg-raising predicates, although there still will be some anti-rogative predicates that are left unexplained by either account, e.g. *regret* and *deny*.

The idea we will pursue in this paper is similar in nature to the aforementioned accounts of neg-raising predicates: non-veridical preferential predicates like *hope* are prohibited from combining with interrogative clauses, because such combinations are bound to result in trivial meanings. We will furthermore show that this analysis also accounts for the fact that their veridical counterparts like *be happy* are responsive.

The structure of the present paper is as follows. In §2, we will present our main empirical observation that veridicality correlates with anti-rogativity in the domain of preferential predicates. In §3, we will develop our core account, which we will refine in §4. §5 is devoted to discussion of the role of prepositions, most notably *about*, in the present phenomenon. §6 concludes.

2 Veridicality and anti-rogativity

Following previous studies on the typology of attitude predicates, especially Anand and Hacquard (2013) (see also Bolinger 1968, Heim 1992, Villalta 2008), we recognize two major semantic classes among them. We say an attitude predicate is *representational* if it expresses a 'propositionally consistent attitudinal state' (Anand and Hacquard 2013:

	Representational	Non-representational (preferential)
Veridical	*know, forget, remember*	*be glad, be surprised, be happy*
Non-veridical	*believe, be certain, doubt*	*hope, wish, demand*

Table 1: Examples of four classes of attitude predicates generated by veridicality and representationality.

3) and is *non-representational* otherwise.[2] For instance, predicates of (un)acceptance (e.g. *know, believe, be certain, deny*) are all representational. Of particular interest for us in this paper are *preferential predicates* (alt.: order-based predicates) which constitute a sub-class of non-representational predicates. Preferential predicates express comparisons of alternatives based on preference orders. They include desideratives (e.g. *hope, wish, want, fear, be surprised, be happy*) and directives (e.g. *demand*).

We observe that veridicality correlates with anti-rogativity in the domain of preferential predicates. We say that a clause embedding predicate V is *veridical* if $\ulcorner \alpha\ V$s that $p \urcorner$ entails $\ulcorner p \urcorner$.[3] Veridicality crosscuts the representational vs. non-representational distinction, giving rise to four classes of attitude predicates, as summarized in Table 1.

We submit that all non-veridical preferential predicates are anti-rogative. Let us consider some examples. Firstly, non-factive preferential predicates are generally anti-rogative.

(4) a. *Alice prefers which students will be invited to the party.
b. *Ben hopes/wishes which students will be invited to the party.
c. *Chris expects/fears how many students will be invited to the party.

All of these predicates are compatible with finite declarative complements.

(5) a. Alice prefers that Andrew will be invited to the party.
b. Ben hopes/wishes that Becky is invited to the party.
c. Chris expects/fears that Cathy is invited to the party.

It should be remarked that there are preferential predicates that cannot (easily) take finite complements, declarative or interrogative, e.g. such as *want* and *be uneasy.* These predicates are neither anti-rogative nor responsive, and their selectional restrictions need to be somehow lexically stipulated, perhaps as a syntactic condition.

Finally, let us look at preferential predicates that are compatible with interrogative complements. The ones in the following examples are all responsive and veridical (factive, in fact) when combined with declarative complements. (Some of these cases sound better with a preposition like *about*, but we should be careful as *about* itself might make an interrogative complement available. This issue will be taken up in §5.)

(6) a. Andy is surprised (at/by) which students are invited to the party.
b. Ben is glad/happy which students are invited to the party.

[2] Anand and Hacquard (2013) lists some linguistic phenomena (namely, mood selection, parenthetical uses, compatibility with epistemic modals) that could be used as diagnostics for representationality of attitude predicates. It should nonetheless be mentioned that the empirical landscape is not as clear as one might wish. For example, as Anand and Hacquard (2013) discusses, mood selection might not be an entirely reliable test, especially given its cross-linguistic variability.

[3] Factivity is a special case of veridicality. An embedding predicate V is *factive* if $\ulcorner \alpha\ V$s that $p \urcorner$ presupposes $\ulcorner p \urcorner$.

c. Chris liked/hated which students were invited to the party.

Note that the *which*-NP clauses in the examples cannot have a free relative interpretation (Huddleston and Pullum 2002: 398). That these predicates can embed genuine interrogative complements (as opposed to free relatives) can be further confirmed using the test involving *wh-else* (Ross 1967: 38):

(7) a. Andy is surprised (at/by) who else is invited to the party.
b. Ben is glad/happy who else is invited to the party.
c. Chris liked/hated who else was invited to the party.

These data corroborate the hypothesized correlation between veridicality and anti-rogatitivity within preferential predicates. However, it should be mentioned that one direction of the correlation, i.e., that veridical preferential predicates are responsive, is not exception-less. One notable exception is *regret*, which is factive but anti-rogative (Lahiri 2002, Egré 2008). The focus of our analysis is the other direction of the correlation, i.e., that all non-veridical preferential predicates are anti-rogative. Anti-rogativity of *regret* would require a yet another account.

Before leaving the section, we would like to stress that our generalization has nothing to say about the veridicality of representational predicates and their selectional properties. However, it is noticeable that veridicality generally implies compatibility with interrogative clauses in the domain of representational predicates as well. As mentioned above, neg-raising matters for non-veridical representational predicates. For instance, *believe* and *predict* are both non-veridical, but the former is anti-rogative, while the latter is responsive. Veridical representational predicates (e.g. *know*), on the other hand, are both non-neg-raising and responsive. We have nothing new to add here, and refer the interested reader to Egré (2008), Theiler et al. (2017) and Mayr (2017).

3 Why veridicality matters for preferential predicates

In this section we will spell out our explanation as to why veridical preferential predicates are responsive, while non-veridical ones are anti-rogative. The core idea is that non-veridical preferential predicates with interrogative clauses give rise to trivial meaning while veridical preferential predicates do not, regardless of the complement clause-type. We will formalize this using (i) a uniform approach to clause-embedding (Ciardelli et al. 2013, Uegaki 2015, Theiler et al. 2016) (§3.1) and (ii) the degree-based semantics for preferentials (Romero 2015) (§3.2).

3.1 A uniform approach to clausal embedding

We follow Ciardelli et al. (2013), Uegaki (2015), Theiler et al. (2016) and take a uniform approach to clause-embedding where both declarative and interrogative complements denote sets of propositions and all clause-embedding predicates take sets of propositions as arguments. We assume that declarative sentences denote singleton sets of propositions, while interrogative clauses denote non-singleton sets of propositions.[4] (See §4.3 for the

[4]We could include all non-trivial stronger propositions in the denotations, as in certain versions of Inquisitive Semantics, but such structure is unnecessary for the purposes of this paper.

treatment of exhaustivity in embedded questions.)

(8) a. $[\![\textsf{Alice jumped}]\!]^w = \{ \lambda w.\ \texttt{jump}_w(a) \}$
b. $[\![\textsf{whether Alice jumped}]\!]^w = \{ \lambda w.\ \texttt{jump}_w(a),\ \lambda w.\ \neg\texttt{jump}_w(a) \}$
c. $[\![\textsf{who jumped}]\!]^w = \{ \lambda w.\ \texttt{jump}_w(x) \mid x \in D \} \cup \{ \lambda w.\ \neg\exists x \texttt{jump}_w(x) \}$

In this setting, representational predicates like *be certain* and *know* have an existential semantics, as in (9).

(9) a. $[\![\textsf{be certain}]\!]^w = \lambda Q_{\widehat{\langle s,t \rangle}}.\lambda x_e.\ \exists p \in Q[\texttt{certain}_w(x,p)]$
b. $[\![\textsf{know}]\!]^w = \lambda Q_{\widehat{\langle s,t \rangle}}.\lambda x_e\!:\ \exists p \in Q[p(w)].\ \exists p \in Q[p(w) \wedge \texttt{know}_w(x,p)]$

All clause-embedding predicates take a set of propositions, so they are all type-compatible with both interrogative and declarative complements. For instance, the denotation of *believe* is of the same type as that of *know*:

(10) $[\![\textsf{believe}]\!]^w = \lambda Q_{\widehat{\langle s,t \rangle}}.\lambda x_e.\ \exists p \in Q[\texttt{believe}_w(x,p)]$

The anti-rogativity of *believe*, therefore, needs to be explained by other means than type incompatibility. As mentioned before, Theiler et al. (2017) and Mayr (2017) propose to reduce it to its neg-raising property.

3.2 Degree-based semantics for preferential predicates

Now we are in a position to discuss our analysis of preferential predicates. We follow Romero's (2015) degree-based semantics, which is an adaptation of Villalta's (2008) ordering-based analysis of preferentials. The degree-based semantics offers an attractive account of the anti-rogativity of non-veridical preferential predicates with a reasonable assumption about the semantics of degree constructions in general.

Before jumping to the concrete analysis, we mention an important aspect of the semantics of preferential predicates: focus-sensitivity. Villalta (2008) observes that focus has truth-conditional effects with bouletic predicates. Here's an example illustrating this (modeled after Romero 2015: (13)):

(11) CONTEXT: Natasha does not like teaching logic, and prefers syntax, but she is not allowed to teach both. This year, it is likely that she needs to teach logic, and if so, she prefers to do so in the morning, as she prefers to have all her teaching in the morning.
a. Natasha hopes that she'll teach logic in the MORning. TRUE
b. Natasha hopes that she'll teach LOgic in the morning. FALSE

Similar observations suggest preferential predicates are generally focus sensitive. Romero (2015) provides the following example for *surprise*:

(12) CONTEXT: Lisa knew that syntax was going to be taught. She expected syntax to be taught by John, since he is the best syntactician around. Also, she expected syntax to be taught on Mondays, since that is the rule.
a. It surprised Lisa that John taught syntax on TUESdays. TRUE
b. It surprised Lisa that JOHN taught syntax on Tuesdays. FALSE

These observations show that the alternatives that are compared in the semantics of preferential predicates are partly determined by the focus structure.

The degree-based semantics for preferentials by Romero (2015) builds on this insight, and treats the focus structure of the complement as providing the *comparison class* against which the subject's preferences are compared. Concretely, assuming the Roothian focus semantics (Rooth 1992), we take the context to provide a set of alternatives C, which preferential predicates refer to.[5] For example, the semantics for *be happy* looks like (13) with the auxiliary definitions for functions $\mathtt{Pref}$ and θ in (13).[6] Here we tentatively assume that the standard of comparison given by θ is the mean degree with respect to C, but we will explore a more realistic option in §4.1.

