

(Non-)specificity across languages: constancy, variation, ν -variation*

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Abstract Indefinites are known to give rise to different scopal (specific vs non-specific) and epistemic (known vs unknown) uses. Farkas & Brasoveanu (2020) explained these specificity distinctions in terms of stability vs. variability in value assignments of the variable introduced by the indefinite. Typological research (Haspelmath 1997) showed that indefinites have different functional distributions with respect to these uses. In this work, we present a formal framework where Farkas & Brasoveanu (2020)’s ideas are rigorously formalized. We develop a two-sorted team semantics which integrates both scope and epistemic effects. We apply the framework to explain typological variety of indefinites, their restricted distribution and licensing conditions, and some diachronic developments of indefinite forms.

Keywords: indefinites, typology, specificity, non-specificity, epistemic inferences, quantification, team semantics, dependence logics, two-sorted theories

1 Introduction

Indefinites display a great variety in form and meaning across languages. This paper deals with two core phenomena in the domain of indefinite pronouns and determiners, and it examines them from a cross-linguistic viewpoint. First, specific and non-specific interpretations. Example (1) is an illustration:

- (1) Ali wants to buy a mug.
- a. Specific: There is a specific mug (the SALT32 mug) which Ali wants to buy.
 - b. Non-specific: Ali wants to buy a mug, any mug would do.

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The ambiguity in (1) reflects also the scope behaviour of the indefinite with respect to the attitude verb *want*: *a mug* receives wide scope in (1a) and narrow-scope in (1b).¹

Second, indefinites are known to give rise to different epistemic inferences with respect to the identity of the referent:²

- (2) A politician participated in the event.
- a. Known: The speaker knows which politician participated in the event.
 - b. Unknown: The speaker doesn't know which politician participated in the event.

In a recent introductory article Farkas & Brasoveanu (2020) examined these distinctions between scopal and epistemic specificity.³ They argued that these notions are related to stability versus variability of reference across different assignments of the variable introduced by the indefinite. Their work ended with two challenges. First, new theoretical tools need to be developed or refined to rigorously study these differences in stability and variability. Second, the relevant linguistic phenomena underlying these distinctions need to be carefully studied.

For the first challenge, we develop a novel formal framework using tools from team logics and dependence logic.⁴ We show that our account captures both specific vs non-specific and known vs unknown uses. For the second challenge, languages mark these specificity and epistemic distinctions in the lexical meaning of particular indefinite forms. We will refer to such indefinites as *marked indefinites*. To make our discussion concrete, and typological comparisons possible, we rely on the work of Haspelmath (1997), who examined the functional distributions of indefinites in 40 languages.

We show that our account captures the typological variety of marked indefinites within and across languages, explaining also why certain types of indefinites are unattested. We account for the restricted distributions and licensing conditions of marked indefinites. Our framework predicts also some diachronic developments of indefinites in terms of semantic weakening.

This paper is structured as follows. Section 2 outlines the core data of our investigation and how languages mark specificity distinctions cross-linguistically. Section 3 introduces our formal framework with the relevant technical machinery and background notions. Section 4 shows how this framework can be applied to

1 (Fodor & Sag 1982; Farkas 1981; Reinhart 1997; Kratzer 1998; Winter 1997; Schwarzschild 2002; Brasoveanu & Farkas 2011; Charlow 2020).

2 (Fodor & Sag 1982; Farkas 1994; Kamp & Bende-Farkas 2019).

3 In their work, they also introduced the notion of partitive specificity, which we do not address here.

4 (Hodges 1997; Väänänen 2007a,b; Galliani 2012, 2021).

model the typological variety of indefinites, together with several proprieties and phenomena associated with marked indefinites. Section 5 concludes.

2 Indefinites across languages

In Section 1, we examined different specificity and epistemic readings associated with indefinites. Example (2) illustrates these contrasts for English *someone*:

- (3) a. Specific known (SK): Someone called. I know who.
b. Specific unknown (SU): Someone called. I do not know who.
c. Non-specific (NS): John needs to find someone for the job.

Cross-linguistically, languages developed lexicalized form with restricted distributions with respect to the uses in (2). For instance, German *irgend-* is incompatible with specific known, as the infelicitous continuation in (4) shows:

- (4) Irgendein Student hat angerufen. #Rat mal wer?
some student has called. guess who?
'Some (unknown) student called. #Guess who?'

To make cross-linguistic comparisons possible, we will rely on the data gathered by Haspelmath (1997), who examined indefinites' systems in 40 languages and developed a functional map of indefinites with nine main functions.⁵ Figure 1 displays a semantic map for the German indefinite determiner *irgend-*, where the colored area indicates the functions available for *irgend-*.

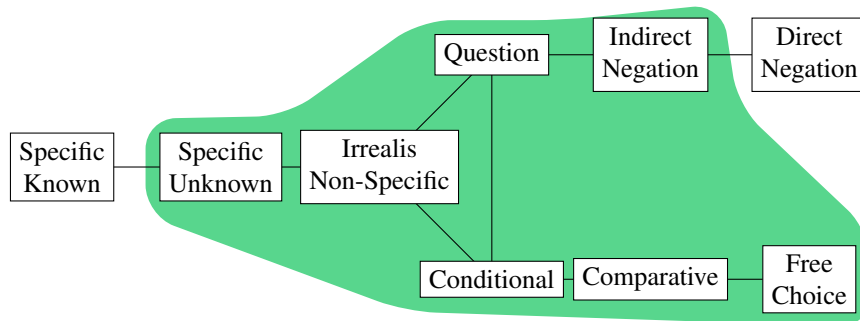


Figure 1 Haspelmath's map for German *irgend-*

⁵ Haspelmath (1997) restricted his analysis to indefinite pronouns and determiners formed with indefinite markers (e.g. English *some-* or *any-*) which occur in a series (e.g. *some-thing*, *some-where*, ...). This excludes from our work expressions such as *a certain*, which however have a specific-like flavour. An interesting research question is to determine if the behaviour of indefinites marked for specific uses parallels entirely specificity markers like *certain* in combination with indefinite articles.

