A team semantics for FC indefinites and their grammaticalization

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Overview Free Choice (FC) indefinites are a type of determiner phrase that conveys a 'freedom of choice' effect (all individuals in the domain are possible values for the indefinite). In (1a), the FC indefinite *any* conveys that there is a book that Sue can take, and all books are possible options. FC indefinites are typically associated with a restricted distribution (e.g., they are ungrammatical in episodic contexts like in (1b)).

(1) a. Sue can take any book.

   b. *Sue took any book.

Aloni & Degano (2022) recently proposed a team-semantics framework for (non)-specific indefinites, using tools from dependence logic (Väänänen 2007). Building upon their work, we extend their framework to include FC indefinites. Our extension captures the restricted distribution of FC indefinites and their relationship with other types of indefinites.

Numerous studies have examined the grammaticalization process of free choice indefinites (Haspelmath 1997, de Vos 2010, Degano & Aloni 2021, a.o.). Our work shows how the diachronic evolution of FC indefinites can be formally analyzed through a team-based system. We improve on Degano & Aloni 2021 by analysing the step-by-step grammaticalization path of FC indefinites within a team-semantics framework, and by strengthening the typological generalizability of the diachronic patterns of FC indefinites. Our work shows how the diachronic evolution of FC indefinites can be formally analysed through a team-based system, and how formal logical frameworks can provide valuable insights into the analyses of grammaticalization processes.

Grammaticalization of FC Indefinites Diachronic studies on the grammaticalization of *wh*-based free choice indefinites (Haspelmath 1997, de Vos 2010 for Dutch *wie dan ook*, Pescarini 2010 for French *n'importe qu-* , Degano & Aloni 2021 for Italian *qualsiasi*, Halm (2021) for Hungarian *akárki*, a.o.) have found a common trend in the early stages of development, which involves two types of constructions: unconditionals and appositives. To illustrate this trend, we will use the Dutch indefinite *wie dan ook* as a representative item, while keeping the rest of the simplified examples in English. For the original examples, we refer the reader to the aforementioned studies. It is worth noting that these diachronic patterns are consistent across languages, which reinforces the typological robustness of our findings.

PHASE I: UNCONDITIONAL. The first phase displays unconditional constructions like (2), where the unconditional is headed by a *wh*-element, in combination with other elements (typically scalar particles and the verb *to be* or *to want*) which will constitute the final form of the indefinite.

(2) *Wie dan ook* comes to the talk, I should present well.
   Unconditional: Whoever comes to the talk, I should present well.

PHASE II: APPOSITIVE. In the second phase, the *wh*-construction takes the form of an appositive clause, often reduced with *wie dan ook* between two commas. Cross-linguistically, we observe two prominent constructions: (3), where the appositive clause is anchored to a 'referential' expression such as a proper name, and (4), where the anchoring is typically to a 'non-referential' expression such as an indefinite. We note that in the former case, the appositive leads to an ignorance reading, whereas in the latter, it generates a free choice reading. It is important to note that the second type of construction in (4) generally requires a modal in the main clause, whereas the construction corresponding to ignorance readings in (3) does not.

(3) John, *wie dan ook*, passed the exam.
   Ignorance: John passed the exam and the speaker does not know who John is.

(4) A student, *wie dan ook*, can pass the exam.
   Free Choice: Any student can pass the exam.

PHASE III: FC INDEFINITES. The grammaticalization path is complete and the *wh*-expression escapes the boundaries of the appositive and it is fully used as a determiner or a pronoun. Typical features of grammaticalization (morphological compounding, phonological reduction, loss of inflection, …) often occur.

(5) *Wie dan ook* can pass the exam.
   Free Choice: Anyone can pass the exam.

Team Semantics for FC Indefinites Aloni & Degano (2022) developed a two-sorted team semantics framework which accounts for (non)-specific indefinites cross-lingustically. In a team-based system, formulas are supported by sets of assignments (teams) rather than single ones. The system is two-sorted and formulas are also evaluated with respect to a world variable. The designated variable for the actual world is v, which encodes the speaker (or relevant agent) epistemic state. Table 2 at the end shows an example of a team corresponding to an epistemic state containing two possibilities, v_1 and v_2, the two possible values for v. In an initial team only v is defined, and new discourse information is added by variables introduced by quantifiers or modals. Different dependencies atoms from dependence logic can be employed to capture the distinct functional distributions of indefinites. For instance, this system offers a principled explanation for the distribution of the Georgian specific *-ghats* series versus the non-specific *-me* series.

We extend Aloni & Degano (2022) with FC indefinites by means of a total variation atom, which corresponds to the anonymity atom studied by Väänänen (2022) in the context of database theory (note that this differs from the upward-closed non-dependence/variation var atom used by Aloni & Degano (2022) to model non-specific indefinites). We show that this condition is sufficient to capture the enriched meaning of FC indefinites and their restricted distribution. In fact, the atom $VAR_{|D|}(v, x)$ ensures that in all epistemic possibilities of the speaker, all values for x are possible. Table 1 summarizes the relevant semantic clauses from Aloni & Degano (2022), together with the total variation atom.