(13) $[\![\textsf{be happy}_C]\!]^w = \lambda p_{\langle s,t\rangle}.\lambda x\colon\ p(w) \wedge \mathtt{believe}_w(x,p) \wedge p \in C.\ \mathtt{Pref}_w(x,p) > \theta(\{\mathtt{Pref}_w(x,p') \mid p' \in C\})$

(14) a. $\mathtt{Pref}_w(x,p) :=$ the maximum degree to which x prefers p at w
b. $\theta(\{d_1, d_2, ..., d_n\}) := \sum_{i=1}^{n} d_i/n$

In prose, x *is happy that* p presupposes that p is true, that x believes that p, and that p is a member of the focus alternatives C, and asserts that the degree to which x prefers p at w is greater than the *average* degree of $x's$ preferences for alternatives in C. As Romero (2015) argues, the last presupposition that $p \in C$ is an instance of a presupposition existing in degree constructions in general, that the comparison class includes the comparison term.

Note that (13) assumes that *be happy* semantically selects for a proposition. To reformulate the analysis to fit the uniform approach to clausal embedding introduced in the previous section, we make the predicate select for a set of propositions and relate the subject and the set using (14) via existential quantification:[7]

(15) $[\![\textsf{be happy}_C]\!]^w = \lambda Q_{\widehat{\langle s,t\rangle}}.\lambda x\colon\ \exists p \in Q[p(w) \wedge \mathtt{believe}_w(x,p) \wedge p \in C].$

$$\exists p'' \in Q \left[\begin{array}{c} p''(w) \wedge \mathtt{believe}_w(x,p'') \wedge p'' \in C \wedge \\ \mathtt{Pref}_w(x,p'') > \theta(\{\mathtt{Pref}_w(x,p') \mid p' \in C\}) \end{array} \right]$$

Let us see how (15) works with concrete interrogative and declarative complements. First, following Beck (2006), we take *wh*-items to be necessarily focused. Given this, in our semantics, the focus-semantic value of a *wh*-complement turns out to be equivalent to its ordinary-semantic value, as in (16).[8] Letting $\mathcal{Q}$ be the focus/ordinary semantic

[5]We assume for the sake of exposition that focus association with preferential predicates is conventional (in the sense of Beaver and Clark 2008), but nothing crucial hinges on this. See Romero (2015) for discussion. Also to avoid clutter, we conflate variables in the object language and meta-language.

[6]The formulation in (i) uses a *measure function* $\mathtt{Pref}$ that maps individual-proposition pairs to degrees instead of relations between degrees and individuals/propositions used in Romero (2015). This is because of presentational reasons (the former formulation results in shorter formulae) and nothing crucial hinges on this choice.

[7]In (15), to avoid the 'binding problem' concerning the existential quantifications in the presupposition and the assertion, the content of the presupposition is repeated in the scope of the existential quantification in the assertion. See Spector and Egré (2015) for a similar solution to the binding problem in the domain of question-embedding.

[8]As pointed out to us by Henriette de Swart (p.c.), this equivalence might not hold when number morphology is involved. Concretely, while $[\![\textsf{which student}]\!]^w$ ranges over singular individuals, its focus value $[\![\textsf{which student}]\!]^f$ might include plural individuals, in which case, the ordinary semantic value will be a subset of the focus semantic value. As far as we can see there is no empirical reason to assume that $[\![\textsf{which student}]\!]^f$ contains plural individuals. Technically, we could exclude plural individuals by assuming a type-distinction between singular and plural individuals, e.g. singular individuals are type e,

value of the interrogative complement, *be happy* with an interrogative complement can be analyzed as in (17):

(16) $\mathcal{Q} := [\![\,\textsf{who jumped}\,]\!]^w = [\![\,[\textsf{who}]_F\ \textsf{jumped}\,]\!]^f$

(17) $[\![\,\textsf{John is happy}_C\ \textsf{(about) [[who]}_F\ \textsf{jumped]}{\sim}C\,]\!]^w$ is

- defined only if $\exists p \in \mathcal{Q}[p(w) \wedge \texttt{believe}_w(j,p) \wedge p \in C]$;
- if defined, true iff $\exists p'' \in \mathcal{Q} \left[\begin{array}{c} p''(w) \wedge \texttt{believe}_w(j,p'') \wedge p'' \in C \\ \texttt{Pref}_w(j,p'') > \theta(\{\texttt{Pref}_w(j,p') \mid p' \in C\}) \end{array} \right]$

Given the definition of the $\sim$-operator in (18) (Romero 2015, cf. Rooth 1992), C in (17) is constrained as in (19).

(18) $[\![\,\alpha{\sim}C\,]\!]^o$ is defined only if $C \subseteq [\![\,\alpha\,]\!]^f$; if defined, $[\![\,\alpha{\sim}C\,]\!]^o = [\![\,\alpha\,]\!]^o$

(19) $C \subseteq [\![\,\textsf{who jumped}\,]\!]^f = \mathcal{Q}$

All in all, (17) presupposes that there is a true answer of $\mathcal{Q}$ which John believes, and asserts that a true answer of $\mathcal{Q}$ which John believes is such that he prefers it to a greater extent than his average preferences for the alternatives in C, which in turn is a subset of $\mathcal{Q}$.

Next, a declarative-embedding sentence would be analyzed as in (20), with the variable C constrained by the focus structure as in (21). (Here, we let $A := \lambda w.\ \texttt{jumped}_w(a)$.)

(20) $[\![\,\textsf{John is happy}_C\ \textsf{that [[Alice]}_F\ \textsf{jumped]}{\sim}C\,]\!]^w$ is

- defined only if $\exists p \in \{A\}[p(w) \wedge \texttt{believe}_w(j,p) \wedge p \in C]$
  $\equiv A(w) \wedge \texttt{believe}_w(j,A) \wedge A \in C$;
- if defined, true iff $\exists p'' \in \{A\} \left[\begin{array}{c} p''(w) \wedge \texttt{believe}_w(j,p'') \wedge p'' \in C \wedge \\ \texttt{Pref}_w(j,p'') > \theta(\{\texttt{Pref}_w(j,p') \mid p' \in C\}) \end{array} \right]$
  $\equiv A(w) \wedge \texttt{believe}_w(j,A) \wedge A \in C \wedge \texttt{Pref}_w(j,A) > \theta(\{\texttt{Pref}_w(j,p') \mid p' \in C\})$

(21) $C \subseteq [\![\,\textsf{that [Alice]}_F\ \textsf{jumped}\,]\!]^f = \mathcal{Q}$

That is, (20) presupposes that Alice jumped and that John believes that Alice danced, and asserts that John prefers Alice's jumping to a greater extent than his preferences for the alternatives in C, which again is constrained by $\mathcal{Q}$.

Thus, the degree-based analysis provides a straightforward account of both declarative and interrogative-complementation under veridical preferential predicates. Romero (2015) shows that the degree-based analysis enables an attractive account of two puzzles concerning veridical preferential predicates: (i) incompatibility with *whether*-complements and (ii) (typical) incompatibility with strongly-exhaustive embedded questions. Another virtue of the degree-based analysis is that (with a suitable syntax-semantics assumptions) it can account for the behavior of preferential predicates as gradable predicates, as in their occurrence in comparatives:

(22) a. Andrew is happier that Alice jumped than Bill is.
b. Ben liked/hated that Alice jumped more than Bill did.

while plural individuals are type $\widehat{e}$. See 13 for another technical way of excluding plural individuals from the focus value.

3.3 Deriving the anti-rogativity of non-veridical preferentials

Building on the semantics for veridical preferentials in the previous section, we propose the semantics of non-veridical preferential, such as *hope*, as follows:

(23) $[\![\,\mathsf{hope}_C\,]\!]^w = \lambda Q_{\widehat{\langle s,t\rangle}}.\lambda x : \exists p\!\in\! Q[p \in C].$
$$\exists p'' \!\in\! Q[p'' \in C \wedge \mathtt{Pref}_w(x,p'') > \theta(\{\mathtt{Pref}_w(x,p') \mid p' \in C\})]$$

In contrast to the veridical preferential *be happy* in (15), which requires that the preferred answer is *true* and is *believed by the subject*, the non-veridical preferential *hope* in (23) lacks such requirements. The body of the function simply states that there is an answer (which is also a member of C) that the subject prefers to a greater extent than the average given C.

With a declarative complement, (23) derives the meaning that the subject prefers the proposition denoted by the complement to a greater degree than the average given focus alternatives:

(24) $[\![\,\mathsf{John\ hopes}_C\ \mathsf{that\ [[Alice]}_F\ \mathsf{jumped]}{\sim}C\,]\!]^w$ is

- defined only if $A \in C$;
- if defined, true iff $\mathtt{Pref}_w(j,A) > \theta(\{\mathtt{Pref}_w(j,p') \mid p' \in C\})$

On the other hand, the meaning predicted for (23) with an interrogative complement, exemplified in (25), turns out to be systematically trivial, assuming an additional presupposition triggered by θ, given in (26).

(25) $[\![\,\mathsf{John\ hopes}_C\ \mathsf{[[who]}_F\ \mathsf{jumped]}{\sim}C\,]\!]^w = 1$ iff

- defined only if $\exists p\!\in\!\mathcal{Q}[p \in C]$;
- if defined, true iff $\exists p''\!\in\!\mathcal{Q}[p'' \in C \wedge \mathtt{Pref}_w(j,p'') > \theta(\{\mathtt{Pref}_w(j,p') \mid p' \in C\})]$

(26) **Variability presupposition**
$\theta(\mathcal{D})$ is defined only if $|\mathcal{D}| \neq 1$

The presupposition states that the degrees in the comparison class cannot be all equal. In other words, in order for comparison to make sense, there has to be variability in the relevant degrees. Empirically, the oddness of the following kind of example motivates the variability presupposition in degree constructions in general:

(27) #No circle is round (for a circle).

If it were not for the variability presupposition, (27) would be felicitous and true, because all circles are equally round and none of them stand out in terms of roundness. That the sentence is odd suggests that something like the variability presupposition (26) is at work.