| TYPE | FUNCTIONS | | | EXAMPLE |
|------------------------|-----------|----|----|-------------------------|
| | SK | SU | NS | |
| (i) unmarked | ✓ | ✓ | ✓ | Italian <i>qualcuno</i> |
| (ii) specific | ✓ | ✓ | ✗ | Georgian <i>-ghats</i> |
| (iii) non-specific | ✗ | ✗ | ✓ | Russian <i>-nibud</i> |
| (iv) epistemic | ✗ | ✓ | ✓ | German <i>irgend-</i> |
| (v) specific known | ✓ | ✗ | ✗ | Russian <i>koe-</i> |
| (vi) SK + NS | ✓ | ✗ | ✓ | unattested |
| (vii) specific unknown | ✗ | ✓ | ✗ | Kannada <i>-oo</i> |

Table 1 Possible Types of Indefinites

The relevant functions for our work are specific known, specific unknown and non-specific.⁶ Combinations of these functions lead to 7 possible indefinite types, summarized in Table 1 together with the relevant example.

Unmarked indefinites don't have any restriction with respect to these functions; specific indefinites admit only specific uses; non-specific indefinites admit only non-specific uses; and epistemic indefinites allow for both SU and NS uses. The last two types deserve some remarks. Type (vi), encoding SK and NS but not SU, is unattested in the data collected by Haspelmath (1997). Type (vii), admitting only SU uses, is very infrequent: out of the 40 languages that Haspelmath (1997) examined, only 1, Kannada, had such indefinite.

Table 2 displays some within-language distinctions. Generalization are difficult to make, given the limited amount of data.⁷ Overall, we see that the combination specific + non-specific is very common. And also the epistemic type is quite widespread. In the case of Russian we observe that there are two marked indefinites⁸ to express NS: the epistemic *-to*, which also admits SU uses; and the non-specific *-nibud*, which only admits non-specific uses. However, Russian speakers tend to select *-nibud* for NS and *-to* for SU. Why then *-to* maintained its NS uses and did not

⁶ Haspelmath (1997) assumed that indefinites marked for specificity presuppose the existence of their referent (i.e., they can be paraphrased with a *there* construction), and they can have discourse referents. With these assumptions, indefinites marked only for specificity admit only wide-scope readings. We take indeed this to be the hallmark of specificity. It might be possible that some of these indefinites also allow for non-wide-scope readings in combination with other operators. In that case, those apparent (functional) specific uses can be explained following strategies similar to Kratzer (1998) or Schwarzschild (2002).

⁷ Moreover, we also note that there are equivalent expression (e.g. *a specific*) which albeit not being indefinites, they have meanings similar to some of the marked indefinites we consider here.

⁸ Russian has also other indefinites which might admit non-specific uses. We do not include them here, as they are commonly considered to be tied to different registers.

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| LANGUAGE | INDEFINITE | FUNCTIONS | | | TYPE |
|----------|------------|-----------|----|----|------------------|
| | | SK | SU | NS | |
| Italian | un qualche | X | ✓ | ✓ | epistemic |
| | qualcuno | ✓ | ✓ | ✓ | unmarked |
| Russian | koe- | ✓ | X | X | specific known |
| | -to | X | ✓ | ✓ | epistemic |
| | -nibud | X | X | ✓ | non-specific |
| Japanese | -ka | ✓ | ✓ | ✓ | unmarked |
| Turkish | bir | ✓ | ✓ | ✓ | unmarked |
| | herhangi | X | ✓ | ✓ | epistemic |
| German | etwas | ✓ | ✓ | ✓ | unmarked |
| | irgend | X | ✓ | ✓ | epistemic |
| Georgian | -ghats | ✓ | ✓ | X | specific |
| | -me | X | X | ✓ | non-specific |
| Ossetic | -dær | ✓ | ✓ | X | specific |
| | is- | X | X | ✓ | non-specific |
| Kazakh | bir | ✓ | ✓ | ✓ | unmarked |
| | älde | ✓ | ✓ | X | specific |
| Kannada | -oo | X | ✓ | X | specific unknown |
| | -aadaruu | X | X | ✓ | non-specific |

Table 2 Marked indefinites across languages

become a specific unknown indefinite?

In the next section, we will develop a formal framework which will help us address this question, together with other several proprieties and puzzles associated with marked indefinites. In particular, we will account for the variety of marked indefinites in Table 1 (Section 4.3); the restricted distribution and licensing conditions of non-specific indefinites (Section 4.4); the ignorance inferences of epistemic indefinites (Section 4.5); the diachronic pathway from non-specific to epistemic (Section 4.5); and how marked indefinites interact with scope (Section 4.7).

3 Two-sorted Team Semantics

Traditionally, formulas are interpreted with respect to a single evaluation point. In team semantics formulas are interpreted with respect to sets of evaluation points, rather than single ones. These evaluations points can be valuations (as in propositional team logic, Yang & Väänänen (2017)), assignments (as in first-order team semantics, Galliani (2021); Lück (2020)) or possible worlds (as in team-based modal logic, Aloni (2022); Lück (2020)). This set of evaluations is usually called a *team*.

In what follows, we will work with a *two-sorted* first-order framework, with variables ranging over individuals and worlds.

Definition 1 (Two-sorted model) A *two-sorted model* is a triple $M = \langle D, W, I \rangle$ composed of a domain of individuals $Dom_d(M) = D$, a domain of worlds $Dom_w(M) = W$, and an interpretation function I assigning an element of D to every constant symbol and a subset of n -tuples constructed from W and D to every n -ary predicate symbol.