(6) a. Sue can take any book.

    b. $\exists_l w \exists_s x(\phi(x, w) \wedge VAR_{|D|}(v, x))$

    c. $VAR_n(\vec{z}, u) \Leftrightarrow$ for all $i \in T : |\{j(u) : j \in T \text{ and } i(\vec{z}) = j(\vec{z})\}| \geq n$

We will discuss the impact of this total variation condition with respect to the typological generalizations of indefinite systems outlined in Aloni & Degano (2022).

Formal Diachronic Analysis We will now analyze the grammaticalization process outlined above.

PHASE I: UNCONDITIONALS. We assume that the 'antecedent' of an unconditional is an interrogative clause (Rawlins 2008, Ciardelli 2016, a.o). A team system naturally gives rise to a treatment of questions, like in inquisitive semantics (Ciardelli et al. 2018). For a question of the form 'what is x?', which we write as $?x\phi(x, v)$, the answerwood conditions would correspond to all initial teams which support $\exists_s x(\phi(x, v) \wedge dep(\varnothing, x))$, and thus we would get: $[\![?x\phi(x, v)]\!] = \{T : M, T \models \exists x(\phi(x, v) \wedge dep(\varnothing, x))\}$. We can further define $Alt(?x\phi(x, v))$, like in inquisitive semantics, as the set of maximal teams in $[\![?x\phi(x, v)]\!]$.

The latter enables us to analyze unconditionals headed by a *wh*-element, which is sufficient for the constructions we aim to explain. We will discuss how we can also deal with other type of interrogative structures in the antecedent of an unconditional more generally.

(7) UNCONDITIONAL
$M, T \models ?x\phi(x, v) \Rightarrow \psi(v) \Leftrightarrow \forall T' \in Alt(?x\phi(x, v)) : M, T \cap {}^1 T' \models \psi(v)$

A team T supports an unconditional iff for *all* alternatives T' of the antecedent, their intersection with T supports the consequent. We propose that a form of pragmatic enrichment which guarantees $T \cap T'$ to be *non-empty* (cf. Aloni 2022) is operative here. The antecedent of unconditionals is typically associated with an exhaustivity operator (Rawlins 2008). Given this constraint, it follows that the teams T which support a pragmatically enriched unconditional support a variation condition of the form $VAR_{|D|}(\varnothing, x)$ (i.e., $M, T \models \exists_s x(\phi(x, v) \wedge VAR_{|D|}(\varnothing, x))$). We will also discuss a weaker requirement which still gives us $VAR_{|D|}(\varnothing, x)$, without the need of assuming exhaustivity in the antecedent.

(8) UNCONDITIONAL
Wie dan ook comes to the talk, I should present well

    a. <u>At-issue:</u> $?x\phi(x, v) \Rightarrow \psi(v)$

    b. $\rightsquigarrow$ <u>Pragmatic inference:</u> $VAR_{|D|}(\varnothing, x)$

PHASE II: APPOSITIVES. It it typically assumed that appositives contribute to a separate non-at-issue dimension of semantic meaning (Potts 2005). Our proposal is that the variation condition $VAR_{|D|}(\varnothing, x)$, which was initially due to the unconditional, now represents the contribution of the appositive at a non-at-issue level.

For the ignorance case, we treat proper names as terms whose value is fixed with respect to the value of v (i.e., $dep(v, j)$ holds for any name j). This notion of rigidity is in fact compatible with the desired ignorance

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[1]For simplicity, we assume here that T and T' are defined over the same domain. We can generalize such intersection for teams over different domains using standard tools.

inference. The $VAR_{|D|}(\varnothing, j)$ triggered by the appositive in (9b) guarantees that the value of j is (fully) not determined across the epistemic possibilities of the speaker. Note that the stronger $VAR_{|D|}(v, j)$ would be contradictory even in the presence of a modal in the main clause, since $VAR_{|D|}(v, j)$ would contradict $dep(v, j)$.

(9) John, *wie dan ook*, passed the exam.

    a. <u>At issue:</u> $\phi(j, v)$

    b. <u>Non at-issue:</u> $VAR_{|D|}(\varnothing, j)$

When the anchor of the appositive is non-referential as in (10), we observe that the stronger $VAR_{|D|}(v, x)$ does not lead to a contradiction; rather, it would be entailed by $VAR_{|D|}(\varnothing, x)$ in the presence of a modal and in cases of teams of maximal information. We conjecture that the typicality of such configurations in this context may have led to the strengthening of $VAR_{|D|}(\varnothing, x)$ to $VAR_{|D|}(v, x)$.

