Who and what do *who* and *what* range over cross-linguistically?*

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Abstract Dayal's (1996) account of the presuppositions of *wh*-questions makes faulty predictions for languages which draw number distinctions in the domain of simplex *wh*-expressions: Dayal predicts that a singular *wh*-expression should always give rise to a *Uniqueness Presupposition*; the *Anti-Singleton Inference* associated with its plural counterpart is expected to be parasitic on the uniqueness presupposition. We provide new data from Greek, Hungarian and Spanish, where simplex *wh*-expressions inflect for number. We claim that singular simplex *wh*-expressions do not give rise to a Uniqueness Presupposition, but plural simplex *wh*-expressions nonetheless give rise to an Anti-Singleton Inference. We provide an analysis of these facts that is consistent with Dayal's account of constituent questions, by assigning simplex *wh*-expressions a type-ambiguous denotation.

Keywords: plurality, questions, quantification, *Maximize Presupposition!*, polymorphism

1 Overview

Simple *wh*-phrases like *who* trigger singular agreement on the verb in English, but nevertheless allow plural answers: e.g. the question-answer pair in (1) is fully grammatical and coherent.

(1) a. Q: Who wrote that paper?
     b. A: Jeroen, Martín and Frank.

The best current analysis of the effect of number on simple and complex *wh*-phrases is due to Dayal (1996). In this paper, we observe that Dayal's (1996) classical account of the presuppositions of *wh*-questions makes faulty predictions for languages which draw number distinctions in the domain of simplex *wh*-expressions. The problem, in short, is as follows: Dayal predicts that a singular *wh*-expression should always give rise to a *Uniqueness Presupposition* (UP); the *Anti-Singleton*

Inference (ASI) associated with its plural counterpart is parasitic on the UP. Dayal's analysis is tailored to account for the properties of *which*-questions. Once we look beyond languages such as English, to languages where simplex *wh*-expressions such as *who* inflect for number, we observe that singular simplex *wh*-expressions do not give rise to a UP, but plural simplex *wh*-expressions nevertheless give rise to an ASI. This is unexpected, according to Dayal's theory.

We consider and dismiss two possible approaches to solving this problem:

   i. Dispensing with Dayal's answerhood operator.

   ii. Dispensing with the so-called "weak" theory of plurality (Sauerland, Anderssen & Yatsushiro 2005 and others) in the domain of simplex *wh*-expressions

We argue that both would amount to ad-hoc solutions to the problem. Rather, we provide an analysis that maintains both Dayal's theory of constituent questions and the weak theory of plurality, by positing higher-order meanings for simplex *wh*-expressions.

In §2, we introduce the basic facts concerning the interpretation of constituent questions in English, and Dayal's analysis. In §3, we introduce data from Greek, Hungarian and Spanish – languages in which simplex *wh*-expressions are inflected for number. The prediction, based on Dayal's analysis, is that singular simplex *wh*-expressions should give rise to a UP. This turns out to be false. In §4, we show how to reconcile Dayal's theory with the cross-linguistic data, by allowing simplex *wh*-expressions to range over higher-order semantic objects and in §5.2 we refine our analysis to account for a wider range of data. In §6, we follow-up on some issues brought up by our analysis and finally in §7 we briefly conclude.

2 Background

A constituent question formed with a singular *which*-phrase carries a *Uniqueness Presupposition* (UP), as illustrated by the infelicity of the answer in (2b) to the question in (2).

(2) Which employee left early?

   a.   Moss left early.

   b. #Roy and Moss left early.

A constituent question formed with a plural *which*-phrase (a plural *which*-question), on the other hand, carries an *Anti-Singleton Inference* (ASI), as illustrated by the infelicity of the answer to (3a) to the question in (3).[1]

(3)   Which employees left early?

    a.   #Roy left early.

    b.   Roy and Moss left early.

The standard account of the UP of singular *which*-questions is due to Dayal (1996). Dayal's analysis rests on the following two premises: (i) singular *which*-phrases range over atomic individuals *only*, and (ii) the *Maximal Informativity Principle* (MIP), stated informally in (4).

(4)   *Maximal Informativity Principle (*MIP*)*
A question Q presupposes the existence of a unique, maximally-informative true answer to Q.

We capture the principle in (4) by adopting Dayal's covert, presuppositional *answerhood operator* ANS at LF, with the semantics in (5). It is intuitive to think of ANS as the correlate of the definite determiner *the* in the propositional domain. It takes a set of propositions Q, and an evaluation world w, presupposes that there is a unique $p \in Q$ s.t. p is true in w, and p entails every other true member of Q, and returns that p.

(5) $\text{ANS}_w(Q) = \iota p \in Q[p(w) \wedge \forall p' \in Q[p'(w) \rightarrow p \subseteq p']]$

Following Hamblin (1973) and Karttunen (1977), Dayal assumes that questions denote answer-sets. Suppose that, in the world of evaluation @, the extension of employee_@ is as in (6). This means that the denotation of the question (2) will be the set of propositions $\{①, ②, ③\}$ in (7).

(6) $[\![\text{employee}_@]\!] = \{\text{Roy}, \text{Moss}, \text{Jen}\}$

(7) $[\![\text{which employee left early?}]\!] = \begin{Bmatrix} ① \text{ that Roy left early,} \\ ② \text{ that Moss left early,} \\ ③ \text{ that Jen left early} \end{Bmatrix}$

Suppose that in @, only Moss in fact left early. In this instance, only ② is true. It follows that the question in (7) has a unique true answer, and therefore the MIP is satisfied. The maximal-informativity requirement in particular is vacuously satisfied.

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[1] At this stage, we adopt UP and ASI as descriptive terms, without commitment to the precise status of the meaning component under consideration.

Suppose now that in @, both Roy and Moss, and nobody else in fact left early. In this instance, both ① and ② are true, but ③ is false. Furthermore, ① and ② are equally informative, i.e., ① does not entail ②, and ② does not entail ①. The MIP is therefore not satisfied in such an instance, and this is reflected by the infelicity of the answer in (2b).

According to Dayal's account then, the UP of singular *which*-questions is not lexically triggered, e.g., by *which*, but rather is an epiphenomenon that arises due to the interaction between semantic singularity and the MIP.

What about the ASI in (3)? The ASI can straightforwardly be accounted for as a reflex of the pragmatic principle *Maximize Presupposition!* (MP!) (Heim 1991, Sauerland 2008), building on Dayal's account of the UP. An informal statement of MP! is given in (8).

(8) *Maximize Presupposition! (informal)*   (Heim 1991)
     Do not use ϕ if there is a presuppositionally stronger $\psi \in \mathsf{alt}(\phi)$.

Concretely, we follow Sauerland, Anderssen & Yatsushiro (2005) in assuming that morphosyntactically plural expressions range over both atomic individuals and groups (although this is not crucial here). The denotation of employees$_@$ is therefore the set given in (9), i.e. the closure of the set of atomic employees under the sum-formation operator $\oplus$. The denotation of the question in (3) is the set of propositions in (10). Suppose that, in @, both Roy and Moss in fact left early. In such a scenario, the propositions ①, ②, and ③ are all true. There is a unique, maximally-informative proposition, namely ③. ③ entails both ① and ②[2], but is neither entailed by ① nor ②. This correctly predicts that (3b) is a felicitous answer to the question in this scenario.

(9) $[\![\text{employees}_@]\!] = \left\{ \begin{array}{c} \mathsf{Roy}, \mathsf{Moss}, \mathsf{Jen}, \\ \mathsf{Roy} \oplus \mathsf{Moss}, \mathsf{Roy} \oplus \mathsf{Jen}, \mathsf{Moss} \oplus \mathsf{Jen}, \\ \mathsf{Roy} \oplus \mathsf{Moss} \oplus \mathsf{Jen} \end{array} \right\}$

(10) $[\![\text{which employees left early}]\!] = \left\{ \begin{array}{l} \text{① that Roy left early} \\ \text{② that Moss left early} \\ \text{that Jen left early} \\ \text{③ that Roy} \oplus \text{Moss left early,} \\ \text{that Roy} \oplus \text{Jen left early,} \\ \text{that Moss} \oplus \text{Jen left early,} \\ \text{that Roy} \oplus \text{Moss} \oplus \text{Jen left early} \end{array} \right\}$

2 In this particular instance, the entailment goes through in this direction due to the fact that *leave early* is a distributive predicate. In other words, if the group consisting of *Roy* and *Moss* left early, we may infer that Roy left early, and we may infer that Moss left early.

Now suppose that, in @, in fact only Moss left early. In this instance, the set in (10) only has a single true member: ③. Recall the principle *Maximize Presupposition!* in (8). We assume that *which employee left?* is an alternative to *which employees left?*. As we have seen, *which employee left?* presupposes that a unique employee left, due to the MIP. By the logic of *Maximize Presupposition!* then, since the speaker chose not to use the singular alternative, the speaker must not be certain that its presupposition is defined, i.e. they must not be certain that a unique employee left. In this way, we derive the ASI.