A two-sorted first-order team is just a set of assignments mapping world variables to elements of W and individual variables to elements of D . We first define a variable assignment and then a team.⁹

Definition 2 (Variable Assignments) Given a two-sorted first-order model $M = \langle D, W, I \rangle$ and a set of variables $Z = Z_d \cup Z_w$, an assignment i is a function from Z s.t. $i(z) \in D$ if $z \in Z_d$ and $i(z) \in W$ if $z \in Z_w$. For any variable z_* and any element e_* with $*$ $\in \{d, w\}$, we write $i[e_*/z_*]$ for the assignment function with domain $Z \cup \{z_*\}$ s.t. for all variable symbols $l \in Z \cup \{z_*\}$:

$$i[e_*/z_*](l) = \begin{cases} e_* & \text{if } l = z_* \\ i(l) & \text{otherwise} \end{cases}$$

Definition 3 (Team) Given a two-sorted first-order model $M = \langle D, W, I \rangle$ and a set of variables $Z = Z_d \cup Z_w$, a team T over M with domain $Dom(T) = Z$ is a set of assignments i with domain Z .

3.1 Teams as information states

Teams represent information states of speakers and in initial teams only factual information is represented, encoded by a designated variable for the actual world v .

Definition 4 (Initial Team) A team T is *initial* iff $Dom(T) = \{v\}$.

The possible values of v in a team represent different ways the world might be (epistemic possibilities). Intuitively, a team where v receives only one value is of maximal information.

We will assume that a sentence is felicitous if it is supported by an initial team:

⁹ To keep the definitions general, we indicate the sort in the subscript. z_d and z_w will be individual and world variables. Similarly, e_d will be an element of D and e_w an element of W . Later, we will use more conventional labels.

Definition 5 (Felicitous sentence) *A sentence is felicitous/grammatical if there is an initial team which supports it.*

In the team represented in Table 3, the first row indicates the variables present in the team and the rows below the values assigned by the assignments in the team. The initial team is depicted in yellow and conveys that the epistemic possibilities the speaker entertains are v_1 , v_2 and up to v_n . Discourse information is then added by operations of assignment extensions, which can introduce individual or world variables. As said, teams encode the information state of the speaker. For instance, in Table 3 the speaker is certain about - or *knows* - the value of x , since x is constant across all her epistemic possibilities. However, the speaker does not know the value y . World variables, like w , can also be introduced to model modals or attitudes verbs, as we will see in the next sections.

| v | x | w | y | ... |
|-------|-----|-------|-------|-----|
| v_1 | a | w_1 | b_1 | ... |
| v_2 | a | w_2 | b_2 | ... |
| ... | a | ... | ... | ... |
| v_n | a | w_n | b_n | ... |

Table 3 Team as information state (initial team in yellow)

3.2 Assignment extensions

Our assignment extensions are based on similar operations in dynamic and team semantics (Groenendijk & Stokhof 1991; Dekker 1993; Aloni 2001; Väänänen 2007b; Galliani 2012):

Definition 6 (Universal Extension) *Given a model $M = \langle D, W, I \rangle$, a team T and a variable z_* with $*$ $\in \{d, w\}$, the universal extension of T with z_* is denoted by $T[z_*]$:*

$$T[z_*] = \{i[e_*/z_*] : i \in T \text{ and } e_* \in \text{Dom}_*(M)\}$$

Universal extensions consider all assignments that differ from the ones in T only with respect to the value of z_* . Table 3(b) is an example, assuming the initial team in Table 3(a) and a domain of two individuals. Note that universal extensions are unique.

Definition 7 (Strict Functional Extension) *Given a model $M = \langle D, W, I \rangle$, a team T and a variable z_* with $*$ $\in \{d, w\}$, the strict functional extension of T with z_* is*

denoted by $T[f_s/z_*]$:

$$T[f_s/z_*] = \{i[f_s(i)/z_*] : i \in T\}, \text{ for some strict function } f_s : T \rightarrow \text{Dom}_*(M)$$

Strict functional extensions assign only one value to z for each assignment in the original T . Table 3(c) shows one of the four possible examples.

Definition 8 (Lax Functional Extension) Given a model $M = \langle D, W, I \rangle$, a team T and a variable z_* with $*$ $\in \{d, w\}$, the lax functional extension of T with z_* is denoted by $T[f_l/z_*]$:

$$T[f_l/z_*] = \{i[e_*/z_*] : i \in T \text{ and } e_* \in f_l(i)\}, \text{ for some lax function } f_l : T \rightarrow \wp(\text{Dom}_*(M)) \setminus \{\emptyset\}$$

Lax functional extensions amount to assign one or more values to z for each original assignment in T . Table 3(d) shows one of the nine possible examples.