(10) A student, *wie dan ook*, can pass the exam.

    a. <u>At issue:</u> $\exists_l w \exists_s x(\phi(x, w))$

    b. <u>Non at-issue:</u> $VAR_{|D|}(\varnothing, x)$ (later/eventually strengthened to $VAR_{|D|}(v, x)$)

A relevant issue is how the two dimensions are related to each other in such a way that the anaphoric relations are maintained. For the cases in (9) and (10), it is sufficient to evaluate the non-at issue dimension with respect to the team extended by the operators in the at-issue dimension (i.e., $VAR_{|D|}(\varnothing, x)$ in (10b) would be evaluated with respect to $T[f_l/w][f_s/x]$). We will generalize this by working with a merge operation between the two dimensions which mimics dynamic conjunction (Nouwen 2007, Schlenker 2020):

$T \models merge(\phi_{\text{at-issue}} \wedge \phi_{\text{non-at-issue}})$ iff $T \models \phi_{\text{at-issue}}$ and there is a T' s.t. $T[\phi_{\text{at-issue}}]T'$ and $T' \models \phi_{\text{non-at-issue}}$

Our analysis suggests that the distinction between *at-issue* and *non-at-issue* is not only a synchronic phenomenon. Rather, it appears that languages are attuned to this divide during grammaticalization.

PHASE III: FREE CHOICE INDEFINITE

In the last phase, our item becomes syntactically a full determiner and the strengthened $VAR_{|D|}(v, x)$ is integrated in the semantics of the indefinite, in line with our initial treatment of FC indefinites, which derives their quasi-universal meaning and restricted distribution.

(11)   a. *Wie dan ook* can pass the exam.

     b. $\exists_l w \exists_s x(\phi(x, v) \wedge VAR_{|D|}(v, x))$

$t ::= c \,|\, z_d \,|\, z_w$

$\phi ::= P(\vec{t}) \,|\, \neg P(\vec{t}) \,|\, \phi \vee \psi \,|\, \phi \wedge \psi \,|\, \exists_{strict} z \phi \,|\, \exists_{lax} z \phi \,|\, \forall z \phi$
$| \, dep(\vec{z}, z) \,|\, var(\vec{z}, z) \,|\, VAR_n(\vec{z}, z)$

$\begin{array}{lll}
M, T \models P(t_1, \ldots, t_n) & \Leftrightarrow & \forall j \in T : \langle j(t_1), \ldots, j(t_n) \rangle \in I(P^n) \\
M, T \models \neg P(t_1, \ldots, t_n) & \Leftrightarrow & \forall j \in T : \langle j(t_1), \ldots, j(t_n) \rangle \notin I(P^n) \\
M, T \models \phi \wedge \psi & \Leftrightarrow & M, T \models \phi \text{ and } M, T \models \psi \\
M, T \models \phi \vee \psi & \Leftrightarrow & T = T_1 \cup T_2 \text{ for } T_1 \text{ and } T_2 \text{ s.t. } M, T_1 \models \phi \ \& \ M, T_2 \models \psi \\
M, T \models \forall z \, \phi & \Leftrightarrow & M, T[z] \models \phi \\
M, T \models \exists_{s(trict)} z \, \phi & \Leftrightarrow & \text{there is a strict function } f_s \text{ s.t. } M, T[f_s/z] \models \phi \\
M, T \models \exists_{l(ax)} z \, \phi & \Leftrightarrow & \text{there is a lax function } f_l \text{ s.t. } M, T[f_l/z] \models \phi \\
M, T \models dep(\vec{u}, z) & \Leftrightarrow & \text{for all } i, j \in T : i(\vec{u}) = j(\vec{u}) \Rightarrow i(z) = j(z) \\
M, T \models var(\vec{u}, z) & \Leftrightarrow & \text{there is } i, j \in T : i(\vec{u}) = j(\vec{u}) \text{ and } i(z) \neq j(z) \\
M, T \models VAR_n(\vec{u}, z) & \Leftrightarrow & \text{for all } i \in T : |\{j(u) : j \in T \text{ and } i(\vec{z}) = j(\vec{z})\}| \geq n
\end{array}$

Table 1: Syntax and relevant semantic clauses from Aloni & Degano (2022), together with $VAR_n(\vec{u}, z)$. Formulas are interpreted w.r.t a two-sorted model $M = \langle D, W, I \rangle$, where D is a set of individuals and W a set of worlds. The strict and lax existentials (Galliani 2012) are used to model individual vs world quantification respectively (here z and u are variables of arbitrary type). Dependencies atoms can also be defined over terms.

T	v	w	x	y
i_1	v_1	w_1	d_1	d_1
i_2	v_1	w_2	d_2	d_1
i_3	v_2	w_1	d_1	d_1
i_4	v_2	w_2	d_2	d_1

Table 2: Illustration of a two-sorted team $T = \{i_1, i_2, i_3, i_4\}$ with domain $Z = \{v, w, x, y\}$, and $D = \{d_1, d_2\}$, $W = \{v_1, v_2, \ldots\}$. The team supports $dep(\varnothing, y)$ and $VAR_{|D|}(v, x)$.

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