Questions formed with simplex *wh*-expressions (simplex *wh*-questions) carry neither a UP nor an ASI, patterning with neither singular nor plural *which*-questions. Note furthermore that simplex *wh*-expressions are morphosyntactically singular, as diagnosed by the fact that they trigger singular agreement, as illustrated in (11).[3]

(11) Who {is | *are} leaving early?

    a. Roy is leaving early.

    b. Roy and Moss are leaving early.

If *who* were *semantically* singular, then the MIP would predict that *who*-questions should carry a UP, but this is evidently not the case. To avoid this faulty prediction, Dayal conjectures that simplex *wh*-expressions are in fact number neutral – that is to say, that they range over both atomic individuals and pluralities. Note that according to the weak theory of plurality, this essentially amounts to saying that simplex *wh*-expressions are semantically plural. We can account for the lack of the ASI due to the absence of a semantically singular competitor.[4]

Dayal's account of the apparently exceptional behaviour of simplex *wh*-expressions therefore rests on an idiosyncratic lexical property – simplex *wh*-expressions in languages like English, despite being morphosyntactically singular, are semantically

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3 There seem to be certain environments in which some speakers accept plural agreement with a simplex *wh*-expression.

(i) Who are a happy couple?
     Roy and Moss are a happy couple.

Our impression is that speakers are likely to accept plural agreement with a simplex *wh*-expression, when the predicate is a collective atom predicate, according to Winter's (2001) classification schema. It is a matter for further research to determine exactly the conditions under which simplex *wh*-expressions in English may trigger plural agreement.

4 Note that this reasoning relies on the assumption that, e.g., *which person* does not count as a competitor to *who* for the purposes of *Maximize Presupposition!*. This seems reasonable in light of recent work on the nature of alternatives, arguing that alternatives to an expression α should be structurally simpler, or at most as complex as α (Katzir 2008, Fox & Katzir 2011).

number-neutral (plural). Mismatches between morphosyntactic and semantic numerosity are not unheard of.[5]

3 Cross-linguistic data

Greek, Hungarian and Spanish, much like English, have both *which*-phrases (i.e., complex *wh*-phrases with a nominal restrictor) and simplex *wh*-expressions. Singular *which*-phrases give rise a UP, much like in English – this is illustrated in (12)-(14). Plural *which*-phrases give rise to an ASI, again, much like in English – this is illustrated in (15)-(17).

(12) Pjos   andras efige noris?   Greek singular *which*-Q: ✓UP
     who.SG man.SG left   early?

     a.   John left early.

     b. #John and Bill left early.

(13) Melyik fiú   ment el?   Hungarian singular *which*-Q: ✓UP
     which boy.SG goes away?

     a.   John went away.

     b. #John and Bill went away.

(14) ¿Qué chico   se   fue pronto?   Spanish singular *which*-Q: ✓UP
     Which boy.SG REFL left early?

     a.   John left early.

     b. #John and Bill left early.

(15) Pji   andres efigan noris?   Greek plural *which*-Q: ✓UP
     who.PL man.PL left   early?

     a. #John left early.

     b.   John and Bill left early.

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5 Consider, e.g., the case of group DPs, such as *the committee*, or *my family*, which despite being morphosyntactically singular (at least in certain varieties of English), show many of the hallmarks of semantic plurality, such as compatibility with collective predicates, as illustrated in (1).

(i)   The committee gathered.

     Authors such as Bennett (1974), Pearson (2011), Magri (2012) have argued that group DPs should be analysed as semantically plural yet morphosyntactically singular.

(16) Melyik fiúk   mentek el?   Hungarian plural *which*-Q: ✓ASI
     which boy.PL went   away?

    a. #John went away.
    b. John and Bill went away.

(17) ¿Qué chicos se   fueron pronto?   Spanish plural *which*-Q: ✓ASI
     Which boy.PL REFL left   early?

    a. #John left early.
    b. John and Bill left early.

When we turn to simplex *wh*-expressions however, the facts are more surprising. Unlike in English, in Greek, Hungarian and Spanish simplex *wh*-expressions inflect for number – there is a morphological distinction between *who*.SG and *who*.PL. As illustrated in (18)-(20), a simplex *wh*-expression formed with *who*.SG carries neither a UP nor an ASI, as reflected by the acceptability of the answers in all three languages.

(18) Pjos   efige noris?   Greek singular simplex *wh*-Q: ✗UP
     who.SG left   early?

    a. John left early.
    b. John and Mary left early.

(19) Ki   énekel?   Hungarian singular simplex *wh*-Q: ✗UP
     who.SG sings?

    a. John sings.
    b. John and Mary sing.

(20) ¿Quién se   fue pronto?   Spanish singular simplex *wh*-Q: ✗UP
     Who.SG REFL left early?

    a. John left early.
    b. John and Bill left early.

Recall that, according to the analysis of the ASI with plural *which*-questions outlined in the previous section, the derivation of the ASI relies on a competitor with a UP, via the logic of *Maximize Presupposition!*. Given that a question formed with *who*.SG in Spanish/Hungarian does not carry a UP, setting aside that this is itself mysterious, the prediction is that a question formed with *who*.PL should not carry an ASI. Surprisingly, however, questions formed with *who*.PL in Greek, Hungarian and Spanish *do* carry an ASI, as illustrated by the examples in (21) through (23).

	English	Greek/Hungarian/Spanish
who.SG Q	✗UP	✗UP
who.PL Q	–	✓ASI
which NP.SG Q	✓UP	✓UP
which NP.PL Q	✗ASI	✗ASI

Table 1   Presuppositions of *wh*-questions

(21) Pji   efigan noris?   Greek plural simplex *wh*-Q: ✓ASI
      who.PL left   early?

    a. #John left early.
    b. John and Mary left early.

(22) Kik   énekelnek?   Hungarian plural simplex *wh*-Q: ✓ASI
      who.PL sing?

    a. #John sings.
    b. John and Mary sing.

(23) ¿Quiénes se   fueron pronto?   Spanish plural simplex *wh*-Q: ✓ASI
      Who.PL   REFL   left   early?

    a. #John left early.
    b. John and Bill left early.

To briefly summarise, simplex *wh*-questions in languages with *who*.SG and *who*.PL raise two problems for Dayal's classical analysis of constituent questions, and our extension to the ASI based on *Maximize Presupposition!*: (i) questions formed with *who*.SG fail to give rise to a UP, despite the fact that singular *which*-questions carry a UP, and (ii) questions formed with *who*.PL give rise to an ASI, despite the fact that their singular competitor does not give rise to a UP. Our results are schematized in Table 1.

3.1   Possible responses

Here we briefly consider two possible responses to the issues raised by the cross-linguistic data for Dayal's theory, and suggest some reasons to pursue alternatives. The first and most obvious option would be to claim that number morphology on simplex *wh*-expressions is semantically inert – both *who*.SG and *who*.PL are semantically plural. This would account for the lack of a UP with *who*.SG, but it

would fail to account for the ASI with *who*.PL. Furthermore, this would lead to a lack of congruity between the morphology and the semantics, leading to concomitant learnability issues. We believe therefore that this option should be dispreferred on both empirical and conceptual grounds.

Another possibility would be to claim that *who*.SG is *number neutral* (Dayal's suggestion), whereas *who*.PL is interpreted as an *exclusive plural*. That is to say that *who*.SG quantifies over atomic individuals and pluralities, whereas *who*.PL quantifies over pluralities only.[6] Maldonado (2020) essentially adopts this analysis in order to account for the Spanish paradigm. We discuss her analysis in more depth in section §5.2. Adopting an exclusive interpretation for *who*.PL would account for the ASI, but this would beg the question of why *who*.SG does not acquire a UP via competition with *who*.PL, since the two competitors are in a superset-subset relation. There are also good reasons to believe that in the general case, plural expressions range over both atomic individuals and pluralities,[7] so this would amount to a construction-specific stipulation, tailored to account for the contribution of number in this particular environment.

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6 In some work on epistemic indefinites in Spanish, exactly this move is made. See for example Martí 2008 and Luis Alonso-Ovalle 2011, which claim that *algun* is number neutral and *algunos* is an exclusive plural. We don't discuss this work in depth here, but note that this analysis runs into problems with data such as the following – the plural indefinite *algunos* allows a collective interpretation with predicates such as *weight 30kg* and *drink 40 beers*, but the singular indefinite does not.

(i) a. Algunos estudiantes pesan 300 kilos (juntos).
       Some.PL students weigh 300 kilograms (together)

   "Some students weigh 300 kg"

   b. Algunos estudiantes bebieron 40 cervezas (juntos) (y otros 40 vinos).
      Some.PL students drink 40 beers (together)

   "Some students are drinking 40 beers."

(ii) a. #Algun estudiante pesa 300 kilos (juntos).
        Some.SG student weigh 300 kilograms (together)

   "Some students weigh 300 kg."

   b. #Algun estudiante bebió 40 cervezas (juntos) (y otros 40 vinos).
      Some.SG student drink 40 beers (together)

   "Some students are drinking 40 beers."

7 For example, Sauerland, Anderssen & Yatsushiro observe that plural indefinites in downward entailing contexts range over both pluralities *and* atoms.