| (a) | (b) | (c) | (d) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|-------|------------|-------|-------|-------|-------|--|-----|-----|--------|-------|-------|----------|-------|-------|----------|-------|-------|----------|-------|-------|----------|--|-----|-----|------------|-------|-------|----------|-------|-------|----------|--|-----|-----|------------|-------|-------|----------|-------|-------|----------|-------|-------|----------|
| <table style="width: 100%; border-collapse: collapse;"> <tr><th style="border-right: 1px solid black; padding: 2px 5px;">v</th><th style="padding: 2px 5px;">T</th></tr> <tr><td style="border-right: 1px solid black; padding: 2px 5px;">v_1</td><td style="padding: 2px 5px;">i_1</td></tr> <tr><td style="border-right: 1px solid black; padding: 2px 5px;">v_2</td><td style="padding: 2px 5px;">i_2</td></tr> </table> | v | T | v_1 | i_1 | v_2 | i_2 | <table style="width: 100%; border-collapse: collapse;"> <tr><th style="border-right: 1px solid black; padding: 2px 5px;">v</th><th style="border-right: 1px solid black; padding: 2px 5px;">y</th><th style="padding: 2px 5px;">$T[y]$</th></tr> <tr><td style="border-right: 1px solid black; padding: 2px 5px;">v_1</td><td style="border-right: 1px solid black; padding: 2px 5px;">d_1</td><td style="padding: 2px 5px;">i_{11}</td></tr> <tr><td style="border-right: 1px solid black; padding: 2px 5px;">v_1</td><td style="border-right: 1px solid black; padding: 2px 5px;">d_2</td><td style="padding: 2px 5px;">i_{12}</td></tr> <tr><td style="border-right: 1px solid black; padding: 2px 5px;">v_2</td><td style="border-right: 1px solid black; padding: 2px 5px;">d_1</td><td style="padding: 2px 5px;">i_{21}</td></tr> <tr><td style="border-right: 1px solid black; padding: 2px 5px;">v_2</td><td style="border-right: 1px solid black; padding: 2px 5px;">d_2</td><td style="padding: 2px 5px;">i_{22}</td></tr> </table> | v | y | $T[y]$ | v_1 | d_1 | i_{11} | v_1 | d_2 | i_{12} | v_2 | d_1 | i_{21} | v_2 | d_2 | i_{22} | <table style="width: 100%; border-collapse: collapse;"> <tr><th style="border-right: 1px solid black; padding: 2px 5px;">v</th><th style="border-right: 1px solid black; padding: 2px 5px;">y</th><th style="padding: 2px 5px;">$T[f_s/y]$</th></tr> <tr><td style="border-right: 1px solid black; padding: 2px 5px;">v_1</td><td style="border-right: 1px solid black; padding: 2px 5px;">d_1</td><td style="padding: 2px 5px;">i_{11}</td></tr> <tr><td style="border-right: 1px solid black; padding: 2px 5px;">v_2</td><td style="border-right: 1px solid black; padding: 2px 5px;">d_2</td><td style="padding: 2px 5px;">i_{22}</td></tr> </table> | v | y | $T[f_s/y]$ | v_1 | d_1 | i_{11} | v_2 | d_2 | i_{22} | <table style="width: 100%; border-collapse: collapse;"> <tr><th style="border-right: 1px solid black; padding: 2px 5px;">v</th><th style="border-right: 1px solid black; padding: 2px 5px;">y</th><th style="padding: 2px 5px;">$T[f_l/y]$</th></tr> <tr><td style="border-right: 1px solid black; padding: 2px 5px;">v_1</td><td style="border-right: 1px solid black; padding: 2px 5px;">d_2</td><td style="padding: 2px 5px;">i_{12}</td></tr> <tr><td style="border-right: 1px solid black; padding: 2px 5px;">v_2</td><td style="border-right: 1px solid black; padding: 2px 5px;">d_1</td><td style="padding: 2px 5px;">i_{21}</td></tr> <tr><td style="border-right: 1px solid black; padding: 2px 5px;">v_2</td><td style="border-right: 1px solid black; padding: 2px 5px;">d_2</td><td style="padding: 2px 5px;">i_{22}</td></tr> </table> | v | y | $T[f_l/y]$ | v_1 | d_2 | i_{12} | v_2 | d_1 | i_{21} | v_2 | d_2 | i_{22} |
| v | T | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| v_1 | i_1 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| v_2 | i_2 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| v | y | $T[y]$ | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| v_1 | d_1 | i_{11} | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| v_1 | d_2 | i_{12} | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| v_2 | d_1 | i_{21} | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| v_2 | d_2 | i_{22} | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| v | y | $T[f_s/y]$ | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| v_1 | d_1 | i_{11} | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| v_2 | d_2 | i_{22} | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| v | y | $T[f_l/y]$ | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| v_1 | d_2 | i_{12} | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| v_2 | d_1 | i_{21} | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| v_2 | d_2 | i_{22} | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

Table 4 Initial Team (a), universal y -extension (b), strict functional y -extension (c), and lax functional y -extension (d).

3.3 Dependence and Variation atoms

Team semantics frameworks are often equipped with dependence atoms - expressions which impose conditions of dependence on the variable's values given by the different assignments. In this work, we adopt the following two atoms:

Definition 9 (Dependence Atom)

$$M, T \models \text{dep}(\vec{x}, y) \Leftrightarrow \text{for all } i, j \in T : i(\vec{x}) = j(\vec{x}) \Rightarrow i(y) = j(y)$$

Definition 10 (Variation Atom)

$$M, T \models \text{var}(\vec{x}, y) \Leftrightarrow \text{there is } i, j \in T : i(\vec{x}) = j(\vec{x}) \ \& \ i(y) \neq j(y)$$

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The first atom in Definition 9 asserts that if any two assignments agree on the value of \vec{x} , they also agree on the value of y (i.e. the value of y is *dependent* on the value of \vec{x}). The variation atom in Definition 10 corresponds to the metalinguistic negation of the definition of Dependence Atom above. It is valid when there is at least a pair of assignments for which the value of y varies and \vec{x} is the same. Table 5 displays a team of three assignments together with some illustrations.

| T | x | y | z | l | | |
|-----|-------|-------|-------|-------|--------------------|----------------------|
| i | a_1 | b_1 | c_1 | d_1 | $dep(x,y)$ | ✓ |
| j | a_1 | b_1 | c_2 | d_1 | $dep(\emptyset,l)$ | ✓ |
| k | a_3 | b_2 | c_3 | d_1 | $dep(xy,z)$ | ✗ |
| | | | | | | $var(x,z)$ ✓ |
| | | | | | | $var(\emptyset,x)$ ✓ |
| | | | | | | $var(x,y)$ ✗ |

Table 5 Dependence and Variation atoms - Illustrations

We now give precise rules for semantic clauses of the formulas of our language (Hodges 1997; Väänänen 2007a; Galliani 2012).¹⁰

