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Where do Chinese wh-items fit?

1. Introduction.

As is well known, Chinese wh-expressions have at least four major different uses exemplified in (1)-(4):

(1) Interrogative

Zhangsan chi-le shenme

Zhangsan eat-PFV what

'What did Zhangsan eat?'

(2) Negative

Zhangsan mei chi shenme dongxi

Zhangsan not eat what thing

'Zhangsan didn't eat anything.' or 'Zhangsan didn't eat anything special.'

(3) Existential

Zhangsan haoxiang chi-le shenme

Zhangsan seem eat-PFV what

'Zhangsan may have eaten something.'

(4) Universal

Zhangsan shenme dou gei-le ni

Zhangsan what DOU give-PFV you

'Zhangsan has given you everything.'

This diverse behavior has earned them the label of 'indeterminates' (Kuroda 2004). In the present paper, we provide a unified analysis of their interrogative, negative and existential uses as polar indefinites.[1] We also provide a hypothesis concerning their place in a general typology of indefinites. Our proposal builds directly on Karttunen's (1977) semantics for wh-words on the one hand and on recent alternative based analyses to polarity phenomena (from Krifka (1994) and Lahiri (1998) to Chierchia (2006, 2012a,b)), on the other. We claim, in particular, that their behavior can be best understood as being driven by the implicatures that wh-words, qua indefinites, share with other indefinites. The main difference between Chinese wh-words and Polarity Sensitive Items (PSIs) on the one hand and plain indefinites on the other is that for the former such implicatures are not subject to relevance: the alternatives activated by wh-words/PSIs must be factored into meaning without the option of 'cancelling' their effect. In contrast, the alternatives of ordinary indefinites are subject to relevance: they may or may not be factored into meaning depending on the context. This sole difference together with the fact that (unlike PSIs of the more familiar English type) Chinese wh-words can take part in question formation along the lines proposed by Karttunen, wholly determines their distribution.

The proposal that wh-words in Chinese are Polarity Sensitive Items (PSIs) has been widely discussed in the literature (e.g. Cheng 1991, REFs). However we think it may be useful to sketch how such an idea can be pursued within an alternative based semantics that addresses in a unified manner ordinary scalar implicatures, along with a wide variety

[1] Universal uses of Chinese wh's within a framework compatible with the one presented here are discussed in Liao (2011).

of epistemic and polarity effects. We will not be able to present our semantics in all its formal details within the limits of the present paper. But we can try to provide the reader with a sense of the architecture of the proposal and a map of how to locate Chinese wh-words within it.

One may of course think that trying to develop a uniform theory of scalar implicatures, polarity phenomena and wh-words is both hubretic and wrong-headed. All we can do here is sketch an existence proof for such an approach and hope to intrigue our readers into considering that the results are conceptually simple and empirically far reaching. We clearly will not able to compare what we are doing with the many interesting, existing alternatives.[2]

We will proceed along the following lines. In section 2 we sketch the relevant background and outline a theory that deals uniformly with ordinary indefinites (like *a/some* in English) and their implicatures as well as with (some) polar indefinites (like *irgendein* in German) and their implicatures. In section 3 we discuss in more detail (if still quite briefly) the distribution of Chinese wh-words and outline their basic syntax and semantics, placing them in a tightly constrained typology of indefinites. In section 4, we discuss variation in the Polarity System: in particular we discuss the difference between Strong vs. Weak NPIs, as that is relevant to analyzing in a finer way the behavior of Chinese wh-words. In Section 5 we show in more detail how their distribution is derived (and, arguably, understood) from the proposal developed in sections 3 and 4. We conclude, and point to pending issues, in section 6.

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[2] The general program we are pursuing is outlined in Fox (2007), Chierchia, Fox and Spector (to appear) and Chierchia (2012a); a more full-fledged development of such program can be found in Chierchia (2012b).

2. Background: Towards a unified theory of scalar implicatures and polarity sensitivity.

Ordinary scalar items like *or* and the indefinite article *a* in English are known to give rise to Scalar Implicatures (SIs).

(5) a. i. We will hire either Mary or Sue.

ii. Possible SI: We won't hire both Mary and Sue.

b. i. John has met a student from my class.

ii. Possible SI: John hasn't met more than one student in my class.

Moreover in certain contexts such items give also rise, with varying degree of strength, to Free Choice (FC) implicatures. We illustrate this with respect to the indefinite article (but parallel facts hold of disjunction):

(6) a. i. Pick a card

ii. Possible FC implicature: you are free to pick any card

b. i. You must marry a rich person

ii. Possible FC implicature: any rich person will do

In the present section we sketch a unified theory of these two phenomena (i.e. the possible presence of strictly scalar and free choice implicatures with ordinary indefinites). We then show how to extend such an approach to account for the (obligatory) Negative Polarity (NP) and Free Choice (FC) construals of morphologically marked indefinites such as *irgendein* in German,[3] illustrated in (7a-b) respectively.

(7) a. Niemand hat irgeindein Buch mitgebracht

Nobody has irgendein book brought along

'Nobody has brought along any book.'

[3] *Irgendein* is morphologically composed from the indefinite article *ein* and the FC prefix *irgend-*.

b. Du muss irgendein reiche Person heiraten

You must irgendein rich person marry

'You must marry a rich person, any rich person.'

We will conclude the section by giving an indication of how variation in the polarity system may be handled, with special reference to so called 'strong' Negative Polarity Items (SNPIs), as that turns out to be directly relevant to our proposal on Chinese wh-words.

2.1. Scalar terms and their FC effects.

Ordinary scalar and free choice implicatures can be derived along the following lines. First an indefinite like *a* activates alternative that can be grouped in two major classes: (strictly) scalar alternatives (SAs) and domain alternatives (DAs). For example:

(8) Semantic components of *a book*:

a. Basic meaning (BM): $\lambda P \exists x \in D[book(x) \wedge P(x)]$

b. Scalar alternative (SA): $\lambda P \forall x \in D[book(x) \rightarrow P(x)]$[4]

c. D(omain)-alternatives (DAs): $\{\lambda P \exists x \in D'[book(x) \wedge P(x)]: D' \subseteq D\}$

When we merge indefinites with other phrases, their basic meanings are composed in the usual way, while their alternatives are composed as in Focus/Alternative-based Semantics (Hamblin 1973, Rooth 1992), through pointwise function application. Thus at the sentential level we get semantic components of the following sort:

(9) a. You borrow a book

b. BM: $\exists x \in D[book(x) \wedge borrow(you, x)]$

[4] We are assuming that the scalar alternative to *a* is *every* only for simplicity's sake. It would be more accurate to maintain that *a* forms a scale with the numerals (*two, three*, …).

c. SA: $\forall x \in D[book(x) \rightarrow borrow(you, x)]$

d. DAs: $\{\exists x \in D[book(x) \wedge borrow(you, x)]: D' \subseteq D\}$

On a domain with two books a and b, the propositions in (9) can be schematically represented as disjunctions/conjunctions of the following sort:

(10) a. BM: $a \vee b$ (where a = you borrow book a, and b = you borrow book b)

b. SA: $a \wedge b$

c. DA: {a, b}

Such alternatives, when relevant, are factored into meaning through an exhaustification operator *O*, essentially a phonologically null counterpart of the focus-sensitive operator *only*.

(11) $O_{DA \cup SA}(p) = p \wedge \forall q \in DA \cup SA[q \rightarrow p \subseteq q]$, (where $\subseteq$ = entails)

O takes two arguments: a set of propositions (here DA∪SA), represented as a subscript on O) and a proposition p (the prejacent); $O_{DA \cup SA}(p)$ simply says that p is the only true member of the set of propositions DA∪SA. If we compute $O_{DA \cup SA}(p)$ relative to the alternative set in (10), we get a contradiction:

(12) $O_{DA \cup SA}(a \vee b) = (a \vee b) \wedge \neg(a \wedge b) \wedge \neg a \wedge \neg b = \bot$ (contradictory proposition)

However, in line with what is commonly held, we assume that the alternatives of an ordinary scalar item are subject to relevance: they are 'active' and are used to enrich the basic meaning only when warranted by the context. Since contradictions, plausibly, can never be relevant, the SA and DAs of *a*, in plain episodic contexts, can never be both simultaneously relevant. However, the SAs by themselves can be — giving rise to canonical scalar implicatures:

(13) $O_{SA}(a \vee b) = (a \vee b) \wedge \neg(a \wedge b)$

D-alternatives, on the other hand, can never be relevant by themselves, as they would give rise to a contradiction (i.e. $O_{DA}(a \vee b) = (a \vee b) \wedge \neg a \wedge \neg b)$). So far so good. Clearly, DAs in plain episodic contexts (under the present assumptions) are pretty useless. They turn to be much more useful in modal contexts like (14a).

(14) a. You can borrow a book

b. BM: $\Diamond(a \vee b)$

c. SA: $\Diamond(a \wedge b)$

d. DA: $\{\Diamond a, \Diamond b\}$

If we exhaustify assertion (14a) relative to the whole of DA∪SA, we still get a contradiction. However, as argued extensively in Fox (2007), D-alternatives can be 'pre-exhaustified'.[5] In other words, we are allowed to consider the assertion relatively to the alternatives in (15a-b), rather than to the ones in (14c-d):

(15) a. SA: $\Diamond(a \wedge b)$

b. Exh-DA: $\{O\Diamond a, O\Diamond b\}$

where $O\Diamond a = \Diamond a \wedge \neg\Diamond b$, and $O\Diamond b = \Diamond b \wedge \neg\Diamond a$[6]

Exhaustification relative to this set yields the FC reading:

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[5] What we call 'pre-exhaustification' here is Fox's 'recursive exhaustification'. The intuition behind it is that if a DA was to be uttered against the set of alternatives in (14) it would be, in fact, exhaustified. 'Pre-exhastification' plays the same role and is conceptually related to Kratzer and Shimoyama's (2002) 'anti-exhaustivity implicature'.