4   Analysis

4.1   Plurality

To begin with, we lay out our assumptions concerning the semantic contribution of number morphology. Following Sauerland (2003) and Sauerland, Anderssen & Yatsushiro (2005) for concreteness, we assume that NPs are inherently plural – that is to say that they range over both atomic individuals and groups. Furthermore, the singular feature SG is taken to be presuppositional – specifically, it denotes a partialized identity function of type $\langle e, e \rangle$, as in (24a). The plural feature PL, on the other hand, is simply semantically vacuous – it denotes the identity function of type $\langle e, e \rangle$, as in (24b). This is the so-called "weak" theory of plurality (see Sauerland, Anderssen & Yatsushiro 2005 for extensive arguments).

(24)   a. $[\![\text{SG}]\!] = \lambda x_e : \mathsf{atom}_@(x) . x$
       b. $[\![\text{PL}]\!] = \lambda x_e . x$

Due to how the number features are typed, they do not compose with NPs, but rather with DPs of type e. When the DP with which they compose is of a quantificational type (as is the case with *wh*-expressions), the DP moves and the number feature composes with its trace. We illustrate this idea in more detail in the next section.

4.2   Question composition

For concreteness, we assume that *wh*-phrases are existential quantifiers. The denotation assumed for *which employee* is given in (25). The denotation assumed for the interrogative complementizer, which we take to be responsible for the shift from a propositional type to a question type, is given in (26). Following, e.g., Sauerland (1998: p. 243), we assume that C_Q composes first with a propositional variable, which later in the derivation gets bound by a lambda operator, in order to derive a Hamblin-Karttunen question denotation.[8]

(i)   a.   Kai hasn't found any eggs.

      b.   Kai has found no eggs.
           $\rightsquigarrow$ *It's not the case that Kai has found one or more eggs*
           $\not\rightsquigarrow$ *It's not the case that Kai has found more than one egg*

<div align="right">Sauerland, Anderssen & Yatsushiro (2005: p. 419)</div>

8 Sauerland (1998) notes that the introduction of the λp operator at the CP level is construction-specific, and therefore non-compositional. We adopt this assumption here for purely expository purposes.

There are a number of ways in which the LF in (27) can be re-analyzed compositionally, while achieving the same results. Fox (2012), inspired by Shimada's (2007) view of head movement,
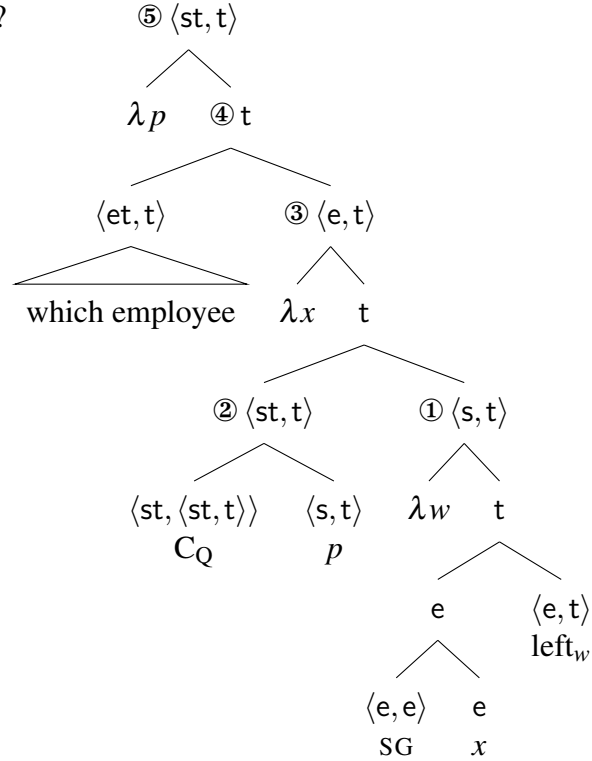
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(25) $[\![\text{which employee}]\!] = \lambda P_{\langle e,t \rangle} . \exists x[\text{employee}_@(x) \wedge P(x)]$

(26) $[\![\text{C}_Q]\!] = \lambda q_{\langle s,t \rangle} . \lambda p_{\langle s,t \rangle} . p = q$

Given the assumptions outlined above, the LF assumed for a simple constituent question is given in (27). Note that, due to the semantics we assume for number morphology, outlined in the previous section, the number feature SG applies to the type e trace left behind by *wh*-movement.[9] The details of the derivation are given in (28).[10]

(27) Which employee left?

⑤ $\langle st, t \rangle$

λp ④ t

$\langle et, t \rangle$ ③ $\langle e, t \rangle$

which employee λx t

② $\langle st, t \rangle$ ① $\langle s, t \rangle$

$\langle st, \langle st, t \rangle \rangle$ $\langle s, t \rangle$ λw t
C$_Q$ p

e $\langle e, t \rangle$
      left$_w$

$\langle e, e \rangle$ e
SG x

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assumes that C$_Q$ composes first with an answerhood operator, which moves, leaving behind a propositional variable. Heim (1994) and Cresti (1995) achieve the same result compositionally by assigning *wh*-expressions a higher type ($\langle \langle e, \langle st, t \rangle \rangle, \langle st, t \rangle \rangle$), although this obscures the parallel between *wh*- and existential quantifiers. Both approaches, as far as we can tell, are compatible with our analysis.

9 More generally, Sauerland (2003) argues explicitly that number features apply to DPs (i.e. expressions of type e), rather than NPs (i.e. expressions of type $\langle e, t \rangle$).

10 Note that for expository simplicity, all nouns and nominal features are assumed to be interpreted rigidly or *de re*.

(28)   a. $[\![①]\!] = \lambda w : \mathsf{atom}_@(x) . \mathsf{left}_w(x)$

       b. $[\![②]\!] = \lambda q . p = q$

       c. $[\![③]\!] = \lambda x : \mathsf{atom}_@(x) . p = \lambda w . \mathsf{left}_w(x)$

       d. $[\![④]\!] = 1$ iff $\exists x : \mathsf{atom}_@(x).\mathsf{employee}_@(x) \wedge p = \lambda w . \mathsf{left}_w(x)$

       e. $[\![⑤]\!] = \lambda p . \exists x : \mathsf{atom}_@(x).\mathsf{employee}_w(x) \wedge p = \lambda w . \mathsf{left}_w(x)$

4.3   Simplex *wh*-expressions

Unlike complex *which*-phrases, which we assume denote rigidly-typed existential quantifiers over individuals (type $\langle et, t \rangle$), we claim that simplex *wh*-expressions can additionally quantify over higher-order semantic objects, such as quantifiers. Ignoring phi features, the denotation we assume for *who* is given in (29). Simplex *wh*-expressions are taken to quantify over members of D_σ, where σ is a variable over types in Σ. We give a recursive characterisation of Σ in (30), and an extensional characterisation in (31).

(29) $[\![\text{who}]\!] = \lambda P_{\langle \sigma, t \rangle} . \exists x_\sigma [P(x)]$ $\sigma \in \Sigma$

(30) $\sigma \in \Sigma$ iff $\begin{cases} \sigma = e \\ \sigma = \langle \sigma_1, t \rangle & \text{where } \sigma_1 \in \Sigma \end{cases}$

(31) $\Sigma = \{ e, \langle e, t \rangle, \langle \langle e, t \rangle, t \rangle, \langle \langle \langle \langle e, t \rangle, t \rangle, t \rangle, t \rangle, \dots \}$

A consequence of our claim that simplex *wh*-expressions are type-flexible is that questions involving simplex *wh*-expressions are in principle ambiguous. If $\sigma = e$, then the result is essentially the same as the LF in the previous section for a simple *which*-question. If $\sigma = \langle et, t \rangle$ however, things get more interesting. The resulting interpretation that obtains for *who* is given in (32).[11]

(32) $[\![\text{who}_{\sigma = \langle et, t \rangle}]\!] = \lambda P_{\langle \langle et, t \rangle, t \rangle} . \exists Q_{\langle et, t \rangle} [P(Q)]$

Due to the way that $\text{who}_{\sigma = \langle et, t \rangle}$ is typed, it should leave behind a trace of type $\langle et, t \rangle$. However, recall that number features may only compose with expressions of type e. For composition to proceed, we must additionally QR the trace of $\text{who}_{\sigma = \langle et, t \rangle}$, leaving behind a variable of type e. The composition of a simplex *wh*-questions involving $\text{who}_{\sigma = \langle et, t \rangle}.\textsc{sg}$ is given in (33).

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11 We thank an anonymous reviewer for pressing us on our prediction that simplex *wh*-expressions can potentially have *super* higher-type readings, i.e., ranging over $D_{\langle \langle \langle e, t \rangle, t \rangle, t \rangle}$ or higher. As it stands, it is unclear to us whether or not this makes any erroneous predictions, or even how to test this empirically. In the absence of evidence, we formulate our analysis in a maximally general way, and leave to future work the question of whether or not higher-type readings need to be further constrained.