Definition 11 (Semantic Clauses)

| | | |
|---|-------------------|---|
| $M, T \models P(t_1, \dots, t_n)$ | \Leftrightarrow | $\forall j \in T : \langle j(t_1), \dots, j(t_n) \rangle \in I(P^n)$ |
| $M, T \models \phi \wedge \psi$ | \Leftrightarrow | $M, T \models \phi$ and $M, T \models \psi$ |
| $M, T \models \phi \vee \psi$ | \Leftrightarrow | $T = T_1 \cup T_2$ for teams T_1 and T_2 s.t. $M, T_1 \models \phi$ and $M, T_2 \models \psi$ |
| $M, T \models \forall z \phi$ | \Leftrightarrow | $M, T[z] \models \phi$ |
| $M, T \models \exists_{\text{strict}} z \phi$ | \Leftrightarrow | there is a strict function f_s s.t. $M, T[f_s/z] \models \phi$ |
| $M, T \models \exists_{\text{lax}} z \phi$ | \Leftrightarrow | there is a lax function f_l s.t. $M, T[f_l/z] \models \phi$ |
| $M, T \models dep(\vec{x}, y)$ | \Leftrightarrow | for all $i, j \in T : i(\vec{x}) = j(\vec{x}) \Rightarrow i(y) = j(y)$ |
| $M, T \models var(\vec{x}, y)$ | \Leftrightarrow | there is $i, j \in T : i(\vec{x}) = j(\vec{x}) \& i(y) \neq j(y)$ |

Definition 12 (Entailment) A formula ϕ entails a formula ψ , in symbols $\phi \models \psi$, if for all M and all T such that $M, T \models \phi$, we have $M, T \models \psi$.

A first order literal is true in a team T iff it is true in all assignments in T . A team T satisfies a conjunction $\phi \wedge \psi$ iff T satisfies ϕ and satisfies ψ . A team T satisfies a disjunction $\phi \vee \psi$ iff T is the union of two subteams, each satisfying one of the

¹⁰ We assume that all formulas are in negative normal form. In Dependence Logic, negation is only defined for literals, as the interaction of negation and dependence atoms leads to failure of substitution of equivalents.

disjuncts.¹¹ We use the universal extension for the universal quantifier, and the strict and lax functional extensions for the strict and lax existentials.¹²

4 Applications

4.1 Indefinites as existentials and scope behaviour

Indefinites are modelled as strict existentials ($\exists_{s(\text{strict})}x\phi$) which are interpreted *in-situ*.¹³ Dependence atoms allow us to easily capture the different scope readings by specifying how the indefinite’s variable co-varies with other operators. For instance, a sentence like (5) is ambiguous between three different readings, depending on the scope of *a doctor* with respect to the universal quantifiers.

As base case, we assume a team of maximal information (i.e. the value of v is fixed). As shown in Table 6, $dep(v, y)$ yields a wide scope interpretation where the value of y is constant; $dep(vx, y)$ yields the intermediate reading where the value of y depends only on the first universal quantifier; and $dep(vxz, y)$ yields narrow scope where the value of y depends on both universal quantifiers.

- (5) Every kid _{x} ate every food _{z} that a doctor _{y} recommended.
- | | |
|-----------------------|---|
| a. Wide scope | $[\exists y/\forall x/\forall z]: \forall x\forall z\exists_s y(\phi \wedge dep(v, y))$ |
| b. Intermediate scope | $[\forall x/\exists y/\forall z]: \forall x\forall z\exists_s y(\phi \wedge dep(vx, y))$ |
| c. Narrow scope | $[\forall x/\forall z/\exists y]: \forall x\forall z\exists_s y(\phi \wedge dep(vxz, y))$ |

For what concerns scope, our approach is conceptually similar to [Brasoveanu & Farkas \(2011\)](#) and leads to the generalization in (6). In our framework, dependency relations are not part of the meaning of the existential, but they are evaluated as separate clauses. This allows us to work with a uniform lexical entry for existentials and with a better behaved logical system.¹⁴

11 We are employing the so-called split or tensor disjunction ([Väänänen 2007b](#)). Note also that with the exclusion of the dependence and variation atom, the framework preserves classicality.

12 It is interesting to note that for downward closed formulas, the strict and the lax existentials are equivalent. Except for the variation atom, all formulas in our language are downward closed.

13 Modelling indefinites as objects which map to the domain of our model is quite standard in frameworks working with a set of evaluation points, as in dynamic semantics. Moreover, we would like to mention [Champollion, Bledin & Li \(2017\)](#), a recent relevant work which integrates dependence logics and dynamic plural logic. [Champollion et al. \(2017\)](#) adopts a variant of our strict existential together with a rigidity requirement comparable to our $dep(\emptyset, x)$ to model indefinites with a specific use. We thank Lucas Champollion for pointing out to us this interesting convergence.

14 The generalization in (6) overgenerates. Unavailable readings can be ruled following a strategy similar to [Brasoveanu & Farkas \(2011\)](#). We do not discuss this any further, as our main concerns here are the typological variety of indefinites and the integration of epistemic readings.

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| | | | | | | | | | | | |
|-------|---------|---------|-------|-------|-------|---------|-------|-------|-------|-------|-------|
| v | x | z | y | v | x | z | y | v | x | z | y |
| v_1 | \dots | \dots | b_1 | v_1 | a_1 | \dots | b_1 | v_1 | a_1 | c_1 | b_1 |
| v_1 | \dots | \dots | b_1 | v_1 | a_1 | \dots | b_1 | v_1 | a_2 | c_2 | b_2 |
| v_1 | \dots | \dots | b_1 | v_1 | a_2 | \dots | b_2 | v_1 | a_3 | c_3 | b_3 |
| v_1 | \dots | \dots | b_1 | v_1 | a_2 | \dots | b_2 | v_1 | a_4 | c_4 | b_4 |

WS: $dep(v,y)$ IS: $dep(vx,y)$ NS: $dep(vxz,y)$

Table 6 Indefinites & Scope

- (6) INDEFINITES & SCOPE
 An unmarked/plain indefinite $\exists_s x$ in syntactic scope of O_z allows all $dep(\vec{y}, x)$, with \vec{y} included in $v\vec{z}$:

$$O_{z_1} \dots O_{z_n} \exists_s x (\phi \wedge dep(\vec{y}, x))$$

4.2 Specific Known, Specific Unknown and Non-Specific

We need to distinguish between full specificity (specific known) and what we called specific unknown: a specific individual, but epistemically not determined. We can capture the difference using possible worlds representing epistemic possibilities. In the former case, the specific individual will be constant across all epistemically possible worlds, while in the latter it will vary. The conditions in Table 7 make our strategy more precise:

| | | | | | | | |
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Table 7 Constancy and variation conditions