[6] In more complex cases, 'pre-exhaustification' requires some care. The choice of alternatives against which a given DA is to be pre-exhaustified must be guided by something analogous to Fox's Innocently Excludable sets. We provide an example in the Appendix.

It should also be noted, that in principle also SAs can be 'pre-exhaustified'; but their pre-exhaustification in general has no effect.

(16) $O_{Exh\text{-}DA \cup SA}(\Diamond(a \vee b)) = \Diamond(a \vee b) \wedge \neg\Diamond(a \wedge b) \wedge \neg O\Diamond a \wedge \neg O\Diamond b$

$= \Diamond(a \vee b) \wedge \neg\Diamond(a \wedge b) \wedge \neg(\Diamond a \wedge \neg\Diamond b) \wedge \neg(\Diamond b \wedge \neg\Diamond a)$

$= \Diamond(a \vee b) \wedge \neg\Diamond(a \wedge b) \wedge (\Diamond a \rightarrow \Diamond b) \wedge (\Diamond b \rightarrow \Diamond a)$

$= \Diamond b \wedge \Diamond a \wedge \neg\Diamond(a \wedge b)$

The bottom line of the derivation in (16) expresses the fact that everything in the domain is an option (with an optional exclusiveness cause tacked on – that is not always present and that we are going to ignore henceforth). This approach generalizes without changes to FC readings under modals of necessity:

(17) a. You must marry a rich person

b. $O_{Exh\text{-}DA}(\Box(a \vee b)) = \Box(a \vee b) \wedge \Diamond b \wedge \Diamond a$

Formula (17b), which we leave to our readers to compute (or else, to look up in, e.g., Fox 2007), comes down to saying that you may marry some rich person and any rich person in the domain (which in our toy model contains just two individuals) constitutes an allowable choice.

The possibility of pre-exhaustifying D-alternatives forces us to reconsider what happens in un-modalized contexts. If we choose in such contexts pre-exhaustified alternatives and we furthermore ignore SAs, we get that the indefinite article *a* winds up meaning the same as its scalar alternative *every* (and *or* winds up meaning *and*):

(18) $O_{Exh\text{-}DA}(a \vee b) = (a \vee b) \wedge \neg Ob \wedge \neg Oa = (a \vee b) \wedge (a \leftrightarrow b) = a \wedge b$

This is obviously wrong. We assume that this possibility is ruled out by an economy principle that says that one cannot get via exhaustification of a sentence S one of the alternatives to S, for in such a case the alternative would have been uttered directly, as

that constitutes the more economical move. This 'functionalistic' account of why (18) is out can be couched as a formal requirement on exhaustification along the following lines:

(19) E(xhaustification)-Economy

*$O_C(p)$, (where $C \subseteq DA \cup SA$), whenever $O_C(p)$ is some member of DA∪SA other that p itself

This is to be viewed as a constraint on how subsets of the lexically induced alternatives to a scalar item may be chosen: when we exhaustify we must never get some member q of DA∪SA. In such case, we should just utter directly q. This constraint blocks (18) while letting the other cases of scalar and FC implicatures through (as in such cases the result of exhaustifying leads to an enrichment of the basic meaning that could not be obtained otherwise). [7]

Taking stock, we obtain standard SIs and FC implicatures for ordinary scalar terms by exhaustifying, when relevant, scalar and (pre-exhaustified) domain alternatives. This provides us with a uniform account of two phenomena (the coming about of scalar and FC implicatures) and is based on simple (if not uncontroversial) principles.

2.2. Morphologically marked FCIs: Face your alternatives.

On the basis of our assumptions so far, there is a straightforward way of addressing the behavior of morphologically marked FC indefinite like German *irgendein*. The

[7] The proper formulation of (19) is as a presupposition on O. More extensive discussion and justification of (various versions of) this principle, can be found in Ivlieva (2011), Fox and Katzir (2011), and Chierchia (2012a).

The approach we are sketching is based on: (i) use of plain O, (ii) flexible alternatives, and (iii) E-Economy. Innocent Excludability only plays a role in pre-exhaustification of DAs. A viable alternative can be worked out that uses (i) non flexible alternatives, (ii) Innocent Excludability and (iii) a principle of 'anti-idleness' requiring that each family of alternatives (i.e. DA and SA) contributes to meaning.

natural move to make is that the lexically determined alternatives to *irgendein*, which are the same as the plain indefinite *ein*, are not subject to relevance. They must always be factored into meaning (and we will provide in section 3 a method of formally enforcing this requirement). There is no way, in other words, to ignore or put in parenthesis the SAs and DAs of *irgendein*. This suffices to account for what sets *irgendein* apart from plain *ein*. Let us see how.

According to our hypothesis, the meaning components of *irgendein* are the same as those of *ein*, with the FC morpheme *irgend* merely signaling that alternatives are not subject to relevance. Accordingly, a simple sentence like (20a), in a non modal context, will have the meaning components in (20b-d), which we keep representing as conjunctions and disjunctions of a's and b's assuming a fixed quantificational domain with two individuals a and b.

(20) a. ??Er heiratet irgendeinen Arzt

He marries eirgendein doctor

b. BM: $\exists x \in D[\text{doctor}(x) \wedge \text{marry}(\text{he}, x)] \approx (a \vee b)$,

under the assumption that $D = \{a, b\}$

c. SA: $a \wedge b$

d. DA: $\{a, b\}$

The exhaustification of the alternatives in (20c-d) leads to contradiction (as we saw in (12) above). And in the case at hand we do not have the option of considering subsets of the alternatives irrelevant. Hence the sentence in (20a) always comes out as contradictory, which explains its deviance in an 'out of the blue' context.

On the other hand, in presence of a modal, the exhaustification mechanism we have set in place yields a coherent meaning with an (obligatory) FC implicature tacked on:

(21) a. Er muss/darft irgendeinen Arzt heiraten

He must/can irgendein doctor marry

'He must/can marry a doctor, any doctor.'

b. $O_{Exh\text{-}DA\cup SA}(\Box(a \vee b)) = \Box(a \vee b) \wedge \Diamond b \wedge \Diamond a \wedge \neg\Box(a \wedge b)$

c. $O_{Exh\text{-}DA\cup SA}(\Diamond(a \vee b)) = \Diamond b \wedge \Diamond a \wedge \neg\Diamond(a \wedge b)$

So in particular, (21a) comes out with (21b-c) as its only reading, which states that obligation/permission is being issued to marry any doctor whatsoever (and no more than one).[8] We believe that this approach extends to other kinds of 'Epistemic Indefinites', even though we cannot pursue how this may happen here.[9]

An advantage of the present approach is that it predicts that the FC reading will tend to disappear in negative (or more broadly, Downward Entailing (DE)) contexts, regardless of the presence of a modal. This can be seen through an example of the following sort:

(22) a. Niemand hat irgendein Buch mitgebracht

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[8] The exclusiveness clause that comes for the SA is not always present in FC contexts (e.g. "you may do problem set A or problem set B" does not necessarily amount to a prohibition of doing both). In the context of morphologically marked FCIs this optionality can not be accounted for in terms of the optionality of SAs. However, it turns out that there are various ways of weakening Scalar Implicatures in presence of a modal (and only in presence of a modal). For example, one might factor in the DAs and SAs separately as follows:

(a) $O_{Exh\text{-}D}(\Diamond O_{SA}(a \vee b)) = \Diamond[(a \vee b) \wedge \neg(a \wedge b)] \wedge \Diamond a \wedge \Diamond b$

For discussion of this issue, see Fox (2007) and Chierchia (2012a,b).

[9] Epistemic Indefinites include items like French *un quelconque* (Jayez and Tovena 2005), Spanish *algun* (Alonso Ovalle and Menendes Benito 2010), Rumanian *vreun* (Falaus 2009). See also Aloni and Port (2011). For a discussion of such items within the present framework, cf. Chierchia (2012a,b).

Nobody has irgendein book along brought

'Nobody brought any book along'

b. BM: $\neg\exists x\in D'[\text{person}(x) \wedge \exists x\in D[\text{book}(x) \wedge \text{bring along}(\text{he}, x)] \approx \neg(a \vee b)$

where $D = \{a, b\}$

c. SA: $\neg(a \wedge b)$

d. DA: $\{\neg a, \neg b\}$

The point here is simply that in a DE context such as (22a) the assertion (22b) entails all of its alternatives (i.e. any member of (22c-d)). Therefore exhaustification of this set of alternatives is vacuous and returns the plain assertion, in which the indefinite *irgendein* comes out as an existential with narrow scope under negation (i.e. a typical NPI-meaning).

As it turns out, the acceptability of FCIs in seemingly non modal environments varies significantly across contexts, type of items, and languages. Thus, for example, a sentence like (23a), which has no overt modal, is acceptable and it indicates that the agent was indifferent to the choice of doors; sentence (23b) is acceptable and it indicates that the speaker is ignorant as to the identity of the caller.

(23) a. John ist hinausgelaufen un hat an irgendeine Tuer geklopft

John ran out and knocked at a door. For all John cared, he might have knocked at any door. [The agent didn't care which door to knock at]

b. Irgendein Student hat angerufen

Irgend-a student has called

Some student called. For all the speaker knows, it might be any student.