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(33)   Who left?

$$\lambda p.\exists Q\left[p=\lambda w.Q\left(\begin{array}{c}\lambda x:\mathsf{atom}_@(x)\\.\,\mathsf{left}_w(x)\end{array}\right)\right]$$

In order to see how the LF in (33) accounts for the lack of a UP in questions involving *who*.SG, consider the extension of (33), where $D_e = \{\,\mathsf{Roy}, \mathsf{Moss}, \mathsf{Jen}\,\}$ in @. Let's assume that Roy and Moss left in @, and Jen didn't leave in @.

The question extension in (34) is the set of propositions $\lambda w.Q(\lambda x : \mathsf{atom}(x).\mathsf{left}_w(x))$, where Q is a quantifier, i.e., a set of sets, which includes the set of atomic individuals that left. In this case, the set of atomic individuals that left is $\{\,\mathsf{R}, \mathsf{M}\,\}$, so the true members of the question extension are those where Q is a set of sets including $\{\,\mathsf{R}, \mathsf{M}\,\}$, and possibly others. Concretely, ① and ② are both true members of the answer set.

(34) $\quad \lambda p . \exists Q [p = \lambda w . Q(\lambda x : \mathrm{atom}_@(x) . \mathrm{left}_w(x))]$

$$= \left\{ \begin{array}{l} \lambda w . \{\{R\}\}(\lambda x : \mathrm{atom}_@(x) . \mathrm{left}_w(x)), \\ \lambda w . \{\{M\}\}(\lambda x : \mathrm{atom}_@(x) . \mathrm{left}_w(x)), \\ \lambda w . \{\{J\}\}(\lambda x : \mathrm{atom}_@(x) . \mathrm{left}_w(x)), \\ ①\lambda w . \{\{R,M\}\}(\lambda x : \mathrm{atom}_@(x) . \mathrm{left}_w(x)), \\ ②\lambda w . \{\{R\},\{R,M\}\}(\lambda x : \mathrm{atom}_@(x) . \mathrm{left}_w(x)), \\ \lambda w . \{\{R,J\}\}(\lambda x : \mathrm{atom}_@(x) . \mathrm{left}_w(x)), \\ \lambda w . \{\{R,M,J\}\}(\lambda x : \mathrm{atom}_@(x) . \mathrm{left}_w(x)), \\ \ldots \end{array} \right\}$$

Recall the MIP in (35) (repeated from (4)):

(35)   *Maximal Informativity Principle* (MIP)
A question Q presupposes the existence of a unique, maximally-informative true answer to Q.

The answer-set in (34) has a maximally-informative true answer – namely, the proposition where Q contains the set consisting of Roy and Moss, and no other sets, ①. This asymmetrically entails all other true members of the answer-set, such as ②. Note that SG is still semantically active – if Q were the set $\{\{R \oplus M\}\}$, then the resulting proposition would be undefined.[12]

As long as σ is resolved to type $\langle et,t \rangle$, singular simplex *wh*-questions are correctly predicted to not necessarily give rise to a UP. As we have seen, however, plural simplex *wh*-questions still give rise to an ASI, despite the fact that their singular counterpart does not give rise to a UP. This is relatively straightforward to account for according to our analysis; we must simply assume that $\phi[who_{\sigma=e}.\mathrm{SG}]$ is always an alternative to both $\phi[who_{\sigma=e}.\mathrm{PL}]$ and $\phi[who_{\sigma=\langle et,t \rangle}.\mathrm{PL}]$ for the purposes of *Maximize Presupposition!*. Since $who_{\sigma=e}$ *left?* globally presupposes that a unique individual left, much like a singular *which*-question, by the logic of *Maximize Presupposition!*, both $who_{\sigma=e}.\mathrm{PL}$ *left?* and $who_{\sigma=\langle et,t \rangle}.\mathrm{PL}$ *left?* give rise to the implicated presupposition that the speaker does not believe that a unique individual

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12 Since we essentially allow quantificational answers into the answer-set induced by simplex *wh*-questions, we make some nuanced predictions regarding the truth conditions of questions embedded under responsive predicates. Consider the following example:

(i) Andy knows who left.

Assuming an orthodox semantics for *know*, under the higher-order reading of *who*, we predict that it should be sufficient for (i) to be true if Andy (correctly) believes *that two students left*, even if he doesn't know exactly which individuals left. This is is clearly too weak. We speculate that competition between the higher-order and "ordinary" readings is crucial in restricting the distribution of higher-order readings. This interaction is an important area for investigation in future research.

left. In section §6.1 we will discuss the implications of assuming a higher order type for $\phi[who_{\sigma=\langle\text{et,t}\rangle}.\text{SG}]$ as well.

4.4   Distinguishing between *who* and *which*

Why is it that simplex *wh*-expressions may range over higher-order semantic objects, whereas *which*-phrases may not? We suggest here that this is due to their respective semantic decomposition. Both simplex *wh*-expressions and *which*-phrases can be decomposed into an abstract morpheme WH, responsible for the quantificational force of the *wh*-expression, and a restrictor. WH has a type-flexible denotation, as given in (36). The restrictor of a *which*-phrase is a (rigidly-typed) NP, which denotes a property of type $\langle e, t\rangle$. The restrictor of a simplex *wh*-expression, on the other hand, is a type-flexible domain variable of type $\sigma \in \Sigma$. The decomposition of a simplex *wh*-expression is given in (37).

(36) $[\![\text{WH}]\!] = \lambda P_{\langle\sigma,\text{t}\rangle} . \lambda Q_{\langle\sigma,\text{t}\rangle} . \exists x_{\sigma}[P(x) \wedge Q(x)]$ $\sigma \in \Sigma$

(37)   . . .

              $\langle\sigma\text{t}, \langle\sigma\text{t}, \text{t}\rangle\rangle$ D_{σ}
                    WH

We see independent evidence that simplex (but not complex) *wh*-expressions may receive higher-type denotations by considering the selectional properties of verbs such as *hope* and *think*. As discussed by, e.g., Moltmann (2013) and Elliott (2017), *think*-type verbs (as opposed to *believe*-type verbs) are only compatible with a certain class of DPs, which following Elliott we label *PropDPs*. We give Elliott: p 173's characterization of *PropDPs* below:

(38)   PropDPs

   a.   DPs headed by the noun *thing*, e.g., *the same thing, a different thing, most things, two things, something, everything,* etc.

   b.   The simplex *wh*-expression *what*.

   c.   Anaphoric expressions such as *it* and *that*.

   d.   Null operators in comparatives.

We illustrate the contrast between *think*-type verbs and *believe*-type verbs with respect to *what* vs. *which*-phrases below:

(39)   *believe*-type verbs

      a.   What does Abed believe?

      b.   Which stories does Abed believe?

      c.   What did Abed tell Britta?

      d.   Which stories did Abed tell Britta?

(40)   *think*-type verbs

      a.   What does Abed think?

      b. *Which { stories | facts|cases|propositions|possibilities } does Abed think?

      c.   What does Abed hope?

      d. *Which { stories | facts|cases|propositions|possibilities } does Abed hope?

Elliott (2017) argues that PropDPs are just those DPs that allow for higher-type readings – concretely, Elliott suggests that propDPs are quantifiers ranging over *properties* – a possibility predicted by our analysis of simplex *wh*-expressions. We note that broadly, the class of propDPs lack lexical restrictors (with the sole exception of the noun *thing*, which we would conjecture is the overt spellout of a type-flexible domain variable). This is in-line with our prediction that only quantificational expressions without lexical restrictors should allow for higher-type readings.

This concludes our basic analysis of the absence of a uniqueness presupposition with singular simplex *wh*-expressions. In the next section, we address the character of the anti-singleton inference in more detail, which will require an elaboration of the principle of *Maximize Presupposition!*.

5   Ignorance Context, *Maximize Presupposition!* and Ineffability

In recent work Maldonado (2020) analyzes the data discussed in the previous section by taking *quién* to be underspecified for number, thereby accounting for the lack of a UP. She furthermore introduces data which concern the choice between singular *quién* and plural *quiénes* in contexts where the speaker is ignorant about the numerosity of the entity questioned. The observation is that singular, rather than plural, *who* must be used in both *more than one* contexts and in *at least one* contexts. Plural *who*, therefore, is only felicitous whenever it is known that a plural individual will be named in the complete answer. The data below, reproduced from her paper, illustrate these contrasts.

(41) a. Una de mis amigas llamó pero no me   acuerdo   quién   (#
          one of my   friends called but   not REFL remember who.SG   (#

            quiénes)
            who.PL)

          'One of my friends called but I don't remember who.'

      b. Una o más de   una persona llamó pero no me   acuerdo
          One or more than one person called but   not REFL remember

            quién   (# quiénes).
            who.SG (# who.PL)

          'One or more than one person called but I don't remember who.'

      c. Varias amigas llamaron pero no me   acuerdo   quiénes (??
          several friends called   but   not REFL remember who.PL   (??

            quién).
            who.SG)

          'Several friends called but I don't remember who.'

What is striking about these data is that plural *who* doesn't pattern with plural *which* as one might expect, since plural *which* is acceptable in *at least one* contexts, as shown in (42b).