Constancy means that the variable x is mapped to the same individual in every assignment, while *variation* guarantees that there is at least a pair of assignments in which x receives different values. Their v counterparts relativize these notions to the world variable v : v -constancy means that the value of x is constant given an epistemic possibility, whereas v -variation guarantees that there is at least an

| TYPE | FUNCTIONS | | | REQUIREMENT | EXAMPLE |
|------------------------|-----------|----|----|--------------------------------------|-------------------------|
| | SK | SU | NS | | |
| (i) unmarked | ✓ | ✓ | ✓ | none | Italian <i>qualcuno</i> |
| (ii) specific | ✓ | ✓ | ✗ | $dep(v, x)$ | Georgian <i>-ghats</i> |
| (iii) non-specific | ✗ | ✗ | ✓ | $var(v, x)$ | Russian <i>-nibud</i> |
| (iv) epistemic | ✗ | ✓ | ✓ | $var(\emptyset, x)$ | German <i>irgend-</i> |
| (v) specific known | ✓ | ✗ | ✗ | $dep(\emptyset, x)$ | Russian <i>koe-</i> |
| (vi) SK + NS | ✓ | ✗ | ✓ | $dep(\emptyset, x) \vee var(v, x)$ | unattested |
| (vii) specific unknown | ✗ | ✓ | ✗ | $dep(v, x) \wedge var(\emptyset, x)$ | Kannada <i>-oo</i> |

Table 8 Marked Indefinites

epistemic possibility in which x receives different values. With these conditions, we can logically characterize the specific known, specific unknown and non-specific functions (see 7). SK is captured by constancy, ensuring speaker knowledge; SU is captured by v -constancy, ensuring specificity, and variation, ensuring unknownness; NS is captured by v -variation, which as we will see will ensure scopal non-specificity.

- (7) a. SK: $\exists x (\varphi(x, v) \wedge dep(\emptyset, x))$ [constancy]
b. SU: $\exists x (\varphi(x, v) \wedge dep(v, x) \wedge var(\emptyset, x))$ [v -constancy + variation]
c. NS: $\exists x (\varphi(x, v) \wedge var(v, x))$ [v -variation]

4.3 Variety

We have now all the ingredients to capture the variety of marked indefinites discussed in Section 2. We summarize our proposal in Table 8.

Unmarked indefinites, like English *someone*, don't have particular requirements, and they can in principle express all the functions that we considered. Specific indefinites are associated with ' v -constancy': the referent of the indefinite is the same in a given world, but it can possibly vary between worlds. The opposite condition, ' v -variation', forms the class of non-specific indefinites. Epistemic indefinites require ' v -variation': the referent of the indefinite must vary, possibly within the same world. 'Constancy', leads to specific known: a unique individual across all worlds.

Let us now turn to the last two types of Table 8, which require a more detailed explanation. The type 'specific known + non-specific' cannot be subsumed under a single atom. It requires that the referent satisfies either ' v -constancy' or ' v -variation', which are contradictory with each other.¹⁵ Therefore, this type can only be captured by a disjunction of atoms, which explains the difficulty of finding a lexicalized

¹⁵ Note in fact that $dep(\emptyset, x)$ implies $dep(v, x)$, which contradicts $var(v, x)$.

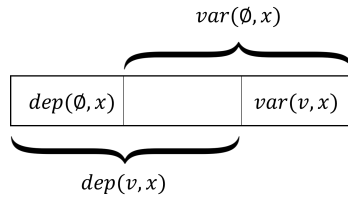


Figure 2 Meaning Space of Marked Indefinites

indefinite encoding almost opposite meanings.¹⁶ To our knowledge, there is no language which encodes this meaning in a particular form.

Moreover, type (vi) constitutes a clear violation of connectedness, normally assumed as a constraint of lexicalizations (Enguehard & Chemla 2021; Gardenfors 2014). For instance, there are no expressions which lexicalize meanings like ‘more than five and less than ten’. The underlying assumption is that numeral modifiers are defined upon a set of numbers which is linearly ordered, and no gaps are possible. In the same way, we claim that the meaning space which defines marked indefinites are the dependence and non-dependence conditions discussed in the present work. Figure 2 orders our atoms according to the degree of variation (from constancy to v -variation), and shows in which sense type (vi) creates a gap in the meaning space of marked indefinites.¹⁷

The last type, specific unknown, requires two atoms: ‘ v -constancy’ for specificity and ‘variation’ for unknown. Crucially, only one language among the ones examined by Haspelmath (1997) had such indefinite. We claim that complexity is the reason. Specific unknown requires two atoms, and a possible lexicalization is therefore less likely to occur.¹⁸

4.4 Licensing

Non-specific indefinites cannot occur freely in episodic sentences, but they need to be licensed by an operator (a universal quantifier, a modal, an attitude verb, ...).

¹⁶ Note that we would need a boolean notion of disjunction: $M, T \models \phi \vee \psi \Leftrightarrow M, T \models \phi \text{ or } M, T \models \psi$.

¹⁷ We observe that the conditions in (7) can be considered the most basic representation of constancy and variation requirements in the variables’ assignment values, and in this sense they constitute minimal meaning elements of the meaning space of indefinites.

¹⁸ This also allows us to answer the question at the end of Section 1. Russian has a dedicated indefinite for NS uses (*-nibud*) and also an epistemic indefinite (*-to*) which express both NS and SU. In practice, speakers select almost always *-to* for SU and *-nibud* for NS. The preferential use of SU for *-to* has a pragmatic root (the speaker is aware that there is an alternative form with only NS uses), but still Russian maintains *-to* as an epistemic, since turning *-to* into a specific unknown would make it more complex. An interesting balance between the language user and the language system.

Examples (8) and (9) illustrate the case of Russian *-nibud*.