[The speaker is ignorant as to the identity of the caller]

The Italian counterpart of German *irgendein*, namely *uno qualsiasi*, seems to allow basically only 'agent-indifference' readings, as the Italian counterpart of (23a) is grammatical, while the Italian counterpart of (23b) is marginal:

(24) a. John e' corso fuori ed ha bussato ad una porta qualsiasi

John AUX ran out and AUX knocked a door qualisasis

b. ??Uno studente qualsiasi ha telefonato

A student qualsiasi AUX called

These examples can be accounted for under the assumption that languages have a null assertoric universal modal compatible with a variety of modal bases, a proposal explicitly put forth in Kratzer and Shimoyama (2002). Different types of FCIs select for specific modal bases. Italian *uno qualsiasi* goes for a bouletic modal base, while German *irgendein* is equally happy with a bouletic and an epistemic one. According to this hypothesis, the interpretation of something like (23a) or (24a) can be represented as follows:

(25) a. $O_{Exh\text{-}DA \cup SA}\ \Box_A$ John knocked at a door$_D$

b. (It is known that) John knocked at a door and

For all the agent cared, it could have been any door =

$\Diamond_A$John knocked on $a_1 \wedge \Diamond_A$John knocked on $a_2 \wedge \ldots$, for any door $a_i \in D$.

where the modal base for '$\Diamond_A$' is the set of worlds compatible with the agent's desires/intentions

The component in (25b) is the signature of freedom of choice. If the context is incompatible with either a bouletic or an epistemic modal base, the result is doomed to

being substandard (as the sentence comes out as contradictory). The following (from Chierchia 2012a) is a case in point:

(26) a. John cheated. Therefore, a student in your class is a cheater.

b. John hat geschummelt. *Deshalb ist irgendein Student aus deiner Klasse ein Betrueger.

The second sentence in (26b) is clearly incompatible with agent-indifference (as it is not an agentive sentence) and with speaker-ignorance (as the context rules it out), whence its deviance.

Even if there are many issues that we are unable to address properly here, the sketch above should suffice to give a sense of how our approach to scalar and Free Choice implicatures naturally extends from plain scalar items to morphologically marked indefinites and accounts for both their similarities and their differences through a minimal change: whether their SAs and DAs can be ignored (as subject to relevance) or not.[10] For those who find our assumptions troublesome, the question becomes whether it is possible to provide a comparatively simple account of such a wide range of phenomena without such assumptions.

3. The place of wh-expressions within a typology of indefinites.

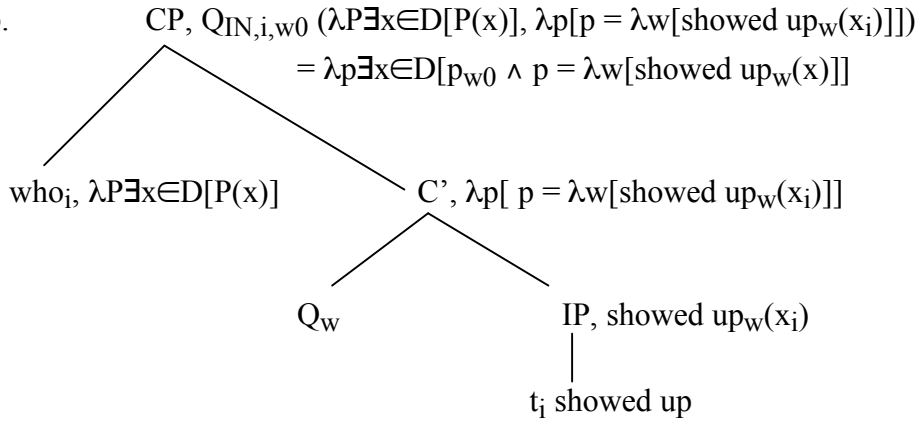
Our purpose for the present section is two-fold. On the one hand, we want to see how we can handle both wh-words and polarity sensitive items as part of the same system. On the other hand, we want to make formally explicit the requirement that active alternatives

[10] There is an alternative way of getting at this difference. It is in principle conceivable that also plain scalar terms have obligatory active alternatives, but they differ from morphologically marked polarity sensitive items in being more tolerant in the kind of modal bases for the null assertoric operator they are compatible with. While this line of approach is different in form from the one developed in the text, clearly the bulk of the insight would carry over. We must leave discussion of this to another occasion.

must be exhaustified. We will achieve both goals through a feature checking device in the spirit of Chomsky (1995).

The classic analysis of wh-questions developed by Karttunen (1977) involves, schematically the following steps:

(27) a. Who showed up?

b. 

c. i. $Q_w(\phi) = \lambda p\ [p = \lambda w[\phi]]$ Proto-Question (PQ) formation

ii. $Q_{IN,i,w0}(\alpha, \beta) = \lambda p[\alpha(\lambda x_i[p_{w0} \wedge \beta(p)])]$ Quantifying into PQ

where α is of type <<e,t>,t>, β is of type <<i, t>, t> and i is the type of worlds

The wh-word moves (in languages with wh-movement) into Spec CP. The interrogative Comp Q forms a Proto-Question (PQ, a set of propositions). The wh-word is then quantified into the PQ (via $Q_{IN,i,w0}(\alpha, \beta)$ = 'quantify α into β relative to the i^{th} variable in world w_0). The result is the set of propositions that constitute true answers to the question in w_0 (in the case at hand, the set of propositions true in w_0 of the form 'x showed up', for x in D). We assume that the analysis of the question corresponding to (27a) in Mandarin, is identical, modulo the fact that wh-words move after spell out in this language (a la Huang 1982). Crucial for our purposes is that wh-words are analyzed as

indefinites (with *who* having the same meaning as *a person*). What teases them apart from other indefinites is that they can be targeted by Q_{IN}, the Quantifying-in process for questions.

To provide a uniform analysis of Chinese wh-words and PSIs and account for the fact that their alternatives must obligatorily factored into meaning (unlike those of ordinary scalar terms), let us assume that all indefinites (polar and non polar, wh- and non wh-) always carry an unvalued feature complex of the form [±σ, ±wh]. The feature σ concerns SAs and DAs. A +σ indefinite has active SAs and DAs; a -σ indefinite does not. Moreover an indefinite is +wh iff it is targeted by an interrogative operator. The feature complex admits of two values '-' and '+' on each of its components. The value '+' is assigned by specific operators. The value '-' is assigned by default, if no suitable operator (in the right configuration) is present in the structure. In particular, let us stipulate that Q, the interrogative comp, assigns '+' to both wh and σ and that the exhaustifying operator O assigns value '+' just to σ. Lexical constraints on specific lexical items may rule out particular feature configurations.

Let us now see what kind of space of possibilities this feature checking apparatus may generate. Consider first plain indefinites like *a* or *some* in English. They can be characterized by the lexical constraint in (28a), which says that these words do not tolerate the value '+' on their wh-feature; such a configuration cannot be spelled out.

(28) a. *some/a[+wh]

b. Q [I saw a boy[+σ, +wh]]

c. O [I saw a boy[+σ, -wh]] IMPLICATURE

d. [I saw a boy[-σ, -wh]] NO IMPLICATURE

For each indefinite, including *some/a*, there are three logical possibilities, exemplified in (28b-c). If *a* is in the scope of an interrogative (Q_{IN}) operator, *a* will be marked with '+' on both σ and wh, resulting in the structure in (28b). However, the lexical constraint in (28a) says that *a* with such a featural configuration cannot be spelled out. Hence, (28b) is ruled out. A second possibility, is that *a* is in the scope of the exhaustifying operator O; such an operator will mark σ as plus, indicating that SAs (and possibly DAs) must be active. An implicature will ensue. The wh-feature, in such a case, gets value '-' by default. Finally, in (28d) no suitable operator is around. Hence, the feature complex can only get a '-' value across the board, via the default. This is a 'legal' featural configuration and the result is well formed. Since SAs and DAs are inactive, no implicature comes about.

Let us consider now a morphologically marked member of the PS, like *irgendein*. It can be characterized by the lexical constraint in (29):

(29) a. *irgendein[-σ]/[+wh]

b. Q [I saw irgendein boy [+σ, +wh]]

c. i. O [I saw irgendein boy[+σ, -wh]] IMPLICATURE

ii. O □[I saw igendein boy[+σ, -wh]]

d. [I saw irgendein boy[-σ, -wh]] NO IMPLICATURE

The constraint in (29a) says that *irgendein* does not ever admit (i) the value '-' on σ or (ii) the value '+' on wh. With respect to property (ii), *irgendein* is just like *ein/a*. But, given property (i), its SAs and DAs *must* always be active. This results in the following distribution. Structure (29b) is ruled out: Q obligatorily assigns value '+' across the board, which yields an illicit configuration, given (29a). The configurations in (29c) are

fine; the SAs and DAs are made active by O. The implicatures come about. They yield a contradiction in the absence of a modal (29c.i); and they yield, instead, the FC effect if a modal is present (29c.ii). Finally, structure (29d) is ruled out by the lexical constraint in (29a). Thus, our feature checking apparatus provides us with a way of formally enforcing the requirement that *irgendein* must have active alternatives, which teases it apart from *some/a*. All members of PS of the familiar sort (*any, ever, in weeks*, etc.) have perhaps a similar featural make up, their differences stemming from constraints on types of alternatives and/or exhaustification modes (cf. on section 4).