(42) *Juan is expecting at least one friend to come to the party.*

      a. #/??Juan no   sabe quiénes van a venir a la fiesta.
              Juan not know who.PL   will   come to the party

          'Juan doesn't know who will come to the party'

      b.   Juan no   sabe qué   amigos van a venir a la fiesta.
              Juan not know which friends will   come to the party

          'Juan doesn't know which friends will come to the party'

In order to account for these data, Maldonado employs a strong plural semantics for *quiénes* (cf. Chierchia 1998, Farkas & de Swart 2010). The simplex plural *wh*-phrase is analyzed as carrying the *more-than-one* requirement as part of its literal meaning, hence its only being compatible with *more than one* contexts. Under that approach, the singular *quién* is assumed to range over both singular and plural entities, hence its acceptability in both *exactly one* and *at least one* contexts. Crucially, however, she notes that she needs to maintain a weak plural semantics for *which*-phrases, since singular *which*-questions carry a UP, whereas plural *which*-

questions are fully compatible with ignorance contexts (see Maldonado 2020: p. 13 for discussion).

Another component of her analysis involves an appeal to a D-linking requirement. Specifically, she argues that there are contexts where even though the *more-than-one* requirement is satisfied, *quiénes* is still not acceptable, and instead the singular *quién* has to be used. The specific example is reproduced below. Her account for why *quiénes* cannot be used in this context is based on the stipulation that *quiénes* can only range over a discourse or contextually salient set, hence the D-linking requirement.

(43)   *Mary and John arrive at their apartment, where there is supposed to be no*
       one. They hear two people whispering inside. Mary asks:
       ¿Quién   (# quiénes) está ahí?
       Who.SG (# who.PL) is   there?

       'Who is in there?'

We won't attempt to analyze this case in detail, but we suspect that a putative D-linking requirement is *not* what is at issue here. Consider an identical context, only this time, Mary notices that one of the two people whispering has a Scottish accent. In such a context, the following question is felicitous:

(44)   Which of you is Scottish?

This indicates that the context in question is able to support the anaphoric requirements of a D-linked *which*-phrase.

As we show in more detail in the following subsection, Maldonado's observation that the singular rather than the plural must be used in (41a) and (41b) is surprising. We account for this data by combining our current analysis with an account of presuppositional strengthening and a constraint against ineffability.

5.1   *Maximize Presupposition* and *Ineffability*

In the following we provide a brief summary of Elliott & Sauerland's (2019) account of *Maximize Presupposition!* (MP) inferences, which we adopt as part of our analysis.

Elliott & Sauerland (2019) provide an account of MP inferences tailored to reconcile the need for global and local application, without invoking dynamic semantics (cf. Singh 2011). Their account is couched in terms of a grammatical operator **exh**, which, following e.g., Marty (2017), they take to be responsible for presuppositional strengthening (i.e., MP inferences). The core of the account is a novel principle AVOID INEFFABILITY!, which (they argue) successfully regulates the availability of global vs. local presuppositional strengthening.

As a preliminary, we follow Elliott & Sauerland (2019) in adopting Magri's (2009) presuppositional formulation of the grammatical exhaustivity operator **exh**. Magri assumes a bidimensional theory of presuppositions (see Karttunen & Peters 1979). A sentence ϕ denotes a pair consisting of its presupposition ϕ_{prs} and its assertion ϕ_{asr}, as in (45). The formulation of **exh** is given in (46). It takes a sentential prejacent ϕ, and returns a pair consisting of ϕ's *strengthened* presupposition, and ϕ's *strengthened* assertion.

(45) $[\![\phi]\!] = \langle \phi_{prs}, \phi_{asr} \rangle$

(46) $[\![[\textbf{exh}_{\text{MP}} \ \phi]]\!] = \langle \text{EXH}_{prs}(\phi), \text{EXH}_{asr}(\phi) \rangle$

Since we focus exclusively on the presuppositional dimension in this paper, only the algorithm for computing the strengthened presupposition is relevant. This is provided in (47). $\text{EXH}_{prs}(\phi)$ is defined in terms of the *presuppositionally excludable alternatives* to ϕ, $\text{EXCL}_{prs}(\phi)$. In informal terms, in order to derive the strengthened presupposition of ϕ,[13] we need to negate the presupposition of every alternative ψ_{prs}, such that ψ_{prs} is logically non-weaker than the presupposition of ϕ.

(47) **Strengthened Presupposition**

    a. $\text{EXCL}_{prs}(\phi) = \big\{ \psi \in \text{ALT}(\phi) : \phi_{prs} \nrightarrow \psi_{prs} \big\}$

    b. $\text{EXH}_{prs}(\phi) = \phi_{prs} \land \forall \psi \in \text{EXCL}_{prs}(\phi)[\psi_{prs} = 0]$

As Elliott & Sauerland (2019) show, presuppositional **exh** straightforwardly accounts for cases where MP inferences are obligatorily computed *locally*, on the assumption that **exh** is obligatorily present at every subsentential node. An example of this is Percus's (2006) famous example, given in (48). If **exh** is obligatorily present at the prejacent of the quantifier *everyone with exactly two students*, as in (49), the oddness of the sentence is successfully accounted for (see Elliott & Sauerland 2019 for details).

(48) #Everyone with exactly two students assigned the same exercise to all his students.

(49) [[Everyone with exactly two students]
    λx **exh** [x assigned the same exercise to all his students]]

The problem with this proposal as it stands is that it predicts that MP inferences should *always* be strong – *global* application should never trump *local* application. Consider e.g., Heim's (1991) example (50). Heim observes that (50) conveys that *the*

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13 In the literature, at least three other terms have been used for this strengthened presupposition: implicated presupposition (Sauerland 2008), antipresupposition (Percus 2006), and presuppositional implicatures (Marty 2017).

speaker does not know that there is a unique 20ft. catfish, rather than the stronger *the speaker knows that there is not a unique 20ft. catfish*. Unfortunately, the aforementioned proposal predicts that the example in (50) should only have a single possible LF, given in (51).[14]

(50) Robert caught a 20ft. catfish.

(51) **exh** K_s **exh** [Robert caught a 20 ft. catfish]

As Elliott & Sauerland (2019) observe, we need a principle that blocks the LF in (51) in exactly those contexts where the speaker is not certain that the presuppositions of the alternative are *not* satisfied. Elliott & Sauerland's proposal is the principle AVOID INEFFABILITY!, as formulated in (52). This principle allows **exh** to be *deactivated*, just in case application of **exh** predicts a presupposition failure for a sentence and *all of its alternatives*.[15]

(52) AVOID INEFFABILITY!: Deactivation of n occurrences of **exh$_{MP}$** to ~~**exh$_{MP}$**~~ in an LF ϕ is licit in a context C iff:

a. there is no other LF ψ in ALT(ϕ), such that ϕ and ψ are Strawson-equivalent

b. C satisfies the presuppositions of ψ

c. ψ contains at most $n-1$ occurences of **exh$_{MP}$**.

This accounts for Heim's example as follows: suppose the speaker is uncertain about whether there exists a unique catfish. Neither (53), nor its alternative (54) is usable. (52) therefore allows *deactivation* of the embedded occurrence of **exh** in (53), resulting in (55).

(53) **exh** K_s **exh** [Robert caught a 20 ft. catfish]

(54) **exh** K_s **exh** [Robert caught the 20 ft. catfish]

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14 Note that we adopt Meyer's (2013, n.d.) *Matrix K axiom*.

(i) **Matrix K Axiom**   (Meyer n.d.: p. 583)
    Assertion of ϕ is parsed as $K_s\phi$ at LF.

    The Matrix K Axiom states that all assertively uttered sentences are covertly modalized by an operator K_s anchored to the beliefs of the speaker s. K is taken to universally quantify over the speaker's doxastic alternatives, much like the attitude verb *believe*.

15 Neither Elliott & Sauerland nor we investigate whether cases can be found where only some alternatives considered by **exh** can be deactivaved (i.e. *pruned* in the terminology of Chierchia 2013), while others remain active. A restatement of (52) using pruning would be equally compatible with our proposal, and we use full deactivation of **exh$_{MP}$** merely for notational convenience.

(55) **exh** K_s ~~exh~~ [Robert caught a 20 ft. catfish]

Note that AVOID INEFFABILITY! doesn't mistakenly rescue the oddness of Percus's (2006) example, repeated below as (56), since the sentence (globally) implies that the speaker knows that everyone has exactly two students, in which case there is a usable alternative – namely, (57). Therefore, the embedded occurrence of **exh** may not be deactivated.

(56) Everyone with exactly two students **exh** assigned the same exercise to all of his students.

(57) Everyone with exactly two students **exh** assigned the same exercise to both of his students.

As discussed by Elliott & Sauerland (2019), one consequence of this system is that if a sentence ϕ has an alternative, the presupposition of which is satisfied in the context of utterance, strengthening of ϕ will always be obligatory. This will be crucial for our account of the usability conditions of *wh*-expressions in Spanish.