The variability presupposition as formulated in (26) amounts to (28) in the case of the example, *John hopes that who$_F$ jumped*.

(28) $|\{\mathtt{Pref}_w(j,p') \mid p' \in C\}| \neq 1$

Given the variability presupposition, (25) turns out to be necessarily true whenever it is defined. This is so since whenever John's preferences for the alternatives in C vary, there is always a proposition in $C \subseteq \mathcal{Q}$ which John prefers more than his average preference for C.

We follow Barwise and Cooper (1981), Gajewski (2002) and Chierchia (2013) in assuming that systematic logical triviality leads to ungrammaticality. In particular, we assume the following principles from Gajewski (2002), where (29-a) is modified from the original to encompass presuppositional denotations.[9]

(29) a. An LF constituent a of type t is L-ANALYTIC iff a's logical skeleton receives the denotation 1 (or 0) under every variable assignment *when the denotation is defined*.

b. A sentence is ungrammatical if its Logical Form contains a L-analytic constituent.

Hence, the L-analyticity ensures that (25) is ungrammatical. On the other hand, even with the variability presupposition, the declarative-embedding variant is *not* L-analytic because of the singleton restriction on existential quantification. That is, (24) is contingent on whether John prefers A more than the average. This explains the anti-rogativity of non-veridical preferentials. Finally, veridical preferentials do not induce L-analyticity regardless of the complement clause type, due to the veridical restriction on existential quantification. The assertion of *be happy*+interrogative in (17) above is non-trivial (even with the variability presupposition) since its truth is contingent on whether John prefers a *true* answer. Similarly to the non-veridical case, *be happy*+declarative is non-trivial because of the singleton restriction.

Before concluding the section, we would like to comment on Anand and Hacquard's (2013) proposal that the lexical semantics of emotive doxastics (a subtype of non-veridical preferentials) such as *hope* and *fear* not only involves the preferential component but also

[9] We also need the definition of LOGICAL SKELETONS, in which all non-logical vocabularies are represented as indexed variables. The desired L-analyticity is guaranteed if the logical skeleton of *hope-wh* sentences looks like the following (X_1 and X_2 are the variables corresponding to the subject and the complement):

(i) $[\ X_1\ [_{v'}\ v\ [_{\text{VP}}\ \text{hope}\ [_{\text{CP}}\ \langle ? \rangle\ X_2]\ ]\ ]\ ]$

Here, v introduces the external argument (Kratzer 1996) and $\langle ? \rangle$ is the interrogative operator in charge of making sure that the proposition-set denoted by the complement is multiple rather than singleton (Roelofsen and Farkas 2015). Under every assignment for indices 1 and 2, (i) is true when its denotation is defined.

A problem here, however, is that there is no known definition of LOGICAL VOCABULARIES under which *hope* is categorized as one. Following van Benthem (1989), Gajewski (2002) defines logical vocabularies in terms of PERMUTATION INVARIANCE, but our denotation of *hope* does not satisfy this criterion, as it depends on e.g., the world of evaluation. In this paper, we do not attempt to offer a definition of logical vocabularies under which *hope* and other attitude predicates can be categorized as logical. Rather, just as in Theiler et al. (2017) and Mayr (2017), our focus is to present an analysis of the selectional restriction of certain clause-embedding predicates in terms of L-analyticity, *assuming* that the predicates can be categorized as logical vocabularies given a suitable definition.

This said, it should be noted that the current problem can be avoided if we assume that L-analyticity is a notion that applies to the intermediate language representing the logical translation of LF. The logical skeleton of a *hope-wh* sentence in such an intermediate representation would contain appropriately typed indexed variables in place of non-logical constants, as follows:

(ii) $\exists p'' \in \langle ? \rangle (Q_1)[p'' \in C_2 \wedge \mathtt{M}_3(x_4, p'', w_5) > \theta(\{\mathtt{M}_3(x_4, p', w_5) \mid p' \in C_2\})]$

Such a formula turns out to be L-analytic under the definition in (29-a), given that $C_2 \subseteq Q_1$ and θ obeys the variability presupposition. We would like to thank Jon Gajewski for discussion on this issue.

the *doxastic condition* that the subject considers the prejacent possible. *Prima facie*, this proposal might appear incompatible with our analysis since the doxastic condition can be seen as providing a restriction on the existential quantification, just as the veridical restriction does in veridical predicates. However, this is not the case, as the doxastic condition provides a restriction on the *comparison class as a whole*. That is, we propose the following rendition of our entry for *hope* to incorporate Anand and Hacquard's (2013) doxastic condition (the underlined part corresponds to the doxastic condition):

(30) $$[\![\,\mathsf{hope}_C\,]\!]^w = \lambda Q_{\widehat{\langle s,t\rangle}}.\lambda x : \exists p \in Q[p \in C] \wedge \underline{\forall p''' \in C[Dox_x^w \cap p''' \neq \varnothing]}.$$
$$\exists p'' \in Q[p'' \in C \wedge \mathtt{Pref}_w(x, p'') > \theta(\{\mathtt{Pref}_w(x, p') \mid p' \in C\})]$$

In this entry, the comparison class C is restricted to those that are compatible with the subject's belief. The variability presupposition of θ then states that the subject's preferences for alternatives in such restricted C vary. Given these presuppositions, the assertion of a *hope-wh* sentence remains to be trivial.

Interpretations of declarative-embedding sentences provide evidence for the different ways in which the veridicality of veridical preferential predicates and the doxastic condition of emotive doxastics are encoded. In (31-a), John's preference for Alice jumping is compared to false alternatives. In contrast, in (31-b), John's preference for Alice jumping is compared only to those alternatives that he considers possible.

(31) a. John is happy that ALICE jumped.
b. John hopes that ALICE jumped.

This suggests that the veridicality of *be happy* does not place a restriction on the comparison class itself whereas the doxastic condition of *hope* does, as in (30). In sum, the doxastic condition of emotive doxastics proposed by Anand and Hacquard (2013) does not threaten our analysis of their anti-rogativity since the condition restricts the comparison class as a whole. In the rest of the paper, we omit the doxastic condition in our analysis of *hope* for the sake of simplicity, but it can be added back without any consequences for our proposal.

4 Refining the analysis

The previous section presented the basic outline of our analysis of the anti-rogativity of non-veridical preferential predicates. However, the analysis also contains several loose ends that must be tightened. In particular, it has empirical problems concerning the treatment of (i) the standard degree in the lexical semantics of preferential predicates, (ii) focused non-*wh*-items in an interrogative clause, and (iii) exhaustivity of embedded questions. In this section, we discuss how our analysis can be refined to deal with these problems.

4.1 Non-average standard

The degree-based semantics for preferential predicates introduced in the previous section assumes that the standard degree of preference is the *average* degree given a comparison class, in line with Cresswell's (1976) pioneering work on the semantics of the 'positive' (plain) form of gradable adjectives. However, as argued by Fara (2000), Kennedy (2007) and Solt (2011), there is evidence that the standard relevant for the positive form of gradable adjectives should be somewhat higher than the average. An example of such evidence is the following sentence from Kennedy (2007: 11):

(32) Nadia's height is greater than the average height of a gymnast, but she is still not tall for a gymnast.

Crucially, (32) sounds consistent. If the interpretation of the positive form *tall* is based on the average standard, it would be contradictory, contrary to fact.

Similarly, the semantics for *be happy* and *hope* do not seem to be based on the average standard. The following examples illustrate this point:[10]

(33) CONTEXT: Bill was given a lottery ticket for free. In this lottery, he draws a card from a deck of seven cards: Card 1 through Card 7. If he draws Card 1, he gets \$1; if he draws Card 2, he gets \$2, and so on. This means Bill's average expected earning is \$4 ($= \frac{\$1+\$2+...\$7}{7}$). Now, he draws Card 5, so he gets \$5, which is above average.

a. Bill is happy that he drew Card 5.
b. Bill hoped that the he would draw Card 5 or above.

The above scenario is constructed so that the degree-based semantics for *be happy* and *hope* with the average standard would predict the sentences to be true (assuming that Bill's preferences are aligned with the amount of money he receives, as is the case for most people). However, intuitively, the sentences do not necessarily sound true. In fact, conjunction of the negation of polar antonyms *happy* and *unhappy* may sound consistent in this situation.

(34) Bill is neither happy nor unhappy that he drew Card 5.

This is not expected under the view where the standard is determined by the average.

As an alternative to the average standard, Solt (2011) proposes that the standard for the positive form of a gradable adjective is a *range* of degrees of the following form (where `Meas` is the measure function associated with the gradable adjective, C is the comparison class, and MAD is the Median Absolute Deviation, as defined below):

(35) $R_{Std:C}(\texttt{Meas}) = median_{x \in C}\texttt{Meas}(x) \pm n \times MAD_{x \in C}\texttt{Meas}(x)$

- $median_{x \in C} f(x) :=$ the median value of $\{ f(x) \mid x \in C \}$
- $MAD_{x \in C} f(x) := median_{x \in C}|f(x) - median_{y \in C} f(y)|$
- n: the parameter determining the width of the range such that $0 < n$

Intuitively speaking, this range covers the median degree, together with the surrounding degrees whose distance to the median is restricted in a way sensitive to the dispersion of all degrees in the comparison class to the median. According to this proposal, the positive form 'x is A' is true iff $\mathbf{m}_A(x)$ is as great as the greatest value in the standard range $R_{Std:C}(\mathbf{m})$. The parameter n determines the 'width' of the range surrounding the median.

The examples in (32)–(33), which are problematic for the average-based standard, can be accounted by employing Solt's (2011) range-based standard. The conjunction in (32) is consistent if Nadia's height is above the average but falls within the standard

[10] We would like to thank Floris Roelofsen for bringing our attention to this kind of cases.

range $R_{Std:C}(\texttt{Tall})$. Similarly, the examples in (33) can be accounted for if Bill's preference for \$5 falls within the range $R_{Std:C}(\lambda p.\texttt{Pref}(b,p))$. More precisely, in the case of (33), Bill's median yield is \$4 and MAD is \$2. Therefore, the \$5 outcome falls within $R_{Std:C}(\lambda p.\texttt{Pref}(b,p))$ if the parameter n is greater than 0.5.