Consider next, English wh-words. Quite clearly, they must be subject to the following lexical constraint in (30a):

(30) a. *who[-wh]

b. Q [who[+σ, +wh] did you see t]

c. O [I saw who[+σ, -wh]]

d. [I saw who[-σ, -wh]]

The configurations in (30c-d) are ruled out, because in absence of an interrogative operator, there is no way for *who* to have its wh-feature set to a legal value. In (30b), *who* is in the local scope of the interrogative Q_{IN} operator (and it moves, as required by the syntax of English). The semantics for this structure is as in (27) above. The alternatives associated with (30b) are:

(31)

DAs	SAs
{∃x∈D[saw(you, x)],	∀x∈D[saw(you, x)],
∃x∈D'[saw(you, x)],	∀x∈D'[saw(you, x)] ,
….}	

The question that arises in this connection is how such a set of alternatives may be factored into the meaning of the corresponding question. A simple hypothesis that comes to mind is that the role of such alternatives might be just that of spelling out the presupposition of the question. Namely, a question is felicitous whenever the speaker is unopinionated as to which members of the alternatives to the question are true.

This presupposition can be readily built into the meaning of the question forming operator $Q_{IN,i,w0}$ (by making $Q_{IN,i,w0}$ (ϕ) defined only if the presupposition associated with its alternative set is satisfied) thereby fulfilling the requirement that the alternatives of a PSI are never to be left idle. [11]

We now finally come to wh-words in Mandarin. The natural conjecture is that their lexical make up is as follows:

(32) a. *shenme[-σ]

b. Q [you saw shenme boy[+σ, +wh]]

c. i. O [I saw shenme boy[+σ, -wh]] IMPLICATURE

ii. O □[I saw shenme boy[+σ, -wh]]

d. [I saw shenme boy[-σ, -wh]]

Chinese wh-words simply disallow the '-' value on σ. It then follows, that they will be grammatical in the scope of an interrogative operator (32b), where they will be interpreted just like their English counterparts. They will also be well formed in the local scope of an exhaustifying operator O, as in (32c). In such a configuration, the FC implicature comes about. If there is a suitable modal operator, the result will be

[11] For a way more sophisticated way of dealing with the SAs and DAs of questions, see Mayr (2010, 2011).

semantically coherent (32c.ii). Their interpretation is expected to be wholly analogous to that of *irgendein*, or some similar member of the PS family.[12] In absence of a modal, the FC implicature will generate a contradiction. Hence, (32c.i), though syntactically well formed will be nonetheless ungrammatical. This is the reason why Chinese wh-words cannot have the non-interrogative indefinite reading in simple positive episodic sentences like *Zhangsan chi-le sheme 'Zhangsan* eat-PERF what'. Finally, if there isn't either Q or O in the local environment of *shenme*, as in (32d), we get something that violates the lexical constraint on (32a) (namely [-σ, -wh]). Hence, Chinese wh-items cannot be used as plain indefinites.

This approach to wh-words and exhaustification makes a strong prediction concerning locality. A feature checking operator will be able to only assign a value to its closest targets (the closest bearer of the relevant feature in its C-command domain). Conversely, an item whose features are in need of a value will only be able to be checked

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[12] As pointed out in Liao (2011), a Chinese wh-indefinite does work like *irgendein* to express FC implicatures (i.e. universal distribution across possible worlds) in the scope of a modal. For example, its use in (a) signals Zhangsan's freedom of choice for fruit-buying. And its use in (b) indicates the speaker's ignorance so that the specification of the thing eaten is disallowed. Furthermore like *irgendein*, a Chinese wh-indefinite somehow can appear in positive episodic sentences, as in (c). But note that this is allowed only when some sort of modal meaning is conveyed. For instance in the current case, (c) conveys that Zhangsan was indifferent in fruit choices.

(a) Zhangsan keyi mai-dian shenme shuiguo
Zhangsan can buy-CL what fruit
'Zhangsan can buy a little bit of fruits.'

(b) Zhangsan keneng yijing chi-le shenme dongxi, (#jiushi baozi)
Zhangsan may already eat-PERF what thing, (#namely bun)
'Zhangsan may have eaten something, (#namely a bun).' (Liao 2011, 9)

(c) Zhangsan zai lu-shang mai-le he shenme shuiguo jiu gan-lai-le
Zhangsan on road-on buy-PERF box what fruit then hurry-come-PERF
'Zhangsan bought a box of fruit at random on his way to this place and then hurried here.' (Liao 2011, 80)

by the closest C-commanding operator. This type of constraints is widely studied under the rubric of 'minimality' (Rizzi 1990, 2004) and 'intervention effects' (e.g., Beck and Kim (1997), Mayr (2010, 2011)). We believe that the present approach has the potential for bringing under the same umbrella a wide range of such effects that have so far resisted a truly unitary analysis. Unfortunately we can't pursue this within the limits of the present work, but we will illustrate it with some simple examples in section 4.

We are aware of the fact that we may be raising as many (perhaps new?) questions as we are trying to address. For example, what is the range of the constraints on specific lexical items one can expect a lexical item to bear? Can there be a *[+σ] lexical item (like there are *[+wh] lexical items)?[13] Can there be a lexical item that puts *no* constraint whatsoever on [±σ, ±wh] at all?[14] Does our feature system potentially cover all and only the attested options in the realm of indefinites? For the time being, we have to leave these questions open.

4. Elements of variation in the Polarity System.

We have now a broad picture of how plain indefinites (like *a/ein*), polarity sensitive indefinites (like *irgendein*) and wh-indefinites (like *who/shenme*) can be viewed as part of a unitary system, in which they are endowed with the same truth conditional meaning and the same set of alternatives. But the variability within such a system is significant. In

[13] We currently think no. Such an item would be an indefinite that never activates SAs or DAs, i.e. an indefinite without implicatures. The most economical way of handling such a creature, if attested, would be in terms of the *absence* of the feature complex [±σ, ±wh].
[14] We currently think yes. Such an item could be freely used as a plain indefinite or as an interrogative. Indefinites in Yukatec Maya described and analyzed by AnderBois (2011) prima facie fit exactly this bill.

particular within the Polarity System we find that variation may affect the following dimentions:

(33) a. Emphasis/focus

Some NPIs carry emphasis or focus (Hindi *ek bhii* and minimizers like *give a damn*); some NPIs do not (*any*)

b. Strength

Weak NPIs are generally acceptable in all DE contexts (*any*/*ever*); others are restricted to Anti Additive ones (*in weeks, punctual until*)[15]

c. Freedom of Choice

Some NPIs have FC uses (*any*); others do not (*ever*)

d. Degree of Freedom of Choices

Some elements (like the *qualsiasi* series in Italian) require total variation across the relevant modal space; other elements (like *algun* in Alonso Ovalle and Menendes Benito 2011) are compatible with, or may require (like *vreun* in Falaus 2009) partial variation

e. Quantificational strength:

Some NPI are typically construed universally (*any*), others existentially (*irgendein*)

We should try to give some sense of how this prima facie bewildering range of variation can be conceptualized within the framework we are exploring, as a preliminary to identify with greater precision the space where Chinese wh items may be dwelling.

[15] A function F is Anti Additive iff $F(A \cup B) \Leftrightarrow F(A) \cap F(B)$. The terminology and generalization is taken from Zwarts 1996.

We do so by sketching how pure NPIs (of both the weak and the strong variety) may be handled.

Given our alternative-and-exhaustification take, our options in dealing with variation are fairly limited. Variation in the PS can only come from one of two sources: (i) lexical restrictions to natural sub-classes of alternatives (ii) natural choices in the modes of exhaustification. Weak vs. strong NPIs give us a chance at illustrating both. As schematically recalled in (33b), the key feature of a weak NPI like *ever* is that it is basically acceptable in DE contexts but not in the typical FC ones. We illustrate this by considering *ever* and *any* in parallel:

(34) a. i. John hasn't smoked anything.

ii. John hasn't ever smoked.

b. i. If John has smoked anything, we will find out.

ii. If John has ever smoked, we will find out.

c. i. You may smoke anything.

ii. *You may ever smoke.

In our system, FC effects (such as those in (34c.i) stem from the possibility of pre-exhaustifying alternatives (in particular, DAs). This option, evidently, is not available for pure weak NPIs like *ever*. This means that *ever* must be lexically restricted to scalar and *un*exhaustified domain alternatives. To illustrate, let us analyze *ever* as an indefinite with the same meaning as *sometimes*. Qua indefinite, *ever* activates SAs and DAs (ranging over time intervals). However, unlike what happens with FCIs, pre-exhaustification of

alternatives is ruled out. If this is correct, a sentence like (34c.ii) is bound to come out as contradictory. Its meaning components come out as follows:

(35) a. BM: $\Diamond\exists t\in D[\text{smoke}(\text{you}, t)] \approx \Diamond(t1 \vee t2)$,

where D = {t1, t2} and *smoke(you, t)* = 'you smoke at t'

b. SA: $\Diamond(t1 \wedge t2)$

c. DAs: $\{\Diamond t1, \Diamond t2\}$, where t1 = *you smoke at t1* and t2 = *you smoke at t2*

As noted above, exhaustification with respect to this set yields a contradiction. It is only resorting to pre-exhaustified DAs that offers a way around such contradiction and induces the FC reading; but this option is not available for NPIs like *ever*.[16]

Interestingly, the lexical ban on incompatible alternatives has no effect on DE contexts. Consider in this connection (34a.ii) above. Its meaning components are as shown in (36):

(36) a. BM: $\neg\exists t\in D[\text{smoke}(\text{John}, t)] \approx \neg(t1 \vee t2)$

b. SA: $\neg(t1 \wedge t2)$

c. DA: $\{\neg t1, \neg t2\}$

Here the lexical constraint on *ever*'s alternatives is respected. And exhaustification with respect to this set works fine, since the assertion entails all of its alternatives. Hence, (34a.ii) is predicted to be grammatical, with the meaning that there is no time at which

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[16] Note that the propositions in Exh-DA, given in (a) below, are mutually incompatible with one another (while those in DA are mutually compatible – cf. (35c)).
(a) Exh-DA: $\{O\Diamond t1, O\Diamond t2\} = \{(\Diamond t1 \wedge \neg\Diamond t2), (\Diamond t2 \wedge \neg\Diamond t1)\}$
So, we may assume that as part of its lexical presuppositions, *ever* includes a ban against incompatible alternatives. The minute the alternatives to *ever* become mutually inconsistent, we get a presupposition failure. In this way, the option of resorting to pre-exhaustified DAs becomes unavailable and sentence (34c.ii) is doomed. Space prevents us from getting in a full blown formalization of this requirement. There are, in principle several ways to go.