5.2   Ignorance contexts in Spanish

Having made precise our assumptions concerning the status of *Maximize Presupposition!*, we'll now enumerate the different representations we propose for simplex and complex *wh*-expressions in Spanish, along with the presuppositions they give rise to in the corresponding *wh*-question. For the time being, we'll put inferences derived via *Maximize Presupposition!* to one side.

***quien*$_{\sigma=\text{e}}$.SG** : When the domain variable σ is set to type e, *quién* (who.SG) strictly ranges over atomic individuals. Therefore, the corresponding *wh*-question presupposes the existence of a unique individual, via *Maximal Informativity*.

***quien*$_{\sigma=\langle\text{et,t}\rangle}$.SG** : When σ is set to type $\langle\text{et},\text{t}\rangle$, *quién* (who.SG), from a set-theoretic point of view, has as its domain sets of sets Q, s.t., every set $X \in Q$ is made up of atomic individuals:

$$\{\, Q \mid \forall X[X \in Q \to \forall x[x \in X \to x \in D_\text{e} \wedge \text{atom}(x)]] \,\}$$

Given a domain $\{\, a,b,c \,\}$, elements of $D_{\langle\text{et,t}\rangle}$ will include both of the following:

- $\{\{\,\}\}$, i.e., the GQ *nothing*.
- $\{\{\,a,b\,\},\{\,a,b,c\,\}\}$, i.e., the GQ derived via the generalized conjunction of (the Montague lift of) a and b.

- 2^{D_e}, i.e., the trivial true GQ.

Therefore, the corresponding *wh*-question is predicted to be presupposition-less, both with respect to *existence* and *uniqueness*.

***quienes*$_{\sigma=e}$.PL** : When σ is set to type e, *quiénes* (who.PL) ranges over both atomic individuals and pluralities. Therefore, the corresponding *wh*-question presupposes *existence* but not *uniqueness*. This corresponds directly to Dayal's (1996) 'number neutral' denotation for *who* in English.

***quienes*$_{\sigma=\langle et,t\rangle}$.PL** : When σ is set to type $\langle et,t\rangle$, *quiénes* (who.PL), from a set-theoretic point of view, has as its domain sets of sets Q, s.t., every set $X \in Q$ is made up of members of D_e (which can be atomic individuals or pluralities):

$$\{\, Q \mid \forall X[X \in Q \to \forall x[x \in X \to x \in D_e]]\,\}$$

When *quienes*$_{\sigma=\langle et,t\rangle}$.PL composes with a distributive predicate, we predict that it should have the same presuppositional status as the corresponding question with *quien*$_{\sigma=\langle et,t\rangle}$.SG, i.e., it should be presuppositionless. There are however complications involving collective predicates, which we put aside for the purposes of discussion here, and come back to in section §6.2.

***que*.SG NP** : Singular complex *wh*-expressions strictly range over atomic individuals. Therefore, the corresponding *wh*-question presupposes the existence of a unique individual (via *Maximal Informativity*). This is identical to *quien*$_{\sigma=e}$.SG, modulo the restrictor.

***que*.PL NP** : Plural complex *wh*-expressions range over atomic individuals and pluralities, therefore the corresponding *wh*-question only presupposes existence. This is identical to *quienes*$_{\sigma=e}$.PL, modulo the restrictor.

Were this the final word, we would have trouble accounting for some of the usage conditions identified by Maldonado (2020). However, we take these predictions as our starting point, and furthermore assume that *wh*-questions give rise to implicated presuppositions via *Maximize Presupposition!*, and that, all else being equal, speakers prefer morphosyntactically simpler expressions.

Following the work of Marty 2017, Spector & Sudo 2017, Anvari 2018, we take the view that there is a single operator **exh** responsible for both presupposition maximization and grammatical implicatures. We assume that the type ambiguity of *quien* and *quienes*, like other ambiguities, is visible to **exh**. Here, we motivate this assumption by presenting a parallel involving third person pronouns in German. We assume that masculine gender and plural number are unmarked (Sauerland 2008).

Note that the form *sie* is ambiguous between the feminine singular and the plural form. Subject-verb disagreement can disambiguate between these two forms, but otherwise a global ambiguity exists.

sie.**FEM,SG**$_i$: presupposes that i is female and atomic.

er.**MASC,SG**$_i$: presupposes that i is atomic.

sie.**PL**$_i$: presuppositionless.

For the purposes of *exh*, the two forms of *sie* must give rise to distinct alternatives. Specifically, the masculine *er* is simultaneously considered presuppositionally stronger than the plural *sie* and presuppositionally weaker than the feminine singular *sie*. This accounts for the use of *er* as the unmarked singular animate pronoun. The scale of presuppositional strength of the pronominal alternatives is as follows:

(58) **German pronouns ordered by presuppositional strength:**
$$sie.\text{FEM},\text{SG} \gg er.-\text{FEM},\text{SG} \gg sie.-\text{FEM},-\text{SG}$$

Note the parallel with the scale of presupposition strength that we propose for forms of *quién* and *quiénes*, provided below. In both cases, there are two alternatives that are phonologically identical, one of which is truth-conditionally stronger and one of which is truth-conditionally weaker than a relevant competing form.

(59) **Spanish *wh*-expressions ordered by presuppositional strength:**
$$quien_{\sigma=e}.\text{SG} \gg quienes_{\sigma=e}.\text{PL} \gg quien_{\sigma=\langle et,t\rangle}.\text{SG} \gg quienes_{\sigma=\langle et,t\rangle}.\text{PL}$$

Recall that singular *which*-questions give rise to strong *uniqueness* presuppositions. Therefore *Maximize Presupposition!* isn't relevant here – in terms of the proposal introduced in the previous section, exhaustification is vacuous. We simply predict that a singular *which*-question should only be usable in a context where uniqueness is satisfied. As we've already seen, this is borne out – see (60) (repeated from (14)).

(60) ¿Qué chico se fue pronto?
Which boy.SG REFL left early?

    a.   John left early.

    b. #John and Bill left early.

Since $quien_{\sigma=e}$.SG essentially means the same thing as *which person*, it might seem as if we also predict a uniqueness presupposition here, but an occurrence of *quién* is always in principle ambiguous between $quien_{\sigma=e}$.SG and $quien_{\sigma=\langle et,t\rangle}$.SG – therefore, the putative uniqueness presupposition associated with $quien_{\sigma=e}$.SG is in practice undetectable.

When unique existence is presupposed, Maldonado shows using example (61) that only *quién* is acceptable, but that once existence and cardinality greater than one is presupposed as in (62), only *quiénes* is fully acceptable.[16]

(61) Una de mis amigas llamó pero no me acuerdo quién (# quiénes)
     one of my friends called but not REFL remember who.SG (# who.PL)

     'One of my friends called but I don't remember who.'

(62) Varias amigas llamaron pero no me acuerdo quiénes (?? quién).
     several friends called but not REFL remember who.PL (?? who.SG)

     'Several friends called but I don't remember who.'

In a context that doesn't satisfy existence, we predict that only $quien_{\sigma=\langle et,t\rangle}$.SG and $quienes_{\sigma=\langle et,t\rangle}$.PL should be usable, since these are the only forms which don't give rise to an existence presupposition. In fact, Maldonado shows that only *quién* is usable in such a context, see (63). We take this to be because speakers prefer the morphosyntactically simpler singular form over the plural form.[17,18]

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16 Maldonado furthermore notes that the singular is unacceptable in (62), but perceives the unacceptability to be weaker than that of *quiénes* in (61). We hypothesize that this difference may be due to the fact that with *quiénes* the alternative *quién* is structurally less complex, and therefore the alternative is predicted to be available by approaches to scalar alternatives such as that of Katzir (2008) and Fox & Katzir (2011). In contrast, the alternative *quiénes* for $quien_{\sigma=\langle et,t\rangle}$.SG in (62) is more complex and therefore Katzir (2008) and Fox & Katzir (2011) predict it to not be available unless it is available in context. In (62), the previous plural noun phrase *varias amigas* does make the plural morpheme available, and therefore the unacceptability of *quién* is expected. But we suggest that the difference in status Maldonado notes can be related to that between structual availability of the alternative vs. contextual availability.

17 We view this as an instance of the Brevity maxim (Grice 1975 and also Goldstein 2013, and Yatsushiro & Sauerland 2019.

18 Since, according to our analysis $quien_{\sigma=\langle et,t\rangle}$.SG and $quienes_{\sigma=\langle et,t\rangle}$.PL are equivalent (at least, with distributive predicates), we predict that in a context where there is uncertainty between zero vs. two or more instances of the question, both forms should be possible. This is tested in (18), which is judged relative to a context where the speaker isn't certain of anyone entered the room, but if someone did, it was at least two people. Our informants judged that only *quién* is acceptable n such a context. This is consistent with our conjecture that, where $quien_{\sigma=\langle et,t\rangle}$.SG and $quienes_{\sigma=\langle et,t\rangle}$.PL are both possible, the simpler form is preferred.

(i) ¿{Quién entró | #quiénes entraron} en la habitación?
    {who.SG entered.SG | who.PL entered.PL} in the room

    "Who entered the room?"