- (8) *Ivan včera kupil kakuju-nibud' knigu.
 Ivan yesterday bought which-INDEF. book.
 'Ivan bought some book [non-specific] yesterday.'
- (9) Ivan hotel spet' kakuju-nibud' pesniu.
 Ivan want-PAST sing-INF which-INDEF. song.
 'Ivan wanted to sing some song [non-specific].'

In Section 3.1, we have defined what counts as an initial state and the conditions under which a sentence is grammatical. This, together with the $var(v,x)$ requirement for non-specific indefinites, is enough to explain cases like (8) and (9).

To see this, suppose that we have an initial state where v is assigned to two worlds (see (a) in Table 9). Recall that non-specific indefinites trigger the v -variation condition: $\exists_s x(\phi \wedge var(v,x))$. In order to satisfy $var(v,x)$, there must be a pair of assignments in which x differs and v is fixed. Note also that our definition of the strict existential rules out branching. It follows that in a condition like (a), the variation requirement of non-specific indefinites cannot be satisfied. By defining a sentence as felicitous if it can be supported by an initial team, our analysis predicts the infelicity of (8).

Let us examine what happens when an operator (e.g. a universal quantifier) intervenes and licenses the non-specific indefinite: $\forall y \exists_s x(\phi \wedge var(v,x))$. The universal quantifier leads to a universal y -extension of the initial team (b). In the extended team $var(v,x)$ can be then satisfied (c).

| (a) | (b) | (c) |
|----------------|------------------------------------|--|
| <u>v</u> | <u>v y</u> | <u>v y x</u> |
| w ₁ | w ₁ a ₁ | w ₁ a ₁ d ₁ |
| w ₂ | w ₁ a ₂ | w ₁ a ₂ d ₂ |
| | w ₂ a ₁ | w ₂ a ₁ d ₂ |
| | <u>w₂ a₂</u> | <u>w₂ a₂ d₂</u> |

Table 9 Licensing of non-specific indefinites

Other operators, like modals, can license non-specific indefinites.¹⁹ In a two-sorted language, we analyse modals as (lax) quantifiers over worlds ($\diamond_w \sim \exists_{l(ax)} w$; $\square_w \sim$

¹⁹ Note that other indefinites cannot license non-specific indefinites. This follows since indefinites are *strict* existentials.

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$\forall w$) modulo an accessibility relation. Recall in fact that the lax notion of existential allows for branching extensions which satisfy v -variation.

4.5 Epistemic indefinites

Epistemic indefinites (EIs) trigger $var(\emptyset, x)$, which is compatible with both specific unknown and non-specific uses.

- (10) Irgendein Student hat angerufen. #Rat mal wer?
 some student has called. #guess who?
 ‘Some (unknown) student called. #Guess who?’

Our account predicts that in episodic contexts like (10), $var(\emptyset, x)$ gives rise to the ignorance component of EIs: $var(\emptyset, x)$ ensures that the value of x is not constant across all epistemic possibilities (i.e., the speaker does not know the value of x). Note also that this account readily explains the availability of non-specific (or co-variation) uses in the presence of other operators. The crucial fact is that the two readings reflect the different scope of the indefinite, which is handled by dependence atoms (see Section 4.1). Consider the example in (11) and the supporting teams in Table 10:

- (11) Jeder_y Student hat irgendein_x Buch gelesen.
 every student has irgendein book read
- a. SPECIFIC UNKNOWN: $\forall y \exists_s x (\phi \wedge dep(v, x) \wedge var(\emptyset, x))$
 b. NON-SPECIFIC: $\forall y \exists_s x (\phi \wedge dep(vy, x) \wedge var(\emptyset, x))$

| (a) | (b) | (c) |
|-------|---------------------------|---------------------------|
| v | $v \quad y \quad x$ | $v \quad y \quad x$ |
| v_1 | $v_1 \quad b_1 \quad a_1$ | $v_1 \quad b_1 \quad a_1$ |
| v_2 | $v_1 \quad b_2 \quad a_1$ | $v_1 \quad b_2 \quad a_2$ |
| | $v_2 \quad b_1 \quad a_2$ | $v_2 \quad b_1 \quad a_1$ |
| | $v_2 \quad b_2 \quad a_2$ | $v_2 \quad b_2 \quad a_2$ |

Table 10 (a) Initial team; (b) Specific unknown; (c) Non-specific (co-variation)

It is worth pointing out that previous approaches²⁰ assumed that EIs trigger an anti-singleton constraint which requires the domain of the indefinite to contain

²⁰ (Alonso-Ovalle & Menéndez-Benito 2010, 2017).

more than one individual. Our variation condition shares the same underlying idea. However, unlike [Alonso-Ovalle & Menéndez-Benito \(2017\)](#), we do not derive the ignorance effect as an implicature, but as part of the meaning of the indefinite, which also explains its undefeasibility. Moreover, our framework integrates the non-specific or co-variation uses of EIs in a more general theory of indefinites and scope.

We conclude by pointing out that some EIs display NPI uses under negation and some of them allow for free choice. Enriching our language with an intensional notion of negation, as in [Definition 13](#), and implication, as in [Definition 14](#), would account for the NPI reading.²¹ Generalizing our variation atom to express the full variation would account for free choice. For reason of space, we leave the details of the analysis to future work.

Definition 13 (Intensional Negation) $\neg\phi(v) \Leftrightarrow \forall w(\phi(w) \rightarrow v \neq w)$

Definition 14 (Implication) $M, X \models \phi \rightarrow \psi \Leftrightarrow$ for some $X' \subseteq X$ s.t. $M, X' \models \phi$ and X' is maximal (i.e. for all X'' s.t. $X' \subset X'' \subseteq X$, it holds $M, X'' \not\models \phi$), we have $M, X' \models \psi$

4.6 Weakening & Semantic Change

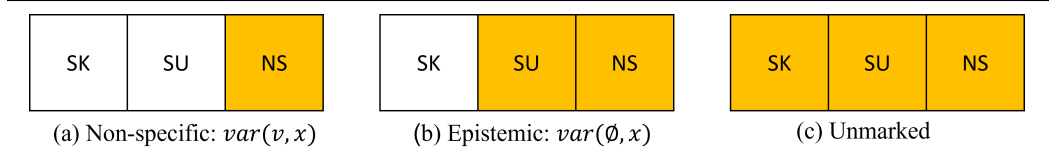
In this section, we consider some diachronic pathways of indefinites and its relationship with the formal systems discussed here. Cross-linguistically, we witness a general tendency of non-specific indefinites to acquire SU uses, turning into epistemic indefinites (the path from (a) to (b) in [Figure 3](#)). This occurred for instance for French *quelque* ([Foulet 1919](#)) and German *irgendein* ([Port & Aloni 2015](#)).