Incorporating this revised notion of standard as a range following Solt (2011), our semantics of preferential predicates can be revised as follows:

(36) $$[\![\,\mathsf{be\ happy}_C\,]\!]^w = \lambda Q_{\widehat{\langle s,t\rangle}}.\lambda x\colon\ \exists p\!\in\! Q[p(w) \wedge \texttt{believe}_w(x,p) \wedge p \in C].$$
$$\exists p''\!\in\! Q\left[\begin{array}{c} p''(w) \wedge \texttt{believe}_w(x,p'') \wedge p'' \in C \wedge \\ \texttt{Pref}_w(x,p'') \geq max(R_{Std:C}(\lambda p'.\texttt{Pref}_w(x,p'))) \end{array}\right]$$

(37) $$[\![\,\mathsf{hope}_C\,]\!]^w = \lambda Q_{\widehat{\langle s,t\rangle}}.\lambda x : \exists p\!\in\! Q[p \in C].$$
$$\exists p''\!\in\! Q[p'' \in C \wedge \texttt{Pref}_w(x,p'') \geq max(R_{Std:C}(\lambda p'.\texttt{Pref}_w(x,p')))]$$

Crucially, this revision in the notion of standard in the semantics of preferential predicates has a significant repercussion for our analysis of the anti-rogativity of non-veridical preferential predicates. According to the range-based semantics, an assertion of preference using *hope-wh* may be logically stronger than the assertion that the preference is greater than the average. This means that the variability presupposition we suggested in §3.3, repeated below, does not guarantee triviality of the assertion relative to the presupposition.

(38) $\theta(\mathcal{D})$ is defined only if $|\mathcal{D}| \neq 1$

It is possible for no proposition in a comparison class to exceed the standard range, as defined in (35), while the variability presupposition is satisfied.

What we would need to derive triviality relative to presupposition is a presupposition apart from (38). In particular, a presupposition of the following form would guarantee triviality.

(39) **Existence of a standing-out element**
$R_{Std:C}(\texttt{Meas})$ is defined only if
$\exists y \in C[\texttt{Meas}(y) \geq median_{x\in C}\texttt{Meas}(x) + n \times MAD_{x\in C}\texttt{Meas}(x)]$

In prose, (39) states that the standard range function $R_{Std:C}$ presupposes existence of an element in the comparison class whose degree is at least as great as the top of the range.

Prima facie, positing such a presupposition seems to be an ad hoc move. After all, the instantiation of (39) in the case where $\texttt{Meas} = \texttt{Pref}$ is precisely what *hope-wh* asserts, given the semantics in (37), i.e., that there is at least one proposition in the comparison class that is at least as preferable as the highest degree in the standard range. Nevertheless, it turns out that the statement in (39) can be proven as a theorem, given Solt's (2011) definition of the standard range, as long as the parameter n is such that $n \leq 1$. It is simply impossible to come up with a comparison class and a measure function such that there is no element that has a degree as high as the highest degree in the standard range with the parameter $n \leq 1$. The proof of this theorem is given in the appendix. The assumption $n \leq 1$ amounts to the claim that more elements than those in the top quantile in a symmetric distribution satisfy the positive form of the relevant gradable adjective, e.g., more individuals than those in the top quantile in height count as 'tall', given a class of individuals whose height is symmetrically distributed. We submit that this is a plausible assumption to make, echoing an intuition expressed by Solt (2011).

This assumption is also in line with Barner and Snedeker's (2008) experimental result on children's interpretation of the gradable adjective *tall*: the children participated their experiment categorized approximately the top-third of the objects in the comparison class (whose height is symmetrically distributed) as 'tall'. We have to leave open whether there is further empirical or theoretical motivation for the assumption that $n < 1$.[11]

Thus, the assertion of *hope-wh* in the range-based semantics remains to be trivial given the definedness condition of the standard range in (39), which in turn has theoretical motivation given reasonable assumption about the parameter. This means that the analysis of the anti-rogativity of non-veridical preferential predicates can be preserved, even after taking into account a more empirically accurate notion of the standard in the analysis of preferentiality.

4.2 Selective focus sensitivity

Another issue concerns the treatment of focus-semantic values of *wh*-clauses. The analysis in §3 hinges on the assumption that the focus-semantic value of a *wh*-clauses is derived from varying the value corresponding to the *wh*-phrase, resulting in a set equivalent to the Hamblin-semantic value of the clause. However, the compositional mechanism of focus interpretation assumed in §3 does not guarantee this. In particular, it predicts that stressed non-*wh*-constituents can also contribute to the focus-semantic value of a *wh*-clause. Romero (2015) uses the following kind of pair to illustrate the fact that this is an undesirable feature:

(40) a. Lisa is happy about when JOHN taught syntax.
b. Lisa is happy about who taught syntax on TUESdays.

The two sentences in (40) are not intuitively equivalent. However, the compositional mechanism of focus interpretation in §3 predicts them to be equivalent because any focus in the complement is predicted to contribute to its focus-semantic value, regardless of whether it is on a *wh*-word or not.

Romero (2015) addresses this problem using the mechanism of selective focus binding from Wold (1996). Here, we will present a solution along the same lines. The basic idea is to allow certain focus-sensitive operators to have *selective* focus-sensitivity by indexing each focus-bearing constituents. In the case of *wh*-clauses, we posit a Q(uestion)-operator that must be co-indexed with a *wh*-element. The overall system then predicts that the focus-value relevant for the interpretation of an embedding emotive factive will be constrained by this requirement on the Q-operator.

In this system, a semantic value is determined with respect to two assignment functions: g and h, where g handles the non-focus variables and h handles focus variables. The two assignment functions have disjoint sets of indices as their domains. We will notate the indices for non-focus variables with Arabic numerals and those for focus variables with Roman numerals. Following Beck (2006),[12] the entries for some of the basic

[11] Another remaining question concerns the relationship between the variability presupposition and Existence of a standing-out element (39). It is possible for every element in the comparison class to have the same value, while respecting (39). This means that if there are empirical data supporting the variability presupposition as discussed in relation to example (27), the data cannot be accounted for by (39) itself, suggesting a need to posit the variability presupposition independently of (39).

[12] Unlike Beck (2006) and following Wold (1996) and Romero (2015), we assume that the $\sim$-operator is indexed and allows selective binding.

vocabularies look like the following (where $[\![\cdot]\!]_o^{g,h}$ is the ordinary-semantic value with respect to the assignments g and h, and $[\![\cdot]\!]_f^{g,h}$ is the focus-semantic value, with respect to the assignments g and h):[13]

(41) a. $[\![\,\textsf{John}\,]\!]_o^{g,h} = j$
b. $[\![\,\textsf{John}\,]\!]_f^{g,h} = j$

(42) a. $[\![\,\textsf{JOHN}_i\,]\!]_o^{g,h} = j$
b. $[\![\,\textsf{JOHN}_i\,]\!]_f^{g,h} = h(i)$

(43) a. $[\![\,\textsf{jumped}\,]\!]_o^{g,h} = \lambda x \lambda w.\texttt{jumped}_w(x)$
b. $[\![\,\textsf{jumped}\,]\!]_f^{g,h} = \lambda x \lambda w.\texttt{jumped}_w(x)$

(44) a. $[\![\,\textsf{who}_i\,]\!]_o^{g,h} = \text{undefined}$
b. $[\![\,\textsf{who}_i\,]\!]_f^{g,h} = h(i)$

(45) a. $[\![\,\textsf{Q}_i\ \varphi\,]\!]_o^{g,h} = \{\,[\![\,\varphi\,]\!]^{g,h[x/i]} \mid x \in D_e\,\}$
b. $[\![\,\textsf{Q}_i\ \varphi\,]\!]_f^{g,h} = [\![\,\textsf{Q}_i\ \varphi\,]\!]_o^{g,h}$

(46) $[\![\,\alpha \sim_i C\,]\!]_o^{g,h}$ is defined only if $g(C) \subseteq \left\{[\![\,\alpha\,]\!]_f^{g,h[x/i]} \mid x \in D_e\right\}$;
if defined, $[\![\,\alpha \sim_i C\,]\!]_o^{g,h} = [\![\,\alpha\,]\!]_o^{g,h}$

The Q-operator in (45) is the interrogative C_0, which has the syntactic (LF) requirement that it must be co-indexed with a *wh*-item inside its prejacent.

Given this setup, we can correctly analyze the declarative and interrogative complements of focus-sensitive preferential predicates. The desired interpretations of the declarative and interrogative complements are derived by the LFs in (47), as illustrated in (48):

(47) a. Lisa is happy(C) [that [[JOHN$_i$ jumped]$\sim_i$ C]]
b. Lisa is happy(C) (about) [Q$_i$ [[who$_i$ jumped]$\sim_i$ C]]

(48) a. $[\![\,\textsf{that [[JOHN}_i\ \textsf{jumped]}\sim_i C]\,]\!]_o^{g,h}$
is defined only if $g(C) \subseteq \{\lambda w.\texttt{jumped}_w(x) \mid x \in D_e\}$
If defined, $[\![\,\textsf{that [[JOHN}_i\ \textsf{jumped]}\sim_i C]\,]\!]_o^{g,h} = \{\lambda w.\texttt{jumped}_w(x) \mid x \in D_e\}$
b. $[\![\,\textsf{Q}_i\ \textsf{[[who}_i\ \textsf{jumped]}\sim_i C]\,]\!]_o^{g,h}$
is defined only if $g(C) \subseteq \{\lambda w.\texttt{jumped}_w(x) \mid x \in D_e\}$;
If defined, $[\![\,\textsf{Q}_i\ \textsf{[[who}_i\ \textsf{jumped]}\sim_i C]\,]\!]_o^{g,h} = \{\lambda w.\texttt{jumped}_w(x) \mid x \in D_e\}$

The system furthermore accounts for the fact that a non-*wh* focus in an interrogative complement does not contribute to the interpretation of preferential predicates. In order for a focused non-*wh*-item to contribute to the interpretation of a preferential predicate, the $\sim$-operator constraining the variable C must be co-indexed with the non-*wh*-focus. This can happen in the following two LFs.