John smoked. This approach, based on general logical properties of alternative sets, can be used to characterize the behavior of weak NPIs in full. Weak NPIs like *ever* are thereby restricted to just DE contexts, thanks to a minimal parametric switch in their lexical meaning with respect to FCIs (a ban on mutually incompatible, i.e. pre-exhaustified, DAs).

Let us turn now to Strong NPIs (SNPIs), which serve well the purpose of showing how variation may come from the choice of exhaustification mode. The main characteristics of SNPIs is that they are restricted to 'strongly negative' environment, as the following paradigm illustrates:

(37) a. i. I haven't ever seen Mary.

ii. I haven't seen Mary in weeks.

b. i. Few students ever spoke during class.

ii. *Few students spoke in weeks.

c. i. If you ever see Mary, you'll like her.

ii. *If you see Mary in weeks, you'll like her.

d. i. Everyone who ever saw Mary liked her.

ii. *Everyone who saw Mary in weeks liked her.

Without entering the merit of Anti Additivity as a predictor of this behavior, we go directly to our proposal, taken from Chierchia (2012b), who in turn builds on the insight of Gajewski's (2011). In informal terms, the basic idea is that while NPIs are generally sensitive to truth conditional content of sentences, SNPIs are sensitive to their *enriched* meaning: truth conditional content plus implicatures plus presuppositions. Sentence (37a.i), which involves negation, has no implicature or presupposition. On the other hand,

sentence (37b.i) does: it implicates that some number of students (one or more) did speak up during class. If we integrate the implicature into the truth conditional component of (37b.i) (as in *less than 5 students spoke during class but some did*), the result is no longer DE. Hence exhaustification fails. While *ever* ignores the presuppositional/implicature component of its environment, *in weeks* cannot. This explains the latter's narrower distribution.

Weak exhaustification (O^W) and strong exhaustification (O^S) differ formally in two ways. First, weak exhaustification can exhaustify DAs and SAs in separate steps, while strong exhaustification must consider DAs and SAs together. Second, weak exhaustification only looks at the assertive component of a proposition, while strong exhaustification looks at the presupposition and the assertive component together. We illustrate this idea by looking first at (37b) – for the implicature part, then at (37c) – for the presupposition part.

In considering (37b) we assume that *few* is interpreted as *less than n* for some contextually specified n. The LFs of (37b.i-ii) are respectively as follows:

(38) a. $O^W_{SA}\ O^W_{DA}$ (less than n $\text{students}_{D[\sigma]}$ $\text{ever}_{D[\sigma]}$ spoke)

b. $O^S_{DA \cup SA}$ (less than n $\text{students}_{D[\sigma]}$ spoke in $\text{weeks}_{D[\sigma]}$)

In (38), for the NPIs *ever/in weeks* to stand a chance, exhaustification must take place at the root level (i.e. above the DE subject noun phrase). But the subject, being a scalar noun phrase, is itself a carrier of the relevant feature complex. Consequently, because of minimality, the DAs and SAs associated with the subject become active. O must target the closest bearer of the relevant feature (and can then proceed onto further bearers in a

'multiple agree' fashion). As it turns out, when scalar DPs activate their alternatives in the configuration in (38), they bring in a deadly effect for strong exhaustification but not for weak exhaustification. To see this, consider first (38a), which involves weak exhaustification. *Less than n students$_{D1}$ ever$_{D2}$ spoke* entails *less than n students$_{D1'}$ ever$_{D2'}$* spoke, whenever D1' $\subseteq$ D1 and D2' $\subseteq$ D2. Hence all DAs are entailed by the assertion and the first exhaustification in (38a) has no effect. Then the second exhaustification, which just considers the scalar alternatives, unproblematically adds the scalar implicature 'but some student did speak'.

Strong exhaustification, on the other hand, encounters a problem, which can be schematically illustrated by the following specific:

(39) $O_{SA \cup DA}$ [less than 2 students$_{\{a,b\}}$ spoke at $t_{\{t1, t2\}}$]

The alternatives to (39) must be all of the propositions of the form *DP$_D$ spoke at D',* for any DP$_{D1'}$ and D2' such that DP is a scalar alternative to *less than 2*, D1' is a subdomain of {a, b}, and D2' is a subdomain to {t1, t2}. Among such alternatives, we will have:

(40) a. No student$_{\{a, b\}}$ spoke at $t_{\{t1, t2\}}$

b. No student$_{\{a\}}$ spoke at $t_{\{t1, t2\}}$

c. No student$_{\{b\}}$ spoke at $t_{\{t1, t2\}}$

None of (40a-c) is entailed by the assertion. Therefore they must be eliminated. This gives us that both a and b must speak, which contradicts the assertion.[17] Therefore strong

[17] We are assuming that "no student" is an alternative to *less than* n; the same result would obtain if we consider alternatives of the form *less than m*. If, on the other hand,

exhaustification in general runs into a semantic problem in non end of scale DE environments.

Turning now to the presuppositional case, namely (37c), we will now show how such a case crashes once presuppositions are factored in. To show this, we adopt von Fintel's (2001) semantics for conditionals, which we give here in simplified form:

(41) a. Let M be a function from contexts c into sets of worlds M_c (a contextually salient modal base).

b. $\| p \Rightarrow q \|^c$ is defined iff $\exists w \in M_c \, \|p_w\|^c = 1$. Whenever defined, $\| p \Rightarrow q \|^c = 1$ iff $\forall w \in M_c \, [\|p_w\|^c = 1 \rightarrow \|q_w\|^c = 1]$.

On the basis of this analysis, the semantic components of (37c.ii) come out as illustrated below (for simplicity, we ignore SAs, as they are of no import on the outcome in the present context):

(42) a. If you see Mary in weeks, you'll like her

b. Enriched Meaning:

$[\exists w \in M_c \, \exists t \in \text{WEEKS} \, [\text{see}_w(\text{you}, t)] \wedge \forall w \in M_c \, [\exists t \in \text{WEEKS} \, \text{see}_w(\text{you}, t) \rightarrow p_w]$

where:

$t \in$ WEEKS = t is an interval at least weeks long

see_w = x sees Mary in w within t,

p_w = you like Mary in w.

c. DAs:

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less than n is presuppositional (along the lines discussed by Gajewsky 2011), then this case would fall under the purview of the case considered next.

$\{\exists w \in M_c \exists t \in D[see_w(you, t)] \wedge \forall w \in M_c[\exists t \in D\ see_w(you, t) \rightarrow p_w]: D \subseteq WEEKS\}$

The exhaustification of (42b) relative to the alternatives in (42c) is a contradiction. None of the alternatives is entailed by the assertion. Hence, they all have to be denied. But then (42a) winds up requiring that a meeting of Mary take place within a period t which is at least weeks long, without some member of the alternative set also being true, i.e. without there being some interval t' which is at least D-long (where D is less than weeks long) within which the meeting of Mary takes place.

We can summarize our proposal on strong NPIs as follows. Weak exhaustification can look at DAs and SAs in sequential steps and it ignores the presuppositional component. Strong exhaustification must look at both DAs and SAs and at the presuppositional component in one fell swoop. This explains in an arguably principled way the different distributional properties of strong vs. weak NPIs.

Summing up what we have done so far, we have the makings of a (much simplified) calculus of Polarity Items, where the latter are indefinites with obligatorily active SAs and DAs. Such a calculus can be schematically presented as in the following table:

(43) A calculus of PSIs

Mode of exhaustification	Alternatives	Type of Polarity Sensitive Item
O^W	DA/SA	Weak NPIs: *ever*
O^W	Exh-DA/SA	NP/FCIs: *irgendein*
O^S	DA ∪ SA	Strong NPIs: *in weeks*
O^S	Exh-DA ∪ SA	Strong NP/FCIs: ???

As can be seen, our calculus leaves it open whether there can be items that require strong exhaustification and also allow for pre-exhaustified DAs. We think that this slot is in fact the one occupied by Chinese wh-items. To this we now turn.

5. Deriving the behavior of Chinese wh-indefinites.

The approach developed in section 3 enables us to view wh-words and polarity items as components of the same system keyed to the feature complex [±wh, ±σ]. Our hypothesis is that Chinese wh-items can be checked by the question forming operator Q and the exhaustifying operator O. The former (Q) assigns values [+wh, +σ] to Chinese wh-items and determines their interrogative uses; the latter (O) assigns values [-wh, +σ] and determines their polar uses. However, the distribution of such polar uses is different from those we have encountered in section 2. Chinese wh-words are fine under modals (overt or, sometimes, covert), where they act as epistemic or FC indefinites; they are also fine under negation and in the antecedent of conditionals. They are, however, ungrammatical in the restriction of universal terms and in the scope of 'Strawson-DE' elements (cf. von Fintel 1999) like *surprise*, as shown below.