[Haspelmath \(1997\)](#) proposed that indefinites gradually acquire new functions on his map (see [Figure 1](#)) from the right (non-specific) region to the left (specific) region due to weakening (an indefinite gets a new function, and it thus becomes weaker than the previous form). This would explain the cases mentioned above. However, we do not witness further weakening triggering the acquisition of SK.²²

Our framework makes the notion of weakening precise in terms of logical entailment between atoms. We indeed observe a weakening from (a) to (b), since

²¹ The definition of negation requires a semantic clause for implication. In [Definition 14](#), we use a variant from the maximal implication of team logics ([Galliani 2012](#); [Yang 2014](#)). From these definitions it follows that for a sentence containing an epistemic indefinite under negation, as in ‘John did not read irgendein-book’, the only initial supporting team is the one in which John did not read any book.

²² [Haspelmath \(1997\)](#) claims that this occurred for Portuguese *algum*. The data however suggests that *algum* is still an epistemic indefinite and SK uses are not allowed. See [Gianollo \(2020\)](#) for an interesting analysis of the Romance descendants of Latin *aliquis*.

**Figure 3** Weakening of indefinites

$var(v, x)$ entails $var(\emptyset, x)$.²³ But no further ‘atomic weakening’ triggering the acquisition of SK, which explains why such development is not attested.²⁴

4.7 Final Proposal & Illustration

Let us recap what we have discussed so far. Indefinites are strict existentials, which are interpreted *in-situ*. The scope of indefinites is accounted by dependence atoms, which allow co-variation with all the variables in the syntactic scope of the indefinite (see 6). Marked indefinites further trigger the obligatory activation of particular dependence or variation atoms:

(12) MARKED INDEFINITES & ATOMS

$$O_{z_1} \dots O_{z_n} \exists_s x (\phi \wedge ATOM)$$

- a. Plain: $dep(\vec{y}, x)$, where $\vec{y} \subseteq v\vec{z}$
- b. Specific Known: $dep(\vec{y}, x)$ with $\vec{y} = \emptyset$
- c. Specific: $dep(\vec{y}, x)$ with $\vec{y} \subseteq \{v\}$
- d. Epistemic: $dep(\vec{y}, x) \wedge var(\vec{z}, x)$ with $\vec{z} = \emptyset$
- e. Non-specific: $dep(\vec{y}, x) \wedge var(\vec{z}, x)$ with $\vec{z} = v$
- f. Specific Unknown: $dep(\vec{y}, x) \wedge var(\vec{z}, x)$ with $\vec{y} = v$ and $\vec{z} = \emptyset$

As an illustration, consider a configuration of the form $\forall z \forall y \exists_s x \phi$ like (5), where instead of the plain indefinite we have a marked indefinite. Our predictions are summarized in Table 11. We predict wide-scope (known and unknown) for specific indefinites.²⁵ Epistemic indefinites allow all scope configurations, except for wide-scope with known referent. For non-specific indefinites, we predict that they do not

²³ Our framework also predicts a weakening from specific known, $dep(\emptyset, x)$, to specific, $dep(v, x)$. We are however not aware of data concerning the development of specific indefinites.

²⁴ To get unmarked indefinites from epistemic ones, we would need $var(\emptyset, x) \vee dep(\emptyset, x)$, which trivializes the dependence conditions, and it is arguably a complex operation. Note also that $var(\emptyset, x) \wedge dep(\emptyset, x) \models \perp$, which shows that SK contradicts the atom for epistemic indefinites.

²⁵ See fn. 6.

| | WS-K $dep(\emptyset, x)$ | WS-U $dep(v, x)$ | IS $dep(vy, x)$ | NS $dep(vyz, x)$ |
|--|-----------------------------|---------------------|--------------------|---------------------|
| unmarked | ✓ | ✓ | ✓ | ✓ |
| specific $dep(\subseteq v, x)$ | ✓ | ✓ | ✗ | ✗ |
| non-specific $var(v, x)$ | ✗ | ✗ | ✓ | ✓ |
| epistemic $var(\emptyset, x)$ | ✗ | ✓ | ✓ | ✓ |
| specific known $dep(\emptyset, x)$ | ✓ | ✗ | ✗ | ✗ |
| specific unknown $dep(v, x) \wedge var(\emptyset, x)$ | ✗ | ✓ | ✗ | ✗ |

Table 11 Marked Indefinites & Scope

allow for wide-scope readings, but they admit other readings. This is explained by the fact that non-specific indefinites need at least one operator with whom they can co-vary. Data from Russian *-nibud* (Partee 2004) supports our predictions:

- (13) Možet byt', Maša xočet kupit' kakuju-nibud' knigu.
 may be, Maša want buy which-INDEF. book.
- Narrow Scope: It may be that Maša wants to buy some book.
 - Intermediate Scope: It may be that there is some book which Maša wants to buy.
 - #Wide-scope: There is some book such that it may be that Maša wants to buy it.

5 Conclusions

We have developed a two-sorted team semantics framework accounting for indefinites. In this framework, marked indefinites trigger the obligatoriness of dependence or variation atoms, responsible for their scopal and epistemic interpretations. We have applied the framework to characterize the typological variety of indefinites in the case of (non-)specificity. We have then showed how this system accounts for several properties and phenomena associated with (non-)specific indefinites.

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