(49) a. *Lisa is happy(C) [Q$_j$ [[who$_i$ saw BILL$_j$]$\sim_j$ C]]

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[13] For *which*-NPs, we assume the following syncategorematic definitions:

(i) a. $[\![\,\textsf{which}_i\ \mathrm{NP}\,]\!]_o^{g,h} = \text{undefined}$
b. $[\![\,\textsf{which}_i\ \mathrm{NP}\,]\!]_f^{g,h} = h(i)$ if $h(i) \in [\![\,\mathrm{NP}\,]\!]_o^{g,h}$; otherwise undefined.

This treatment forces the focus value of *which student* to exclude plural individuals (see footnote 8).

b. *Lisa is happy(C) [Q$_i$ [[who$_i$ saw BILL$_j$]$\sim_j$ C]]

However, these LFs are ill-formed for the following reasons. The complement in (49-a) violates the syntactic requirement that the Q-operator has to be co-indexed with a *wh*-item. Regarding (49-b), we predict the following definedness condition and the ordinary-semantic value:

(50) a. $[\![\,[\text{who}_i \text{ saw BILL}_j] \sim_j C\,]\!]_o^{g,h}$ is defined only if
$g(C) \subseteq \{[\![\,\text{who}_i \text{ saw BILL}_j\,]\!]_f^{g,h[x/ii]} \mid x \in D_e\}$
$\Leftrightarrow g(C) \subseteq \{\lambda w.\texttt{saw}_w(x)(h(i)) \mid x \in D_e\}$

b. If defined, $[\![\,\text{Q}_i \text{ [[who}_i \text{ saw BILL}_{ii}]{\sim_{ii}}\, C]\,]\!]_o^{g,h} = \{\lambda w.\texttt{saw}_w(h(ii))(y) \mid y \in D_e\}$

What is crucial here is the fact that both (50-a) and (50-b) are dependent on the focus-assignment function h. This goes against the following principle of interpretability from Beck (2006):[14]

(51) **Principle of Interpretability**

a. An LF must have an ordinary semantic interpretation. (Beck 2006: 16)

b. An LF φ has an ordinary semantic interpretation only if $[\![\,\varphi\,]\!]_o^g$ is defined.

The principle states that an LF is well-formed only if it has a defined ordinary semantic value *independently of a focus-assignment function*. This is not the case with (50) since both (50-a) and (50-b) are dependent on the focus-assignment function h (i.e., contains free focus variables).

Finally, the system also rules out the following LF, where the $\sim$-operator scopes above the Q-operator.

(52) *Lisa is happy(C) [[Q$_i$ [who$_i$ saw BILL$_{ii}$]]$\sim_{ii}$ C]

This stems from the mismatch in the semantic type of the ordinary semantic value of the interrogative complement and the C variable. This is shown more concretely in the following:

(53) a. $[\![\,[\text{Q}_i \text{ [who saw BILL}_{ii}]] \sim_{ii} C\,]\!]_o^{f,g}$ is defined only if
$g(C) \subseteq \{\{\lambda w.\texttt{saw}_w(x,y) \mid x \in D_e\} \mid y \in D_e\}$

b. If defined, $[\![\,[\text{Q}_i \text{ [who saw BILL}_{ii}]] \sim_{ii} C\,]\!]_o^{f,g} = \{\lambda w.\texttt{saw}_w(x,b) \mid x \in D_e\}$

As seen above, the C variable is required to be a set of sets of propositions while the ordinary semantic value of the complement is a set of propositions. This mismatch guarantees that (52) necessarily violates a presupposition triggered by the embedding preferential predicate, specifically the presupposition that a member of the ordinary complement denotation is a member of C, i.e., the third conjunct in the entry for *be happy* repeated below.

(36) $$[\![\,\text{be happy}_C\,]\!]^w = \lambda Q_{\widehat{\langle s,t\rangle}}.\lambda x\!: \exists p \in Q[p(w) \wedge \texttt{believe}_w(x,p) \wedge p \in C].$$
$$\exists p'' \in Q \left[\begin{array}{c} p''(w) \wedge \texttt{believe}_w(x,p'') \wedge p'' \in C \wedge \\ \texttt{Pref}_w(x,p'') \geq max(R_{Std:C}(\lambda p'.\texttt{Pref}_w(x,p'))) \end{array} \right]$$

[14] The clause in (51-b) is not explicitly stated in Beck's (2006) original formulation. However, it is implicitly present since an ordinary semantic value in her system is denoted by $[\![\cdot]\!]^g$ in contrast to the focus-semantic value $[\![\cdot]\!]^{g,h}$.

Hence, the mechanism of selective focus binding from Wold (1996) and Romero (2015) enables an appropriate treatment of the selective focus-sensitivity of preferential predicates with declarative and interrogative complements.

4.3 Exhaustivity

Finally, the analysis of preferential predicates so far has only dealt with the so-called mention-some reading. That is, the analysis states that a sentence of the form *x is happy about Q* is true iff there is *some* true answer to Q that bears the appropriate preferential relation to x. In fact, the mention-some semantics is crucial in the explanation of the anti-rogativity of non-veridical preferentials in §3.3. However, what is potentially problematic is the fact that embedded questions in principle allow a variety of stronger readings, e.g., weakly-exhaustive, strongly exhaustive and intermediately exhaustive readings (Groenendijk and Stokhof 1984, Heim 1994, Beck and Rullmann 1999, George 2011, Klinedinst and Rothschild 2011, Cremers 2016). How should we account for such stronger readings within the proposed theory of preferential predicates, and how does it affect the analysis of the anti-rogativity of non-veridical preferential predicates?

Presenting a comprehensive account of exhaustivity in questions under different embedding predicates is beyond the scope of this paper (see Theiler et al. 2016 for a recent review and proposal). Rather, we will limit our attention to the kinds of exhaustivity that are empirically attested under preferential predicates. Below, we briefly summarize our empirical assumptions about the attested kinds of question exhaustivity under preferential predicates, following the literature on the topic.

Our starting point is George's (2013) argument that all available data that have been argued to suggest weak exhaustivity, such as (54) (e.g., Beck and Rullmann 1999), are in fact compatible with mention-some readings.

(54) Pat was happy about which students sang, but she wasn't happy about which student didn't sing.

We follow George (2013) on this point, and assume that there is no mechanism in the semantics of embedded question that specifically derives weak exhaustivity, at least under preferential predicates. Instead, a mention-some reading accounts for the data as in (54).

Moving on to strong exhaustivity, although some researchers have argued that preferential predicates *disallow* strong exhaustivity (Beck and Rullmann 1999, Sharvit 2002), recent literature suggests that strong exhaustivity is available under preferential predicates (Klinedinst and Rothschild 2011, Theiler 2014, Cremers and Chemla 2017). Below is an example from Klinedinst and Rothschild (2011: fn.18) that suggests that strong exhaustivity is available with *surprise*:

(55) Four students run a race: Bob, Ted, Alice and Sue. Emily expects Bob, Ted and Alice to run it in under six minutes. Only Bob runs it in under six minutes. Emily is surprised who ran the race in under six minutes (since she expected more people to).

Taking this type of data seriously, we assume that strong exhaustivity is an available reading under preferential predicates.

Finally, although it has been argued that epistemic predicates (e.g., *know*) and communication/conjecture predicates (e.g., *predict*) allow the so-called intermediate exhaustivity of embedded questions,[15] there is no evidence suggesting that preferential predicates allow an intermediately exhaustive reading. For instance, no available evidence indicates that (56) has the intermediately exhaustive reading paraphrased in the quote.

(56) Pat is happy about which students sang.
#"For all students who sang, Pat is happy that they sang; for all students who didn't sing, Pat didn't prefer that they sing."

The absence of intermediate exhaustivity with preferential predicates is also pointed out by Uegaki (2015) and Theiler et al. (2016).

All in all, we assume that preferential predicates allow mention-some and strongly exhaustive readings. The former is necessary to account for data such as (54) while the latter is necessary to account for data such as (55). On the other hand, there is no empirical evidence that semantics should derive weak- and intermediate-exhaustive readings for questions embedded under preferential predicates.

Given this empirical discussion, what we need in addition to the analysis so far is the treatment of strong exhaustivity. To deal with this, we follow Romero (1998, 2016) and Spector (2007) and assume that *wh*-phrases can optionally range over generalized quantifiers (GQs) in addition to entities, resulting in a 'higher-order' interpretation of a *wh*-clause. We propose that this interpretation of a *wh*-phrase is constructed by the basic interpretation which ranges over individuals in such a way that these individuals are first lifted to the corresponding GQs (Montagovian individuals) and then this set of GQs is closed under generalized Boolean operations. For any set of individuals S, the corresponding set of Montagovian individuals is given by $\uparrow S = \{\, \uparrow x \mid x \in S \,\} = \{\, \lambda w.\lambda P_{\langle e,t\rangle}.\ P(x) = 1 \mid x \in S \,\}$. Let us denote the generalized Boolean closure of this set by $\uparrow S^\star$. That is, $\uparrow S \subseteq \uparrow S^\star$ and for any $G_1, G_2 \in \uparrow S^\star$, $-G_1, G_1 \sqcap G_2, G_1 \sqcup G2 \in \uparrow S^\star$, where $-$ is generalized negation, $\sqcap$ generalized conjunction and $\sqcup$ generalized disjunction.[16]

[15] The intermediate-exhaustive reading of a question embedded under *know* and *predict* can be paraphrased as follows:

(i) Pat knows which students sang.
"For all students who sang, Pat knows that they sang; for all students who did not sing, she does not believe that they sang."

(ii) Pat predicted which student would sing.
"For all students who sang, Pat predicted that they would sing; for all students who did not sing, she did not predict that they would sing."

See Cremers and Chemla (2016), Xiang (2016) and Theiler et al. (2016) for detailed empirical overviews on intermediate exhaustivity.

[16] The generalized Boolean operators are standardly defined as follows:

(i) a. Type t is a conjoinable type.
b. If σ is a type and τ is a conjoinable type, $\langle\sigma,\tau\rangle$ is a conjoinable type.