(44) Zhangsan haoxiang chi-le shenme

Zhangsan seem eat-PFV what

'Zhangsan may have eaten something.'

(45) Zhangsan mei chi shenme dongxi

Zhangsan not eat what thing

'Zhangsan didn't eat anything.'

(46) Ruguo ta gen shenme laoshi miantan-le, ta yinggai yijing dedao-le bu-cuo de jianyi

If he with what teacher meet-PFV, he should already get-PFV not-bad of advice

'If he met with a teacher, he should have already gotten nice suggestions.'

(47) *Meige gen shenme laoshi miantan de xuesheng dou dedao-le bu-cuo de jianyi[18]

Every with what teacher meet of student DOU get-PFV not-bad of suggestion

Intended: 'Every student who met with a teacher got good suggestions.'

(48) *Wo hen jingya ta chi shenme shucai

I very surprised he eat what vegetable

'I am surprised that he eats any vegetables.' (Lin 1998, 229)

We conjecture that this behavior follows under the assumption that Chinese wh-words must be exhaustified by O^S and allow, furthermore, for pre-exhaustified domain alternatives. If this conjecture is right, we would have the missing link in table (43) above, predicted by our calculus of Polarity Sensitive Items. In the following subsections we provide our evidence for thinking that our conjecture might be well founded.

5.1. Chinese wh-elements as Strong NP/FC items.

Let us begin with a quick remark about what happens to Chinese wh-items in negative non AA environment like *few* or *less than n*, where they are going to be ruled out on a par with Strong NPIs. Non end of scale DE environments, such as *less than n*, generate positive implicatures that disrupt the strictly DE environments required by Chinese wh-indefinites. Here is an illustration:

(49)??Zhe-ge ban-shang, mei-you shi-ge ren zai kan sheme shu

This-cl class-on, not-have ten-cl person prog see what book

[18] Chinese wh-indefinites are claimed to be good in restriction of universal quantifiers in Kuo (2003). However according to several native speakers we consulted, sentence (47) and sentences presented in Kuo (2003), such as (a) below, were not acceptable.

(a) you shenme ren xihuan de mei yi-ben shu Zhangsan dou bu hui mai

have what people like DE every one-CL book Zhangsan DOU not will buy

'Every book that somebody/anybody likes, Zhangsan will not buy.' (p. 31)

'In this classroom, less than 10 people are reading some books.'

Among the alternatives to (49) some will have the form in (50).

(50) a. no student$_{\{s1-s25\}}$ read some book$_{\{b1, b2\}}$

b. no student$_{\{s1\}}$ read some book$_{\{b1, b2\}}$

c. no student$_{\{s2\}}$ read some book$_{\{b1, b2\}}$

We are assuming here a domain with 25 students and two books. None of the alternative of the form in (50) are entailed. They must all be denied. This contradicts the assertion. Consideration of pre-exhaustified domain doesn't change anything in this connection.[19] So the behavior of Chinese wh-items under negation (as SNPIs) follows from our conjecture.

Let us now turn to the behavior of *shenme* as epistemic indefinites illustrated by (44). Here is what we get. The Logical Form of (44) must be as follows:

(51) a. $O_{Exh\text{-}DA\cup SA}$ (may Zhangsan eat what)

b. BM: $\Diamond(p \vee q)$

In this example we are treating the modal element *haoxiang* (lit. 'seem') as an epistemic modal of possibility. But nothing hinges on the detail of such choice (in particular,

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[19] Because pre-exaustified alternatives to (50a) would have the form in (a) and their negation the form in (b):

(a) O [no student$_{\{s1-s24\}}$ read some book$_{\{b1, b2\}}$] =

no student$_{\{s1-s24\}}$ read some book$_{\{b1, b2\}}$ $\wedge \neg$ no student$_{\{s25\}}$ read some book$_{\{b1, b2\}}$

(b) $\neg$O [no student$_{\{s1-s24\}}$ read some book$_{\{b1, b2\}}$] =

$\neg$no student$_{\{s1-s24\}}$ read some book$_{\{b1, b2\}}$ $\rightarrow$ no student$_{\{s25\}}$ read some book$_{\{b1, b2\}}$

implicatures such as those in (b) lead to the same overall effect as the non pre-exhaustified ones.

nothing would change if *haoxiang* is analyzed as a necessity operator). Assuming a domain with just two edible things (p = Zhangsan eats a and q = Zhangsan eats b), the basic meaning of (51a) is (51b). Use of $O_{Exh\text{-}DA\cup SA}$ requires exhaustifying BM in one step relative to its SAs and to the exhaustified DAs. This alternative set can be schematically represented as follows:

(52) a. SA: $\Diamond(p \wedge q), \Box(p \wedge q), \Box(p \vee q)$

b. Exh-DA:

i. $O(\Diamond p) = \Diamond p \wedge \neg\Diamond q$

ii. $O(\Diamond q) = \Diamond q \wedge \neg\Diamond p$

None of these alternatives is entailed by the assertion. Hence they must all be false yielding (after standard logical simplifications):

(53) $O_{Exh\text{-}DA\cup SA}(\Diamond(p \vee q)) = \Diamond p \wedge \Diamond q \wedge \neg\Box(p \vee q) \wedge \neg\Diamond(p \wedge q)$

This yields a coherent result. A model that satisfies formula (53) might look as follows:

(54) A verifying model:

W1 p, ¬q

W2 q, ¬p

W3 ¬p, ¬q

Thus sentences like (44) are expected to be grammatical and to yield a FC effect pretty typical of epistemic indefinites.

Our results, so far, simply replicate our treatment of NP/FCIs like German *irgendein* (with the extra limitation to strongly negative environments). More interesting is perhaps to see that use of strong exhaustification predicts Chinese wh-items to be OK in the antecedent of conditionals, for we saw that strong NPIs are bad in such environments.

But the point is that pre-exhaustified DAs rescue Chinese wh-words in such cases. We illustrate this by analyzing sentence (46) above, repeated here as (55):

(55) Ruguo ta gen shenme laoshi miantan-le, ta yinggai yijing dedao-le bu-cuo de jianyi
If he with what teacher meet-PFV, he should already get-PFV not-bad of advice
'If he met with a teacher, he should have already gotten nice suggestions.'

As discussed in section 4, a conditional carries an existential presupposition. The presupposition requires that there be at least one world in the relevant modal base where the antecedent clause is true. With such a presupposition, the enriched meaning of (55) is as in (56). Its SAs and Exh-DAs are as in (56b) and (56c).

(56) a. Enriched meaning of (55):

$\exists w \in M_c$ [a ∨ b in w] ∧ $\forall w \in M_c$ [a ∨ b in w → q_w]

under the assumption that D = {a, b},

and where:

(a ∨ b) in w ≈ $\exists x \in D$ [met_w(he, x)]

q_w = he should have already gotten nice suggestions in w

b. SA: $\exists w \in M_c$ [a ∧ b in w] ∧ $\forall w \in M_c$ [a ∧ b in w → q_w]

c. Exh-DA:

i. O(a) = ($\exists w \in M_c$ [a in w] ∧ $\forall w \in M_c$ [a in w → q_w]) ∧ ¬($\exists w \in M_c$ [b in w] ∧ $\forall w \in M_c$ [b in w → q_w])

ii. O(b) = ($\exists w \in M_c$ [b in w] ∧ $\forall w \in M_c$ [b in w → q_w]) ∧ ¬($\exists w \in M_c$ [a in w] ∧ $\forall w \in M_c$ [a in w → q_w]

When we exhaustify (56a) relative to the whole of SA∪Exh-DA, we derive (57).

(57) $O_{Exh\text{-}DA \cup SA}$(56a)

= (56a) ∧ ¬(56b) ∧ ¬(56c.i) ∧ ¬(56c.ii)

= ($\exists w \in M_c$ [a ∨ b in w] ∧ $\forall w \in M_c$ [a ∨ b in w → q_w])

∧ ¬($\exists w \in M_c$ [a ∧ b in w] ∧ $\forall w \in M_c$ [a ∧ b in w → q_w]) Scalar implicature

∧ ($\exists w \in M_c$ [a in w] ∧ $\forall w \in M_c$ [a in w → q_w]) ↔ ($\exists w \in M_c$ [b in w]

∧ $\forall w \in M_c$ [b in w → q_w]) FC implicature

= ($\exists w \in M_c$ [a ∨ b in w] ∧ $\forall w \in M_c$ [a ∨ b in w → q_w]) ∧ ¬$\exists w \in M_c$ [a ∧ b in w]

∧ ($\exists w \in M_c$ [a in w] ↔ $\exists w \in M_c$ [b in w])[20]

The result is both coherent and a sensible rendering of the meaning. A verifying model is provided in (58), where he met a only in world 1, and b only in world 2, and q (= he should have already gotten nice suggestions) is true in world 1 and 2.

(58) A verifying model

W1 he met a; q

W2 he met b; q

The above example reveals an interesting interaction between types of alternatives and modes of exhaustification. Chinese wh-indefinites, with exhaustified alternatives, turn out to be good in antecedents of conditionals, even with strong exhaustification. In contrast with Chinese wh-items, strong NPIs do not activate pre-exhaustified alternatives,

[20] The last equivalence in (57) is obtained because $\forall w \in M_c$ [a ∧ b in w → q_w], $\forall w \in M_c$ [a in w → q_w], and $\forall w \in M_c$ [a in w → q_w] are all entailed by $\forall w \in M_c$ [a ∨ b in w → q_w]. They can therefore be taken out from the formula without any meaning change.

and this eventually leads to a contradiction in the final meaning, as discussed for (37c.ii) in section 4.