(63) ¿Quién (# quiénes) hay en la fiesta?
      Who.SG (# who.PL) was at the party

'Who was there at the party?'

Finally, we turn to cases where only existence is presupposed. Our account prima facie predicts that *quiénes* should be preferred because the presupposition of $quien_{\sigma=e}$.SG is not satisfied, while $quien_{\sigma=\langle et,t \rangle}$.SG is presuppositionless. Maldonado discusses the two relevant examples in (64) (from p. 5) and (65) (from p. 7), which, however, seem to go against our prediction.

(64) Una o más de una persona llamó pero no me acuerdo quién
      One or more than one person called but not REFL remember who.SG

      (# quiénes).
      (# who.PL)

'One or more than one person called but I don't remember who.'

(65) #Juan no sabe quiénes van a venir a la fiesta.
      Juan not know who.PL will   come to the party

'Juan doesn't know who will come to the party'

It turns out that our account actually predicts the oddness of *quiénes* in both true ignorance contexts, where Juan considers it possible that no one will come to the party, (65), as well as in contexts where only existence is presupposed and it's possible that one or more than one person have rung, (64). This is because obligatory local application of **exh** derives a strong anti-singleton inference with *quiénes*.

Why is local application of **exh** obligatory in this instance? Recall §5.1 where we set up a system where application of **exh** is obligatory at every sentential node, and consequently strong MP inferences are always attested, unless the conditions satisfying AVOID INEFFABILITY! are met. Crucially, *quiénes* does have a usable alternative, namely an alternative whose presuppositions are met in the context, which is $quien_{\sigma=\langle et,t \rangle}$.SG. Since the conditions of AVOID INEFFABILITY! are not met, **exh** is obligatory, correctly predicting that *quiénes* is obligatorily strengthened, giving rise to an ASI. Since this inference is incompatible with the context, *quiénes* cannot be used. We schematize the computation of this inference in (66)-(71).

(66)   ③ Juan not know ② **exh** [① ANS who.PL will come to the party]

(67) $[\![①]\!] = \left\langle \begin{array}{l} \text{one or more people will come to the party,} \\ \text{ANS(who.PL will come to the party)} \end{array} \right\rangle$

(68) ①′ ANS who$_{\sigma=e}$.SG will come to the party $\in$ ALT(①)

(69) $[\![①′]\!] = \left\langle \begin{array}{l} \text{exactly one person will come to the party,} \\ \text{ANS(who}_{\sigma=e}\text{.SG will come to the party)} \end{array} \right\rangle$

(70) $[\![②]\!] = \left\langle \begin{array}{l} \text{more than one person will come to the party,} \\ \text{ANS(who.PL will come to the party)} \end{array} \right\rangle$

(71) $[\![③]\!] = \left\langle \begin{array}{l} \text{Juan believes that more than one person will come to the party,} \\ \text{Juan doesn't know who will come to the party} \end{array} \right\rangle$

In contrast to *quiénes*, Maldonado notes that the plural complex *wh*-phrase *qué*.PL is usable whereas *qué*.SG is not in the same type of context, namely an uncertainty scenario where existence is presupposed. The following example is judged relative to a context in which Juan is expecting at least one friend to come to the party, but two or more might come.

(72) Juan no sabe {#qué amigo | qué amigos} van a venir.
      Juan not know {which friend.SG | which friend.PL} go PREP come

      Juan doesn't know which friends will come to the party.

According to our account, this is because *qué*.SG presupposes uniqueness – since (strengthened) *qué*.PL and all of its alternatives are unusable, deactivation of **exh** is licensed in this context via AVOID INEFFABILITY!.

(73) Juan does not know ~~**exh**~~ which friend.PL will come to the party.

This concludes our analysis of the usability conditions governing the distribution of *wh*-questions in Spanish, as discussed by Maldonado. Our primary goal was to account for the lack of a uniqueness presupposition with *who*.SG – this we accomplished by allowing *who*.SG to range over members of $D_{\langle et,t \rangle}$. As Maldonado shows, the usability conditions are more intricate, but these follow from independently motivated mechanisms for capturing *Maximize Presupposition!* inferences. The empirical observations should also carry over to the languages we discussed towards the beginning of this paper, such as Greek and Hungarian. Verification of this prediction awaits future empirical work.

5.3 Evidence against ambiguity

Another possible analysis of the data we introduced at the beginning of this section, suggested by an anonymous reviewer, would be to claim that $quien_{\sigma=e}$.SG is in fact ambiguous between a semantically singular denotation, and a semantically plural denotation. This improves over the idea that $quien_{\sigma=e}$.SG is simply number neutral, in that it can account for the ASI associated with *who*.PL – *who*.PL competes with *who*.SG$_{SG}$. It also successfully captures the absence of the UP with *who*.SG questions. Nevertheless, it still leaves an undesirable incongruity between the morphology and the semantics.

Furthermore, we believe that there is concrete empirical evidence against adopting such a proposal. As we discussed in section §5.2, questions with *who*.SG don't just lack an uniqueness presupposition. They also fail to give rise to an existential presupposition – the ambiguity proposal would erroneously predict that *who*.SG questions presuppose existence by virtue of ranging over individuals or sums only.

Finally, the ambiguity proposal essentially predicts that *who*.SG should be acceptable in a superset of the environments that *who*.PL is acceptable in. It turns out that there are certain collective predicates, such as *to be numerous*, which are acceptable with genuine plurals, but which are incompatible with *who*.SG. We discuss this, and other issues surrounding collective predication in more detail in §6.2.

6 Prospects and open questions

6.1 Restrictions on higher-order quantification

In this section, we consider evidence for higher-order readings of plural *wh*-expressions, as discussed in recent work. We suggest that plurality may constitute an independent source of higher-order readings.

We are not the first to propose that *wh*-phrases can receive higher-order readings. In order to capture the readings of modalized wh-questions, such as (74), Spector (2007), like us, argues that *wh*-phrases can be interpreted as higher-order quantifiers. Consider a context in which Lauren is a movie critic (therefore is subject to obligations involving watching movies). There are four movies: A, B, C and D. Now, consider the Hamblin denotation of (74) – it's going to be the set of propositions of the form, *Lauren has to watch x*, where *x* is a movie. According to a classical Hamblin semantics then, answers to the question in (74) should involve specifying particular movies that Lauren is obliged to watch.

(74) What does Lauren have to watch?

Now, imagine a situation in which Lauren is not obliged to watch any specific movie, but in order to fulfill her assignment, her obligation is to watch A and

B, or C and D – either will do. Spector observes that, in such a situation, it's possible to answer (74) by assertion that *Lauren has to watch A and B or C and D*, and furthermore that this completely answers the question. A classical Hamblin semantics fails to capture this. We can see further evidence pointing in the same direction by looking at modalized *wh*-questions in embedded contexts. If Lauren's obligation is to watch A and B, or C and D – and Josie knows this – then under standard assumptions we predict (75) to be a presupposition failure. Intuitively, however, it is true.

(75)   Josie knows what Lauren has to watch.

In order to account for these facts, Spector suggests that *wh*-phrases with restrictor R can be interpreted as higher-order quantifiers, which take as their restrictor the set of upward-entailing generalized quantifiers that live on R. The generalized disjunction of (the Montague lift of) the plural individuals $A \oplus B$ and $C \oplus D$ will always be included, and therefore an account of (74) and (75) falls out.

The data from modalized *wh*-questions are very much in-line with our claim that simplex *wh*-expressions may range over semantic objects of type $\langle et, t \rangle$, but there is some tension between the claims in Spector 2007 and Fox 2018, and the claims made here. The first obvious difference is that both Spector and Fox restrict higher-order quantification to range only over monotone *increasing* GQs. Spector motivates this claim based on the following argument (from Spector: p. 289): suppose that Jack has to read two novels by Balzac, and is not allowed to read any novel by Nabokov, and that these are the only obligations. In such a context, the strongest statement of the form *Jack has to read Q*, where Q is a generalized quantifier over books, is: *Jack has to read at least two novels by Balzac and no novels by Nabokov*. It follows (according to Spector) that (76) should only be true if Sue knows that Jack must read at least two novels by Balzac, and no novels by Nabokov. Spector's intuition is that (76) has weaker truth conditions, which only require that Sue knows that Jack must read at least two novels by Balzac.

(76)   Sue knows what Jack is required to read.

It seems to us that the requirement that higher-order *wh*-phrases range over *increasing* quantifiers is too strong. Consider the example in (77). Spector's requirement predicts, due to universal projection, that (77) should presuppose that Jack is subject to some reading obligation every day this week. In our estimation, (77) is clearly felicitous in a context where, on some days, Jack is not subject to any reading obligations.

(77)   For each day this week, Sue knows what Jack is required to read.

Fox (2018), building on Spector 2007, points out that a higher-order interpretation can't be available for singular *which*-phrases, on the basis of the contrast between (78a) (repeated from (75)) and (78b) on the one hand, and (78c); both (78a) and (78b) can be true in a context where Lauren is subject to a disjunctive obligation, and Josie knows this; (78c) is presuppositionally stronger – it is only felicitous in a context where Lauren is obliged to watch a specific movie, and Josie knows this.[19]

(78)   a.   Josie knows what Lauren has to watch.

     b.   Josie knows which movies Lauren has to watch.

     c.   Josie knows which movie Lauren has to watch.