(ii) Let τ be a conjoinable type, and let α and β be expressions of type τ.

a. $-\alpha = \begin{cases} \neg\alpha & \text{if } \tau = t \\ \lambda x_{\sigma_1}.\ -\alpha(x) & \text{if } \tau = \langle\sigma_1,\sigma_2\rangle \end{cases}$

b. $\alpha \sqcap \beta = \begin{cases} \alpha \wedge \beta & \text{if } \tau = t \\ \lambda x_{\sigma_1}.\ \alpha \sqcap \beta & \text{if } \tau = \langle\sigma_1,\sigma_2\rangle \end{cases}$

c. $\alpha \sqcup \beta = \begin{cases} \alpha \vee \beta & \text{if } \tau = t \\ \lambda x_{\sigma_1}.\ \alpha \sqcup \beta & \text{if } \tau = \langle\sigma_1,\sigma_2\rangle \end{cases}$

Concretely, the Hamblin-style question denotation involving such a GQ-interpretation of *who* would look like the following:

(57) $\{\, \lambda w.G(\lambda x.\texttt{sang}_w(x)) \mid G \in {\uparrow}\texttt{person}^\star \,\}$
'Which GQ $G \in {\uparrow}\texttt{person}^\star$ is such that $G(\lambda x.\texttt{sang}_w(x))$ is true?'

This denotation includes '(strongly-)exhaustified' answers such as 'only Ann sang'. This is so because the *wh*-phrase contains in its domain the following generalized quantifier: $G = \lambda P_{et}.P(\mathbf{a}) \wedge \bigwedge_{x\in(D_e-\{\mathbf{a}\})} \neg P(x)$. With such an analysis of *wh*-complements in place, the data as in (55) can be accounted for, preserving the existential semantics for embedding predicates. The last sentence in (55) is judged true since, in the given context, there is a generalized quantifier G such that $\lambda w.G(\lambda x.x$ ran the race in under six minutes in $w)$ is surprising to Emily, i.e., the generalized quantifier of the following form $G = \lambda P_{et}.P(\mathbf{b}) \wedge \bigwedge_{x\in(D_e-\{\mathbf{b}\})} \neg P(x)$. It should also be noted that this mechanism only accounts for the *optional* strong exhaustivity of embedded questions, and that we need a different account for the *obligatory* strong exhaustivity of questions embedded under certain predicates, e.g., *be certain*. See Uegaki (2015) and Theiler et al. (2016) for explanations of the obligatory strong exhaustivity under *be certain* in terms of the lexical-semantic property of the predicate.

More precisely, the account can be implemented within the theory of selective focus-binding developed in the previous section. We first revise the definition of the focus-variable assignment function h so that it maps certain indices to generalized quantifiers. In this paper, we designate the *capital* roman numerals (I, II, III...) as those indices that are mapped to generalized quantifiers by h:

(58) a. $[\![\, \mathsf{who}_I \,]\!]_o^{g,h} = \text{undefined}$
b. $[\![\, \mathsf{who}_I \,]\!]_f^{g,h} = h(I)$ where $h(I) \in {\uparrow}\texttt{person}^\star$

Accordingly, we have the following higher-order definitions of the Q-operator and the $\sim$-operator:

(59) a. $[\![\, \mathsf{Q}_I\ \varphi \,]\!]_o^{g,h} = \{\, [\![\, \varphi \,]\!]^{g,h[G/I]} \mid G \in D_{\langle et,t\rangle} \,\}$
b. $[\![\, \mathsf{Q}_I\ \varphi \,]\!]_f^{g,h} = [\![\, \mathsf{Q}_I\ \varphi \,]\!]_o^{g,h}$

(60) $[\![\, \alpha \sim_I C \,]\!]_o^{g,h}$ is defined only if $g(C) \subseteq \{[\![\, \alpha \,]\!]_f^{g,h[G/I]} \mid G \in D_{\langle et,t\rangle} \}$;
if defined, $[\![\alpha \sim_I C]\!]_o^{g,h} = [\![\alpha]\!]_o^{g,h}$

As a result, we have the following definedness condition and the ordinary-semantic value for the higher-order interpretation of a *wh*-complement:

(61) $[\![\, \mathsf{Q}_I\ [[\mathsf{who}_I\ \mathsf{jumped}]{\sim_I}\ C] \,]\!]_o^{g,h}$
is defined only if $g(C) \subseteq \{\lambda w.G(\lambda x.\texttt{jumped}_w(x)) \mid G \in {\uparrow}\texttt{person}^\star\}$;
If defined, $[\![\, \mathsf{Q}_I\ [[\mathsf{who}_I\ \mathsf{jumped}]{\sim_I}\ C] \,]\!]_o^{g,h} = \{\lambda w.G(\lambda x.\texttt{jumped}_w(x)) \mid G \in {\uparrow}\texttt{person}^\star\}$

As discussed above, this accounts for the strongly-exhaustive interpretation of *wh*-complements embedded under preferential predicates. Also, note that the possibility of the higher-order interpretation does not affect the analysis of the anti-rogativity of non-veridical preferential predicates, developed in §3 and refined in §4.1. This is because we have preserved the existential semantics for preferential predicates. The embedding of an interrogative complement under a non-veridical preferential predicate with the existential semantics we developed in §3/§4.1 predicts triviality, as long as the question-denotation and the set of focus-alternatives are equivalent. Such equivalence is guaranteed in (61).

5 Nominalization and *about*

One of the issues we left open in the empirical discussion §2 is the potential complication concerning the role of the preposition *about*. As shown in (62), interrogative complements under some veridical preferential predicates are optionally introduced with a presupposition like *about*. In fact, a preposition seems to be *preferred* in many cases where there is such an option (Egré 2008, Mayr 2017).

(62) a. Max likes which students are invited to the party.
b. Max is happy (about) which students are invited to the party.
c. Max is surprised (about/at) which students are invited to the party.

On the other hand, the presence or absence of *about* does not affect the ungrammaticality of non-veridical preferentials with interrogative complements, as shown below:

(63) a. *Max prefers (about) which students are invited to the party.
b. *Max hopes/wishes (about) which students are invited to the party.
c. *Max expects (about) which students are invited to the party.

The data so far are compatible with the view that *about* in (62) is semantically vacuous and that its distribution is purely a matter of syntax.[17] Under such a view, as long as a predicate is *semantically* incompatible with an interrogative complement, it cannot embed an interrogative complement regardless of the presence of *about*. However, such a view turns out to be too simplistic, as soon as we start considering further data involving other anti-rogative predicates that allow interrogative complements with the help of *about*, as in (64), and cases involving *nominalizations* of non-veridical preferential predicates, as in (65).

(64) a. Pat fears *(about) who will be invited to the party.
b. Pat thought *(about) who will be invited to the party.

(65) a. Pat has (a) preference about who will be invited to the party.
b. Pat has (a) hope/wish about who will be invited to the party.
c. Pat has (an) expectation about who will be invited to the party.

In the rest of this section, we argue that the above data can be accounted for by employing Rawlins' (2013) 'non-orthogonality' semantics for *about*, but restricting its application to traditional adjuncts. To sketch the analysis more concretely, we will assume that there are two lexical entries for *about*: $about_\varnothing$ and $about_R$, where $about_\varnothing$ is semantically vacuous while $about_R$ is the 'Rawlins-style' *about* denoting the non-orthogonality relation between two issues (to be elaborated below). An interrogative CP introduced by

[17]Grimshaw (1990: Ch. 3) presents such a view, employing the notion of theta-marking, which we interpret to be a syntactic mechanism. According to this view, all arguments—whether it is nominal or clausal—must be theta-marked. However, some heads with argument structures do not have the theta-marking ability. Arguments to such a head can be assigned a theta-role by a preposition while semantically participating in the argument structure of the head.

$about_\varnothing$ is allowed as long as the predicate is semantically compatible with an interrogative complement, given the considerations we have made so far in this paper. On the other hand, an interrogative CP introduced by $about_R$ is allowed only in an adjunction structure. Crucially, contra Rawlins, we argue that not all clauses embedded by *about* have the adjunction structure (and hence the non-orthogonality semantics). A further requirement is imposed by the *obligatory transitivity* as a lexical specification of the predicate (Chomsky 1965). If a clause-embedding predicate is obligatorily transitive, it must merge with a complement clause, which may involve $about_\varnothing$ but may not involve $about_R$.

5.1 Rawlins (2013)-style analysis of *about*

To elaborate on the analysis, we begin with our rendition of Rawlins' (2013) semantics for *about*. According to this analysis, *about* denotes a relation between a question and an eventuality that holds if the question is non-orthogonal to the content of the eventuality. This is formally defined as follows:[18,19]

(66) $[\![\,\mathsf{about}_R\,]\!]^w = \lambda Q_{\widehat{\langle s,t\rangle}} \lambda e_v\colon\ e \in Dom(\mathtt{Con}).\ \neg\mathtt{Orthogonal}(Q, \mathtt{Con}(e))$

a. $\mathtt{Con}(e)$ = the content of e ($\mathtt{Con}$: $\langle v, \widehat{\langle s,t\rangle}\rangle$; v: the type for eventualities)

b. $\mathtt{Orthogonal}(Q_1, Q_2)$
$\Leftrightarrow \forall p \in Q_1 \cup \{W - \bigcup Q_1\} \forall p' \in Q_2 \cup \{W - \bigcup Q_2\}[p \cap p' \neq \varnothing]$

Rawlins (2013) assumes an event-semantic analysis of clause-embedding predicates (e.g., Kratzer 2006, Hacquard 2006), according to which attitudinal and speech-report predicates denotes a one-place predicate of content-bearing eventualities. For example, *talk* is analyzed as follows:

(67) $[\![\,\mathsf{talk}\,]\!]^w = \lambda e_v : e \in Dom(\mathtt{Con}).\ \mathtt{Talking}(e)$

Given the entry for *about* in (66) and the event-predicate analysis of *talk* in (67), we can analyze *talk-about* plus an interrogative complement as involving an event-predicate modification. Below, (68) describes the type-driven composition, and (69) the resulting VP interpretation of *talk about who sang*.