5.2. Two cases of intervention.

So far we have derived the observation that Chinese wh-items are grammatical under sentential negation, under modals and in the antecedent of conditionals. We now need to show why they are ungrammatical in the scope of presuppositional verbs like *surprise* and in the restriction of a universal quantifier. We will do so only in general terms, referring our readers to the Appendix for a more explicit computation of some of the relevant results. Our point is that these two cases are ruled out because the presuppositions and/or scalar implicatures associated with verbs like *surprise* and the quantifier *every* produce an intervention effect. In the case of presuppositional verbs, the context is no longer DE once presuppositions are factored in; in the case of *every*, we get an extremely strong FC effect that clashes with the scalar implicature.

Consider first adversative factive predicates like *surprise*. Take (48) as an example, repeated here as (59a).

(59) a. *Wo hen jingya ta chi shenme shucai

I very surprised he eat what vegetable

'I am surprised that he eats any vegetables.'

b. λpλx: p. ¬expect(x,p)

According to (a simplified version of) von Fintel's (1999) analysis, *surprise* presupposes the truth of its complement and asserts that the subject did not expect the complement to hold (59b). If Chinese wh-words are exhaustified via O^S, the components to be considered are:

(60) Enriched meaning:

$\exists x \in \{a, b\}[eat(he, x)] \wedge \neg expect(I, \exists x \in \{a, b\}[eat(he, x)])$

under the assumption that *shenme shucai* 'what vegetable' takes

$D = \{a, b\}$ as its quantificational domain.

Now, it is enough to observe that the first conjunct in (60), i.e. the presuppositional component, is a plain, unmodalized proposition. Exhaustification of this component will inexorably yield a contradiction, as we have seen above. This suffices to rule out this case (and all those with the same structure).

Turning to the restriction of *every*, the relevant example has the structure in (47), repeated below:

(61) *Meige gen shenme laoshi miantan de xuesheng dou dedao-le bu-cuo de jianyi

Every with what teacher meet of student DOU get-PFV not-bad of suggestion

Intended: 'Every student who met with a teacher got good suggestions.'

Let us try to egive a sense of what might be going wrong with such a sentence. In (62) we provide the Logical Form of (61) according to our hypothesis (using the English gloss as representative of the actual Chinese sentence):

(62) $O^S_{Exh\text{-}DA \cup SA}$[every student$_{D1[+\sigma]}$ who met with what teacher$_{D2[+\sigma]}$ got good suggestions]

Chinese wh-words are exhaustified via O^S and admit pre-exhaustified DAs (i.e. Exh-DA). Moreover, since *every* is a scalar term in its own right, it is associated with a domain variable D1. The indefinite *what teacher* is in turn associated with its domain variable D2. Because of minimality, O^S cannot assign value '+' to the features of *what*

teacher without also assigning the same value to the feature of the intervening scalar term *every*, thereby activating its alternatives. So all the scalar and exhaustified DAs of both *every* and *what teacher* will be active. Finally, *every* has a presupposition that its restriction be non empty, presupposition which must be factored into meaning. Thus, the proposition we are dealing with will look as follows.

(63) $O^{S}_{\text{Exh-DA}\cup\text{SA}}$ [∃x∈D1[student(x) ∧ ∃y∈D2[teacher(y) ∧meet(x,y)]] Presupposition

∧ [∀x∈D1[student(x) ∧ ∃y∈D2[teacher(y) ∧meet(x,y)]] → GA(x)]] Assertion

where GA(x) = x got good advice

As it turns out, this sentence is contradictory. The use of pre-exhaustified DAs requires denying all sentences of the following form:

(64) O[∀x∈D1'[student(x) ∧ ∃y∈D2'[teacher(y) ∧meet(x,y)]] → GA(x)]

where D1' ⊆ D1 and D2' ⊆ D2

The denial of all such sentences is tantamount to saying that if the assertion is true of any subdomain of the original D1 and D2, it must also hold of any other such pair. In other words, if the strengthened meaning of the assertion is true, every student must have met every teacher and gotten good advice. However, if you look at the presuppositional component of (63), you'll notice that it contains two scalar terms (two existentials) and that among its scalar alternatives will have:

(65) ∃x∈D1[student(x) ∧ ∀y∈D2[teacher(y) ∧ meet(x,y)]]

This (partial) member of SA is not entailed by the assertion and will have to be negated. But its negation contradicts the negation of the pre-exhaustified DAs in (64).

We do not think this result (if correct) is a technical trick. The point is that conditionals and sentences with *every* have the same general logical form: they are

universal statements with a non vacuity presupposition over their restrictions. The crucial difference lies in what their restriction ranges over: worlds vs. individuals, respectively. Domains of individuals interfere with implicature calculation. Domains of worlds do not. Whence, the relevant contrast between conditionals and universals falls into place.

5. Conclusions.

Our (formally sketchy and highly incomplete) proposal follows through the consequences of a fairly widespread, though controversial, observation: plain indefinites, (many of the) Polarity Sensitive Items, and wh-words share a common trait: they are all existentials. With respect to PSIs this claim is associated with a long standing tradition that finds in the work of Kadmon and Landman (1993) and Krifka (1994), an early formally explicit expression on which our proposal builds. With respect to wh-words, the claim is associated with Karttunen's ground breaking work. We have married this tradition with the idea that indefinites activated scalar and domain alternatives, as seen through the implicatures they give rise to. On the basis of this background, our proposal comes to two main points. First, the main difference between plain indefinites and members of the wh- and PS systems is that the alternatives to the latter are not subject to relevance. They must be factored into meaning and this is responsible for their distribution. Second, a system of feature checking determines specific constraints on types of alternatives and modes of exhaustification. Such constraints are not arbitrary; they track arguably natural classes of alternatives (pre-exhaustified or not) and modes of exhaustification (sensitive to enriched meanings or not). The system of constraints we have developed lead us to expect the existence of Strong NPI/FCIs, i.e. items that alternate between FC and NPI uses, while being constrained in their distribution to 'end-

of-scale' non presuppositional environments. Chinese wh-words appear to fit this slot (down to a level of detail whereby they are expected to be good in the antecedent of conditionals but not in in the restriction of universals).

We are aware of the fact that our having done our computations many times over is no warranty that we are not missing problems. Our main point was to give some sense of why the present approach shows some promise in unveiling a strong, at times surprising uniformity behind the seemingly endless variation of the grammar of polarity sensitive indefinites.

Appendix: Wh's in the restriction of universal DPs.

In this appendix we consider in more detail example (61) above, repeated here:

(1) *Meige gen shenme laoshi miantan de xuesheng dou dedao-le bu-cuo de jianyi

Every with what teacher meet of student DOU get-PFV not-bad of suggestion

Intended: 'Every student who met with a teacher got good suggestions.'

We illustrate why this sentence is contradictory by showing what goes wrong with a finite (and small) model. We leave to the reader to check that larger models would run into the same sort of problems. The simple case we are considering is as in (2), where the domain of the universal quantification is {a, b}, and the domain for the wh-item is {c, d}. So the strengthened meaning of (1) is as in (2b).

(2) a. Suppose that $D_1 = \{a, b\}$, $D_2 = \{c, d\}$

b. Strengthened meaning:

$\exists x \in \{a, b\} \exists y \in \{c, d\} [meet(x, y)] \wedge \forall x \in \{a, b\} \exists y \in \{c, d\} [meet(x, y) \rightarrow GA(x)]$

where GA(x) = x got good advice

Under strong exhaustification, we consider DAs and SAs of all [+σ]-taking items at one step. In the current case, both *meige* 'every' and the wh-word are [+σ]-taking items. They activate their scalar and domain alternatives, and thus we get scalar alternatives of the two scalar items plus their domain variation. Let us start with the SAs.

(3) SAs of (2)

a. $\exists x \in \{a, b\} \forall y \in \{c, d\}[meet(x, y)] \wedge \forall x \in \{a, b\} \forall y \in \{c, d\}[meet(x, y) \rightarrow GA(x)]$

Every student who met every professor got good advice

b. $\exists x \in \{a, b\} \exists y \in \{c, d\}[meet(x, y) \wedge GA(x)]$ (entailed by assertion)

Some student who met some professor got good advice

c. $\exists x \in \{a, b\} \forall y \in \{c, d\}[meet(x, y) \wedge GA(x)]$

Some student who met every professor got good advice

Of the SAs, (3a) and (3c) are not entailed. Their negation tantamounts to

(4) Scalar Implicature of (2)

$\neg \exists x \in \{a, b\} \forall y \in \{c, d\}[meet(x, y)]$

No student met every professor

Let us now turn to the DAs. We assume that they are generated as follows:

(5) i. $||every_D||^{DA} = \{\lambda Q \lambda P . \exists x \in D'[Q(x)]: \forall x \in D' [Q(x) \rightarrow P(x)]: D' \subseteq D\}$

ii. $||[\alpha\ \beta]||^{DA} = \bigvee \{a(b): a \in ||\alpha||^{DA}, b \in ||\beta||^{DA}\}$

where for any set A, $\bigvee A = \{p \vee q: p, q \in A\}$

[$\forall$ A = the closure of A under '$\vee$' (binary join)][21]