Fox (2018) demonstrates that the contrast between singular and plural expressions, with respect to the availability of higher-order quantification, extends beyond the domain of *wh*-phrases. He claims that the examples in (79) (from Fox 2018: p. 427) give rise to a presupposition failure if there is no specific book x, such that Sue is required to read x – for example, if Sue is required to read A or B and nothing else. Moving on to the examples in (80) (from Fox 2018: p. 428), Fox claims that neither presuppose that there is a specific plurality of books X, such that Sue is required to read X. Rather, the examples in (80) may be felicitously uttered in a context where Sue is required to read either A and B *or* C and D, and nothing else.

(79)   a.   Mary is required to read the book Sue is.

     b.   The book that Sue is required to read can be read in one week.

(80)   a.   Mary is required to read the books Sue is.

     b.   The books Sue is required to read can be read in one week.

Because of the sensitivity to number marking, we assume that higher-type readings of *which*-phrases have a different source from higher-type readings of simplex *wh*-expressions like *who*, which are the focus of this paper. One possibility compatible with the syntax-semantics interface we suggest in §4 is to stipulate that plurality makes available not only conjunctions of individual answers, but furthermore disjunctions of the conjoined answers. A less stipulative analysis predicting this effect

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[19] We agree that the presupposition of (78a) is rather weak. For example, it may be felicitously uttered in a context where Lauren is required to watch A or B, and nothing else. The presuppositional strength of (78b) is less clear to us. Our judgment is that (78b) is infelicitous in a context where Lauren is required to watch A or B and nothing else, but may be felicitous in a context where, e.g., Lauren is required to watch A and B *or* C and D, and nothing else. In other words, our impression is that plural morphology imposes a plurality requirement on the disjuncts in such cases, although we concede that the judgments are difficult. This requirement does not straightforwardly fall out from Spector and Fox's accounts.

has been developed by Hisao Kobayashi & Rouillard 2019. Hence, we think that the evidence for higher-type readings of *which*-phrases can be reconciled with our account, but leave the details for future research.

6.2 Collective predication

We begin first with a prediction. If we allow plural *quiénes* to range over quantifiers (over atomic individuals as well as pluralities), then when it combines with a collective predicate, we predict answers conveying that more than one group formed to be acceptable.[20] Alonso-Ovalle & Rouillard (2018) observe that this is indeed the case with the following example.

(81) ¿Quiénes formaron un grupo? Al y   Bob y   Al y   Charles.
       who.PL   formed   a   group Al and Bob, and Al and Charles

'Who formed a group? Al and Bob (formed a group) and Al and Charles (formed a group).'

We derive the question extension for (81) in (82), where Q is a quantifier which includes the set of plural individuals that formed a group. In this case, the set of plural individuals that formed a group is $\{\,A{\oplus}B, A{\oplus}C\,\}$, so the true members of the question extension are those where Q is a set of sets including $\{\,A{\oplus}B, A{\oplus}C\,\}$, and possibly others. The application of the answerhood operator will deliver the proposition $\lambda w . \{\{A{\oplus}B, B{\oplus}C\}\}(\lambda x. \text{form a group}_w(x))$ as the maximally informative answer.

(82) $\lambda p . \exists Q [p = \lambda w . Q(\lambda x. \text{form a group}_w(x))]$

$$= \left\{ \begin{array}{l} \lambda w . \{\{A\}\}(\lambda x. \text{form a group}_w(x)), \\ \lambda w . \{\{B\}\}(\lambda x. \text{form a group}_w(x)), \\ \lambda w . \{\{C\}\}(\lambda x. \text{form a group}_w(x)), \\ \lambda w . \{\{A{\oplus}B\}\}(\lambda x. \text{form a group}_w(x)), \\ \lambda w . \{\{A{\oplus}C\}\}(\lambda x. \text{form a group}_w(x)), \\ \lambda w . \{\{B{\oplus}C\}\}(\lambda x. \text{form a group}_w(x)), \\ \lambda w . \{\{A{\oplus}B, A{\oplus}C\}\}(\lambda x. \text{form a group}_w(x)), \\ \lambda w . \{\{A{\oplus}B, B{\oplus}C\}\}(\lambda x. \text{form a group}_w(x)), \\ \lambda w . \{\{A{\oplus}C, B{\oplus}C\}\}(\lambda x. \text{form a group}_w(x)), \\ \lambda w . \{\{A{\oplus}B, A{\oplus}C, B{\oplus}C\}\}(\lambda x. \text{form a group}_w(x)), \\ \dots \end{array} \right\}$$

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20 In fact, Xiang (2016) has already argued that the only way to account for the acceptability of such answers with plural *which* phrases in English is by allowing the interrogative phrase to quantify over higher order entities.

By contrast, *quienes*$_{\sigma=\text{e}}$.PLwould deliver the set of propositions of the form *x form a group*, which would predict a presuppositionally stronger question meaning, namely that there was a unique plurality that formed a group.

We turn now to an apparently problematic prediction made by our analysis, and offer some speculation. The standard assumption for collective predicates in the semantics literature is that they presuppose that their complement is non-atomic. This is illustrated in (83) for *gather*.

(83) $\llbracket \text{gather} \rrbracket = \lambda w . \lambda x : \neg \text{atom}_{@}(x) . \text{gather}_w(x)$

We therefore expect a presupposition failure when *quién* composes with a collective predicate, since, even under the higher-type meaning, it leaves behind an atomic trace. The examples in (84) and (85) show that this is not the case for *gather* nor for *form*, another collective predicate.

(84) ¿Quién se reunió en el patio?
      who.SG REFL gathered in the playground.

      'Who gathered in the playground?

(85) ¿Quién formó un grupo?
      who.SG formed a group

      'Who formed a group?'

In order to account for this data, Alonso-Ovalle & Rouillard (2018) propose that *quién* ranges over those GQ's that live off the pluralized domain – in other words, Alonso-Ovalle & Rouillard treat *quién* as being semantically plural. We think that this cannot be right due to the fact that *quién* does not pattern with genuine plurals in cases such as the following:[21]

(86) ¿Quién pesa 300kg?
      Who.SG weighs 300kg?

      "Who weighs 300kg?"

If one were to answer, *John, Mary and Bill*, this could not be understood to mean that the group collectively weigh 300kg, but rather it would be obligatorily understood distributively. The following contrast between singular and plural *quién* underscores this point.

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21 Thanks to Luisa Martí and Mora Maldonado for discussion of this data.

(87) ¿{#Quién bebió | quiénes bebieron} 40 cervezas juntos?
       {Who.SG drink | who.PL drink.PL} 40 beer   together?

       "Who drank 40 beers together?"

We thus suggest that the account of collective predicates in (83) is not correct. Rather, it seems desirable to impose the non-atomicity presupposition higher, at the level of the event. Further evidence for this comes from the fact that certain singular quantifiers, like *everyone*, are also compatible with collective predicates, as shown by (88).

(88)   Everyone is gathering in the hallway.

It's worth noting at this stage that *everyone* is selective in the collective predicates it composes with - the distinction seems to track Winter's (2001) set versus atom predicate distinction, as evidenced by the fact that a collective predicate like *numerous*, an atom predicate in Winter's terminology, cannot combine with *everyone*.

(89)   *Everyone is numerous.

While we currently don't have anything further to add to the story, it's clear that this issue posed by collective predicates extends beyond interrogative words. Our hope is that the behaviour of simplex quantificational expressions in such environments will ultimately shed light on the correct semantic analysis of collectivity.

Lastly, note that if collective predicates impose a non-atomicity presupposition on their argument, then (90) poses a serious compositionality puzzle, since there is a stage in the derivation at which *gather* composes with an atomic individual-denoting argument (unless the syntax is rendered more baroque than surface appearances suggest).

(90)   Jeroen is gathering with Martín and Frank.

7   Conclusion

In this paper, we have addressed a puzzle that arises for the standard account of the presuppositions of *wh*-questions. In our view, the exceptional behaviour of simplex *wh*-expressions suggests that some quantificational expressions in natural language are (constrained) *polymorphic*, in line with work by Spector (2007). This gives rise to a degree of type-flexibility which complicates the predictions of theories of the semantics-pragmatics interface.

To briefly summarise our analysis, singular simplex *wh*-expressions fail to give rise to a uniqueness presupposition, because they can range over *quantifiers* of type $\langle et,t \rangle$. An anti-singleton inference still arises for plural simplex *wh*-expressions,

since they compete with the type-rigid denotation of the singular simplex *wh*-expression which ranges over individuals. We address apparently problematic data discovered by Maldonado (2020) by building on existing work, such as Singh (2011), arguing that *Maximize Presupposition!* must be computed for embedded constituents. Once we adopt this refined view of presuppositional implicatures, Maldonado's observations fall out straightforwardly.

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