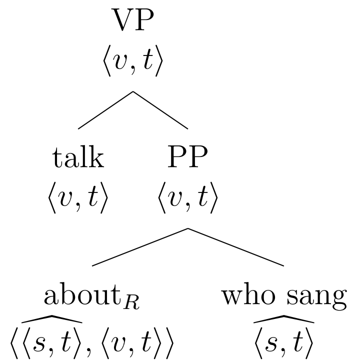
[18]Rawlins (2013) represents a content as an equivalence relation on a set of worlds, following an earlier formulation of propositions in inquisitive semantics (Groenendijk and Roelofsen 2009). Here, we will simply assume that a content is represented as a set of propositions, which may be denoted by an interrogative complement or by a declarative complement, as discussed in §3.1. Accordingly, the notion of orthogonality between two questions is redefined in terms of the consistency of every pair of propositions consisting of an answer (or the complement of the union of answers) from each question.

[19]Here, we specify in the type specification of the $\mathtt{Con}$-function that its argument is an event. This specification makes the type calculation more transparent and correctly accounts for all cases we consider in this section. However, it has potential problems in dealing with cases where the external argument of $about_R$ is an entity, as in (i) below:

(i) The email is about whether Joanna was going. (Rawlins 2013: 341)

This problem can be avoided by defining $\mathtt{Con}$ as a function on entities and treat events as a sub-type of entities, as done by Rawlins (2013).

(68) *Modification with $about_R$-PP*



(69) $[\![\text{talk about}_R \text{ who sang}]\!]^w$
$= \lambda e_v : e \in Dom(\texttt{Con}).\ \texttt{Talking}(e) \wedge \neg\texttt{Orthogonal}([\![\text{who sang}]\!]^w, \texttt{Con}(e))$

The resulting VP interpretation in (69) is a predicate that is true of talking events whose content is non-orthogonal to who sang.

5.2 *About*-PP as a true complement

The semantics of *$about_R$*-PPs described above has flexibility to apply to occurrences of *about* in the complement of other clause-embedding predicates. In particular, Rawlins (2013) argues that *$about_R$* appears in the (traditional) complement of veridical preferentials such as *surprise*, based on the analysis of complementation structure by Kratzer (2006) and Hacquard (2006).

However, it turns out that treating the *about*-PPs in the complement of veridical preferentials along the lines of Rawlins (2013) predicts interpretations that are too weak. To see this, consider the following lexical entry for an emotive factive predicate under the Kratzer-Hacquard-style analysis of attitudes:

(70) $[\![\text{happy}]\!]^w = \lambda e.\texttt{happy}_w(\texttt{Hldr}(e), \texttt{Con}(e))$ (Kratzer-Hacquard style)

In words, under this analysis, *be happy* denotes a predicate of eventualities that holds of an eventuality if its holder is in the happy-relationship with the content of that eventuality. Here, happy is a relationship between an individual and a question-type content which may have the kind of analysis for *be happy* we developed in the previous sections. However, the point we are going to make can be made without committing to a particular analysis of the predicate happy.

In Kratzer's (2006) decompositional semantics for attitudes that Rawlins follows, a *that*-clause serves as an eventuality-modifier that specifies the content of the relevant eventuality. Thus, given the lexical entry for *be happy* in (70), we derive the following truth conditions for a declarative-embedding sentence with *be happy.*

(71) $[\![\text{Max is happy that Ann was invited}]\!]^w = 1$ iff
$\exists e[\texttt{Hldr}(e) = m \wedge \texttt{Con}(e) = \{[\![\text{Ann was invited}]\!]\} \wedge \texttt{happy}_w(\texttt{Hldr}(e), \texttt{Con}(e))]$

This is arguably an adequate analysis of the declarative-embedding case. However, the prediction for the *about+wh* case, given in (72) below, is problematic.

(72) $[\![\text{Max is happy about who was invited}]\!]^w = 1$ iff $\exists e[\texttt{Hldr}(e) = m$
$\wedge \neg\texttt{Orthogonal}([\![\text{who was invited}]\!], \texttt{Con}(e)) \wedge \texttt{happy}_w(\texttt{Hldr}(e), \texttt{Con}(e))]$

According to (72), the sentence is true as long as the content of Max's happiness is non-orthogonal to the question 'who was invited'. This incorrectly predicts the sentence to be true in the following situation:

(73) CONTEXT: Emily is a good old friend of Max. Max is happy whenever Emily is happy, and he is happy whenever he is with her. Their mutual friend Paul is going to throw a singles party. Being a single, Max is invited to the party. Emily isn't invited since she recently started dating with someone from her yoga class. Max is happy that Emily is no longer a single, but he is also sad that Emily won't be at the party.

In (73), the proposition 'Emily is not single' is non-orthogonal to the question 'Who is invited to the party' because the former partially resolves the latter. This means that the truth conditions in (72) are satisfied in (73) given that Max is happy that Emily is not single. This is so since the situation whose content is the singleton set of the proposition 'Emily is not single' meets all the conditions of existential quantification in (72). This prediction is not borne out. In the situation described in (72), the sentence *Max is happy about who was invited* does not sound true.

What the above data suggests is that the *about*-PP complement of *be happy* does not merely provide a content that is non-orthogonal to the content of happiness, but rather the content of happiness itself. To capture this fact, we posit the semantically vacuous *about*$_\varnothing$, and analyze *be happy* as selecting for a complement providing the content in its lexical semantics, as follows:

(74) $$[\![\,\textsf{happy}_C\,]\!]^w = \lambda Q_{\widehat{\langle s,t\rangle}}.\lambda e\colon \texttt{Con}(e) = Q \wedge \exists p \in \texttt{Con}(e)[p(w) \wedge \texttt{believe}_w(\texttt{Hldr}(e), p) \wedge p \in C].\ \exists p'' \in \texttt{Con}(e) \begin{bmatrix} p''(w) \wedge \texttt{believe}_w(\texttt{Hldr}(e), p'') \wedge p'' \in C \wedge \\ \texttt{Pref}_w(\texttt{Hldr}(e), p'') \geq max(R_{Std:C}(\lambda p'.\texttt{Pref}_w(\texttt{Hldr}(e), p'))) \end{bmatrix}$$

This entry is an event-semantic rendition of our previous entry for *be happy* in (36), but, crucially, *with* the internal argument position, pace the Kratzer-Hacquard-style analysis. Given the semantically vacuous *about*$_\varnothing$ and (74), we derive the interpretation for the AP *happy about*$_\varnothing$ *who was invited* as follows:

(75) *Complementation with about*$_\varnothing$

$\langle v,t\rangle$
- happy $\langle\widehat{\langle s,t\rangle}, \langle v,t\rangle\rangle$
- PP $\widehat{\langle s,t\rangle}$
  - about$_\varnothing$
  - who was invited $\widehat{\langle s,t\rangle}$

(76) $$[\![\,\textsf{happy}_C\ \textit{about}_\varnothing\ \textsf{who was invited}\,]\!]^w = \lambda e\colon \texttt{Con}(e) = [\![\,\textsf{who was invited}\,]\!]^w \wedge \exists p \in \texttt{Con}(e)[p(w) \wedge \texttt{believe}_w(\texttt{Hldr}(e), p) \wedge p \in C].\exists p'' \in \texttt{Con}(e) \begin{bmatrix} p''(w) \wedge \texttt{believe}_w(\texttt{Hldr}(e), p'') \wedge p'' \in C \wedge \\ \texttt{Pref}_w(\texttt{Hldr}(e), p'') \geq max(R_{Std:C}(\lambda p'.\texttt{Pref}_w(\texttt{Hldr}(e), p'))) \end{bmatrix}$$

This analysis correctly captures the fact that the *about*-PP provides the content of the happiness itself rather than something that is non-orthogonally related to it. Note that $about_R$ cannot appear in the complement position of *happy*, due to type-mismatch. This is illustrated in the following:

(77) **Complementation with* $about_R$

- !!!
  - happy $\langle \widehat{\langle s,t\rangle}, \langle v,t\rangle\rangle$
  - PP $\langle v,t\rangle$
    - about$_R$ $\langle \widehat{\langle s,t\rangle}, \langle v,t\rangle\rangle$
    - who was invited $\widehat{\langle s,t\rangle}$

Thus, this analysis captures the unavailability of the weak reading predicted by the Rawlins-style analysis.

5.3 Obligatory transitivity

Above, we have seen that an *about*-PPs can in principle be an event modifier involving $about_R$ or a true complement involving $about_\varnothing$. Also, we have argued that the occurrence of *about*-PPs under veridical preferential predicates such as *happy* and *be surprised* is better analyzed as cases of true complements with $about_\varnothing$. In this section, we argue that the rest of the data we introduced in the beginning of this section (repeated below) can also be fully captured in this setup, once we take into account the transitivity of the predicates.

(63) a. *Max prefers (about) which students are invited to the party.
b. *Max hopes/wishes (about) which students are invited to the party.
c. *Max expects (about) which students are invited to the party.

(64) a. Pat fears *(about) who will be invited to the party.
b. Pat thought *(about) who will be invited to the party.

(65) a. Pat has a preference about who will be invited to the party.
b. Pat has a hope/wish about who will be invited to the party.
c. Pat has an expectation about who will be invited to the party.

In our setup, whether a clause-embedding predicate is transitive or not is reflected in the semantic type. A transitive predicate has type $\langle \widehat{\langle s,t\rangle}, \langle v,t\rangle\rangle$, just like *happy* in (74) while an intransitive predicate has type $\langle v,t\rangle$, just like *talk* in (67). A predicate's transitivity can be tested independently of its compatibility with *about*-PPs and the anti-rogative/responsive status. If a predicate can occur without any complement, it is either intransitive or optionally transitive; if a predicate must occur with some kind of complement, it is obligatorily transitive.

The predicates in (63) are all obligatorily transitive, as the ungrammaticality of the following examples suggests.

(78) a. *Max prefers.

b. *Max hopes/wishes.
c. *Max expects.

This means that these predicates have the $\langle\widehat{\langle s,t\rangle},\langle v,t\rangle\rangle$-type lexical entry. As discussed in relation to (77) in the previous subsection, a transitive predicate is incompatible with an $about_R$ -PP for type reasons. Furthermore, we have shown in the discussion up to the previous section that non-veridical preferential predicates cannot embed interrogative complements due to the predicted semantic triviality. This is true whether or not the interrogative complement involves a semantically vacuous $about_\varnothing$. Thus, we capture the ungrammaticality of (63) in both with and without *about*.

Moving onto the predicates in (64), the following examples suggest that they are intransitive or optionally transitive.

(79) a. Why does he fear?
b. Pat thought for a moment.