Let us consider first the basic DAs for (2), namely those obtained by considering simply all the subdomains of the assertion (without closing the result under disjunction):

(6) Basic DAs of (2)

i. $\exists x\in\{a, b\}\exists y\in\{c, d\}[meet(x, y)] \wedge \forall x\in\{a, b\}\exists y\in\{c, d\}[MEET(x, y) \rightarrow GA(x)]$

presupposition the truth conditional content

ii. $\exists x\in\{a, b\}\exists y\in\{c\}[meet(x, y)] \wedge \forall x\in\{a, b\}\exists y\in\{c\}[meet(x, y) \rightarrow GA(x)]$

a or b met c $\wedge$ $\forall x\in\{a, b\}[meet(x, c) \rightarrow GA(x)]$

iii. $\exists x\in\{a, b\}\exists y\in\{d\}[meet(x, y)] \wedge \forall x\in\{a, b\}\exists y\in\{d\}[meet(x, y) \rightarrow GA(x)]$

a or b met d $\wedge$ $\forall x\in\{a, b\}[meet(x, d) \rightarrow GA(x)]$

iv. $\exists x\in\{a\}\exists y\in\{c, d\}[meet(x, y)] \wedge \forall x\in\{a\}\exists y\in\{c, d\}[meet(x, y) \rightarrow GA(x)]$

a met c or d $\wedge$ GA(a)]

v. $\exists x\in\{b\}\exists y\in\{c, d\}[meet(x, y)] \wedge \forall x\in\{b\}\exists y\in\{c, d\}[meet(x, y) \rightarrow GA(x)]$

b met c or d $\wedge$ GA(b)

vi. $\exists x\in\{a\}\exists y\in\{c\}[meet(x, y)] \wedge \forall x\in\{a\}\exists y\in\{c\}[meet(x, y) \rightarrow GA(x)]$

a met c $\wedge$ GA(a)

vii. $\exists x\in\{a\}\exists y\in\{d\}[meet(x, y)] \wedge \forall x\in\{a\}\exists y\in\{d\}[meet(x, y) \rightarrow GA(x)]$

a met d $\wedge$ GA(a)

viii. $\exists x\in\{b\}\exists y\in\{c\}[meet(x, y)] \wedge \forall x\in\{b\}\exists y\in\{c\}[meet(x, y) \rightarrow GA(x)]$

b met c $\wedge$ GA(b)

ix. $\exists x\in\{b\}\exists y\in\{d\}[meet(x, y)] \wedge \forall x\in\{b\}\exists y\in\{d\}[meet(x, y) \rightarrow GA(x)]$

[21] We are using the recursive clause in (5ii) to guarantee that DAs are closed under disjunction; once we consider the subdomains of the SA's they turn out to be without needing this stipulation; but to show that this is so would take us too far afield.

b met d ∧ GA(b)

The logical relations among DAs are as follows:

(7) Logical relations among basic DAs.

i. ∃x∈{a, b}∃y∈{c, d}[meet(x, y)] ∧ ∀x∈{a, b}∃y∈{c, d}[MEET(x, y) → GA(x)]

ii. a or b met c ∧ ∀x∈{a, b}[meet(x, c) → GA(x) iii. a or b met d ∧ ∀x∈{a, b}[meet(x, d) → GA(x)

iv. a met c or d ∧ GA(a) v. b met c or d ∧ GA(b)

vi. a met c ∧ GA(a) vii. a met d ∧ GA(a) viii. b met c ∧ GA(b) ix. b met d ∧ GA(b)

In addition, we get the following entailment relations

i ⇒ vi ∨ vii ∨ viii ∨ ix

iv ⇒ vi ∨ vii (and, therefore, iv = vi ∨ vii)

v ⇒ viii ∨ ix (and, therefore, v = viii ∨ ix)

ii ⇒ vi ∨ viii (but not vice versa)

iii ⇒ vii ∨ ix (but not vice versa)

So we can rewrite the set of DAs in a way that displays all this as:

(8) The set of basic DAs in a logical perspicuous format:

i. ∃x∈{a, b}∃y∈{c, d}[meet(x, y)] ∧ ∀x∈{a, b}∃y∈{c, d}[MEET(x, y) → GA(x)]

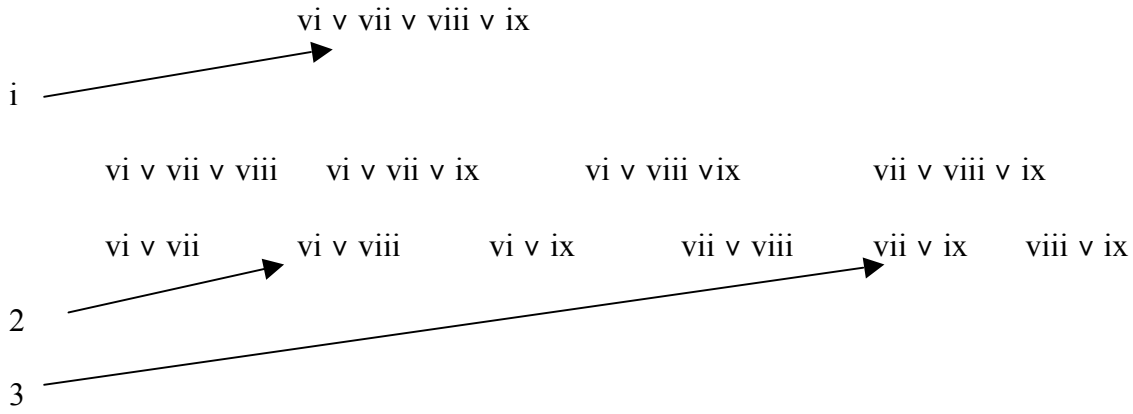
ii. a or b met c ∧ ∀x∈{a, b}[meet(x, c) → GA(x) iii. a or b met d ∧ ∀x∈{a, b}[meet(x, d) → GA(x)

vi ∨ vii viii ∨ ix

vi. a met c ∧ GA(a) vii. a met d ∧ GA(a) viii. b met c ∧ GA(b) ix. b met d ∧ GA(b)

The closure under disjunction of this set is

(9) Total of DAs (closed under pointwise disjunction):



vi. a met c ∧ GA(a) vii. a met d ∧ GA(a) viii. b met c ∧ GA(b) ix. b met d ∧ GA(b)

The lower lines entail the upper ones in the usual manner; i, ii and iii are related to the rest as shown.

This set has to be pre-exhaustified. Pre-exhaustification of any p relative to a set of alternatives ALT conjoins p with the negation of alternatives in ALT that are Innocently Excludable in the sense of Fox (2007) relative to p in ALT:

(10) IE(p, ALT) = ∩{X : X = { p ∧ ¬q: q ∈ALT} and X is consistent and maximal}

We show that relative to vi ∨ vii ∨ viii, only ix is IE. We do so by constructing two sets of maximal exclusions relative to it (MAX1 and MAX2) that have only ix as their intersection:

(11) MAX1 = { vi ∨ vii ∨ viii ∧ ¬ ix

∧ ¬ vi ∧ ¬ viii

∧ ¬ (vi ∨ viii) ∧ ¬ (vi ∨ ix) ∧ ¬ (viii ∨ ix)

∧ ¬ (vi ∨ viii ∨ ix)

∧ ¬ ii ∧ ¬ i ∧ ¬ iii }

MAX 1 corresponds to:

vi = F vii = T viii = F ix = F

MAX2 = { vi ∨ vii ∨ viii ∧ ¬ ix

∧ ¬ vii

∧ ¬ (vii ∨ ix)

∧ ¬ ii }

¬ iii cannot be added to MAX2 consistently; nor can ¬ i.

MAX 2 corresponds to:

vi = T vii = F viii= T ix = F

MAX1 ∩ MAX2 = { vi ∨ vii ∨ viii ∧ ¬ ix }

So ix is IE relative to (vi ∨ vii ∨ viii), while i, ii and iii are not. It follows that

(12) O_{IE}(vi ∨ vii ∨ viii) = vi ∨ vii ∨ viii ∧ ¬ ix

The negation of this is

(13) (vi ∨ vii ∨ viii) → ix

Similarly for the other cases.

It then follows that:

(14) $O_{Exh\text{-}DA}$(i) = i ∧ ((vi ∨ vii ∨ viii) → ix) ∧ ((vi ∨ viii ∨ ix) → vii) ∧

((vii ∨ viii ∨ ix) → vi) ∧ ((vi ∨ vii ∨ ix) → viii)

Since i → vi ∨ vii ∨ viii ∨ ix, we get that all vi, vii, viii and ix must be true. I.e.:

(15) ∀x∈{a, b}∀y∈{c, d}[MEET(x, y) ∧ GA(x)]

this contradicts the SI (4) above. In other words, putting everything together:

(16) $O_{SA\cup Exh\text{-}DA}$ ([∃x∈{a, b}∃y∈{c, d}[meet(x, y)] ∧ ∀x∈{a, b}∃y∈{c, d}[meet(x, y)

→ GA(x)]]) =

i. $[\exists x \in \{a, b\} \exists y \in \{c, d\} [meet(x, y)] \wedge \forall x \in \{a, b\} \exists y \in \{c, d\} [meet(x, y) \rightarrow GA(x)]$ Assertion

ii. $\wedge \neg \exists x \in \{a, b\} \forall y \in \{c, d\} [meet(x, y)]$ Scalar Implicature

iii. $\wedge \forall x \in \{a, b\} \forall y \in \{c, d\} [MEET(x, y) \wedge GA(x)]$ FC implicature

which is a contradiction, as desired.

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