This means that there exist $\langle v,t\rangle$-type entries for *fear* and *think*. As such, an $about_R$-PP is type-wise compatible with these entries, semantically providing a content that is non-orthogonally related to the content of fear/thought. This accounts for the acceptability of interrogative complements with *about* in (64). Note that the semantic incompatibility between the non-veridical preferential predicate *fear* and an interrogative complement is not an issue here, since the *about*-PP in (77-a) involves $about_R$ according to our analysis. The sentence is felicitous and true if, for example, Pat fears that Max will be invited to the party, as the content of Pat's fear is non-orthogonally related to the content of 'who will be invited to the party'.[20]

Finally, the data in (65) fall out straightforwardly once we take into account the status of argument structures for deverbal nouns. As Grimshaw (1990) famously shows, a deverbal noun is ambiguous between an interpretation that involves a full-fledged argument structure (COMPLEX EVENT NOMINAL; CEN) and other interpretations that lack an argument structure (SIMPLE EVENT NOMINAL; SEN, and RESULT NOMINAL; RN). The possibility of the argument-structure-less interpretations explains the compatibility of deverbal nouns with an *about*+*wh*-clause, regardless of the property of the predicates the nouns are derived from.

Specifically, following Moulton (2014), we assume that a SEN denotes a one-place predicate of events, as follows.

(80) $$[\![\, [_{\text{nP}}\ \mathsf{n}\ \sqrt{\mathsf{hope}_C}\ ]\,]\!]^w = \lambda e : \exists p \in \mathtt{Con}(e)[p \in C].$$
$$\exists p'' \in \mathtt{Con}(e)[p'' \in C \wedge \mathtt{Pref}_w(\mathtt{Hldr}(e), p'') \geq max(R_{Std:C}(\lambda p'.\mathtt{Pref}_w(\mathtt{Hldr}(e), p')))]$$

Here, n is the SEN-nominalizer, which existentially closes off the internal argument of the root in Moulton's (2014) analysis. The denotation in (80) can be compositionally derived

[20]It is worth noting that the notion of (obligatory) transitivity is independently invoked by Rawlins (2013) to account for the following selection pattern involving *think* and *believe* (following a suggestion by P. Portner in personal communication to Rawlins):

(i) a. Alfonso thought about Joanna.
b. *Alfonso believed about Joanna.
c. Alfonso believed about Joanna that she was clever. (Rawlins 2013: 340, fn. 5)

The contrast between *think* and *believe* here can be explained by the fact that *think* is not obligatorily transitive while *believe* is.

by assuming (a) Moulton's (2014) analysis of the SEN-nominalizer and (b) the event-semantic rendition of our entry for *hope* in (37) as the denotation of the root $\sqrt{hope}$.[21]

Given this denotation for the noun *hope* we can account for the *about*+*wh*-clause as an adjunct involving $about_R$. The type-driven composition of such an adjunction structure is depicted in (81), with the interpretation in (82).

(81) *NP-adjunction with* $about_R$

$$[_{\text{NP}\ \langle v,t\rangle}\ [_{\text{nP}\ \langle v,t\rangle}\ \text{n}\ \ \sqrt{\text{hope}}\ ]\ \ [_{\text{PP}\ \langle v,t\rangle}\ [\text{about}_R\ \langle\widehat{\langle s,t\rangle},\langle v,t\rangle\rangle]\ \ [\text{who...}\ \widehat{\langle s,t\rangle}]\ ]\ ]$$

(82) $[\![\, [_{\text{nP}}\ \mathsf{n}\ \sqrt{\mathsf{hope}_C}\ ]\ [_{\text{PP}}\ \mathit{about}_R\ \mathsf{who...}]\,]\!]^w$
$= \lambda e\colon \exists p \in \texttt{Con}(e)[p \in C].\ \exists p'' \in \texttt{Con}(e)[p'' \in C \wedge \texttt{Pref}_w(\texttt{Hldr}(e), p'') \geq max(R_{Std:C}(\lambda p'.\texttt{Pref}_w(\texttt{Hldr}(e), p')))] \wedge \neg\texttt{Orthogonal}([\![\,\mathsf{who...}\,]\!]^w, \texttt{Con}(e))$

Just as in the case of *fear-about-wh* discussed above, non-veridical preferential of the root noun does not lead to any semantic triviality. This is so since the content of the hope itself in (82) may not have the form of a question, it just have to be non-orthogonally related to a question. For example, the content of the hope can be that Max will be invited to the party, which is non-orthogonally related to the question of who will be invited to the party.

In sum, the initially puzzling selection behavior involving the preposition *about* in (63)-(65) can be accounted for as a result of the interplay between the ambiguity of *about* between the non-orthogonality reading (Rawlins 2013) and a semantically vacuous reading, and the transitivity of the predicates.

It should be mentioned that the reliance on the obligatory transitivity creates a potential problem with our analysis of predicates such as *be happy* and *be surprised* in §5.2 that they can take an $about_\varnothing$-PP as a true complement. Since these predicates can appear without any CP complement, as in (83), they must have type-$\langle v,t\rangle$ lexical entries.

(83) a. Max is happy.
b. Max is surprised.

Given the proposed analysis, this in turn means that they can combine with an $about_R$-PP as an adjunct. This might appear in conflict with our analysis of these predicates in §5.2. This is not necessarily the case. For, it is possible that these predicates are *optionally* transitive, just like *eat*, i.e., they can take an $about_\varnothing$-PP as a true complement while also optionally appearing without any complement. Treating these predicates as optionally transitive accounts for their selectional properties, including the data in

[21]For the purpose of our argument, it suffices that deverbal nouns have an argument-structure-less interpretation, as in (80), as one of the possible readings. Though, see Moulton (2014) for an argument that CP-taking deverbal nouns such as the noun *hope* do not have the CEN reading, i.e., they always lack an argument structure.

(83). However, something has to be said about the *interpretation* of sentences containing *be happy+about-wh* (discussed in relation to the context involving the singles party in (73)), which suggests that the reading involving an $about_{\varnothing}$-complement rather than the one involving an $about_R$-adjunct is the default option. We suggest that this is due to the Strongest Meaning Hypothesis (Dalrymple, Kanazawa, Kim, Mchombo, and Peters 1998), a general pragmatic principle preferring the strongest available interpretation. The reading with $about_{\varnothing}$ is stronger than that with $about_R$ unless the sentence is embedded under a non-upward-entailing operator. Note that the possibility of optional transitivity does not pose any problem for our analysis of *(to) fear about-wh* and *about-wh* under nominalizations of non-veridical preferentials (e.g., *preference about who will be invited*). This is so since the $about_{\varnothing}$-complementation option, even if it is type-wise available, is ruled out because of the semantic triviality.

6 Conclusions

In this paper, we have put forward a generalization that all non-veridical preferential predicates are anti-rogative, and provided a semantic explanation for this generalization using the uniform semantics of clausal-embedding predicates (Ciardelli et al. 2013, Uegaki 2015, Theiler et al. 2016) and the degree-based semantics for preferential predicates (Romero 2015). The paper thus advances the currently active research into the semantic roots of selectional restrictions (Ciardelli and Roelofsen 2015, Uegaki 2015, Theiler et al. 2017, Mayr 2017).

A Proof of Existence of a standing-out element

Claim Let $R_{Std:C}(M) := median_{x\in C}M(x) \pm n \times MAD_{x\in C}M(x)$, where *median* and *MAD* are as defined in (35). Then, if $n \leq 1$, there is $y \in C$ such that $M(y) \geq max(R_{Std:C}(M))$.

Notational conventions We will refer to $M(x)$ as the 'M-value of x'; $\Delta_x := |median_{y\in C}M(y) - M(x)|$; Also we will abbreviate $MAD_{x\in C}M(x)$ as MAD

Proof We use *reductio*: we assume that there is no element $y \in C$ such that $M(y) \geq max(R_{Std:C}(M))$, and derive contradiction. We divide cases depending on whether C contains odd or even number of elements.

(i) (When C contains an odd number of elements)
We let the number of elements in C to be $2n+1$ and let *med* be the median element in C with respect to M. We can then order all elements in C according to their M-values, as follows (where the M-values of an element in the list is as great as the element to its left):

$$u_1, u_2, ...u_n, med, v_1, v_2, ..., v_n$$

By assumption, for every $v \in \{v_1, ..., v_n\}, \Delta_v < MAD$. Also, $\Delta_{med} = 0 < MAD$.[22] Thus, $v_1, v_2, ..., v_n$ and *med* are all elements whose deviations from

[22] If $MAD = \Delta_{med} = 0$, $R_{Std:C}(M) = median_{x\in C}M(x)$. This means that $med = max(R_{Std:C}(M))$. This contradicts the assumption that there is no element $y \in C$ such that $M(y) \geq max(R_{Std:C}(M))$.

med are smaller than MAD. This means that there are at least $n+1$ elements x such that $\Delta_x < MAD$. Since $n+1 > \frac{2n+1}{2}$, This contradicts the assumption that $MAD = median_{x \in C} \Delta_x$.

(ii) (When C contains an even number of elements)
Again, we let *med* be the median element in C with respect to M. Furthermore, we let $C^+ = C \cup \{med\}$; and let x_{top}^{C+} be the element that has the highest M-value in C^+.
Given (i), $M(x_{top}^{C+}) \geq max(R_{Std:C^+}(M))$. We have two cases:

(a) (When $M(x_{top}^{C+}) = median_{x \in C} M(x)$)
The only case in which this is possible is when all elements in C have the same value, namely, $median_{x \in C} M(x)$. Then, $R_{Std:C}(M) = median_{x \in C} M(x)$, which means that *med* is an element in C whose M-value is at least as great as the highest value in $R_{Std:C}(M)$.

(b) (When $M(x_{top}^{C+}) \neq median_{x \in C} M(x)$)
In this case, $x_{top}^{C+} \in C$. Since $R_{Std:C^+}(M) = R_{Std:C}(M)$, we can conclude that x_{top}^{C+} is an element of C such that $M(x_{top}^{C+}) \geq max(R_{Std:C}(M))$.

Thus, in either case, we derive conclusions contradicting the assumption that there is no element $y \in C$ such that $M(y) \geq max(R_{Std:C}(M))$. ■

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