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# Logic and Engineering of Natural Language Semantics 22 (LENLS22)

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Kobe University
November 25 (Wed) - 28 (Sat), 2026

# Preface

This online proceedings volume contains selected and invited papers on topics in the interdisciplinary fields of linguistics, logic, computation, and philosophy, including the following:

- ✠ Formal syntax, semantics and pragmatics of natural language
- ✠ Model-theoretic and/or proof-theoretic semantics of natural language
- ✠ Computational approaches to semantics and pragmatics
- ✠ Nonclassical logic and its relation to natural language (e.g. substructural, fuzzy, categorical, and topological logic)
- ✠ Formal philosophy of language
- ✠ Scientific methodology and/or experimental design in linguistics

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**Intro:** We analyze a previously unnoticed case of anaphora, which we dub *comp(lement)-subordination*. The phenomenon is exemplified by cases such as (1); in general any determiner which allows for a non-empty complement set may give rise to complement subordination, just in case the scope is the negation of an existential claim involving an indefinite.

(1) a. Three/half/most of my ten students *didn't* write [a paper]$^{y}$.
b. The others (each) sent it$_{y}$ to L&P.

We propose an analysis of comp-subordination as a particular kind of *Q(uantificational)-subordination*, by extending the notion of distributive update developed in *Dynamic Plural Logic* (DPlL) (van den Berg 1996); our key insight is that distributive update introduces a privileged tautology across the entire restrictor set.

**Q-subordination in DPlL:** Quantificational subordination (not to be confused with modal subordination) involves an anaphoric pronoun, with an indefinite antecedent in the scope of a distributive operator as in (2a): here, "it" is interpreted as a variable which *co-varies* with papers written by students. Anaphora to individual papers is only made available by distributing over the students introduced in (2), as demonstrated by the infelicity of (2b) (on the narrow scope reading; *two* > *a paper*).

(2) [Two students]$^{x}$ wrote [a paper]$^{y}$ $\begin{cases} \text{a. they}_{x} \text{ (both) sent it}_{y} \text{to L\&P} \\ \text{b. \#it}_{y} \text{ was well-written} \end{cases}$

The main innovation behind DPlL (van den Berg 1996; see also Nouwen 2003, Brasoveanu 2007) is the idea that (2), as well as introducing a group of students as a (plural) discourse referent (dref), establishes a dependency between individual students and the paper(s) written by them; distributivity in (2a) 're-accesses' the dependencies established by (2). This is modeled by having sentences (indeterministically) update states, realized as *sets of partial assignments*. A simplified translation of (2) into DPlL is given in (3). Note that $\epsilon$ (*random assignment*) accomplishes dref introduction in DPlL.

(3) $\epsilon_{x'} \wedge M_{x'}(Stu(x')) \wedge \epsilon_{x \subseteq x'} \wedge 2(x) \wedge Stu(x) \wedge \delta_{x}(\epsilon_{y} \wedge Pap(y) \wedge 1(y) \wedge Wri(x,y))$

Quantifiers such as "two students" introduce two kinds of plural dref in DPlL: (i) *maxset* anaphora, via $\epsilon_{x'} \wedge M_{x'}(Stu(x'))$; the *maximal* set of students, (ii) *refset* anaphora via $\epsilon_{x \subseteq x'} \wedge 2(x) \wedge Stu(x)$; just two of those students. The distributivity operator $\delta_{x}$ splits the input state into substates keyed on members of the refset, updates each separately, and recombines the outputs (if $s_1$ wrote $p_1$ and $p_2$, and $s_2$ wrote $p_3$, the outputs pair $s_1$ with $p_1$ or $p_2$, and $s_2$ with $p_3$); re-distributing over an output state makes individual paper drefs available for anaphora. We write $\delta_{x}$ for this standard operator; our $\delta_{x,x'}$ below differs from it only in also updating the compset.

**Complement subordination:** Turning to comp-subordination, consider (4).

(4) [Two of my five students]$^{x}$ didn't write a$^{y}$ paper...
a. ...the others (each) submitted it$_{y}$ to L&P.
b. ...\#they$_{x}$ (both) sent it$_{y}$ to L&P.

The refset $x$ introduced by (4) corresponds to two paperless students. Unsurprisingly, distributing relative to $x$ fails to license singular anaphora to papers (4b). This is captured by DPlL, since standard dynamic negation blocks introduction of any drefs. It is also possible, however, to refer back to the *compset*, i.e., the individuals in the maxset *not* in $x$ by using "the others" (Nouwen 2003, Schmitt, Onea & Buch 2017). Distributing relative to the compset allows us to refer back to papers written by them (and carries an implication that *exactly* two students didn't write a paper). DPlL does not capture this, since distributivity never introduces dependencies relative to anything outside of the refset. Note that the problem of comp-subordination is in principle independent of how reference to the compset is established, and we do not commit to a particular analysis; it seems probable to us that 'the others' establishes compset reference indirectly via anaphora to the refset. We note that other varieties of complement anaphora allow for comp-subordination too:

(5) Few of my students didn't ask a question; I gave them plenty of time to prepare it.

Comp-subordination behaves akin to *bona fide* anaphora in multiple respects. Firstly, it is subject to the *formal link condition*, as illustrated by (6a) vs. (6b) ('to be an only child' and 'to not have a sibling' are contextually equivalent).

(6) a. Half of my friends are an only child. #The rest stay in touch with her.
b. Half of my friends don't have [a sibling]$^{y}$. The rest stay in touch with her$_{y}$.

Moreover, like vanilla Q-subordination, complement subordination (7) does not (at least for some speakers) entail uniqueness (example after Heim 1982, Mandelkern & Rothschild 2020).

(7)%Half the boys didn't buy a sage plant—the rest bought 8 others along with it.

We have confirmed the acceptability of (7) with 7 native informants, however a minority find comp-subordination degraded in contexts which contradict uniqueness. We return to uniqueness judgments after presenting the basic analysis.

**Analysis:** We incorporate two crucial components into DPlL: (i) bilateral entries for the existential and negation that validate *Double-Negation Elimination* (DNE) (Krahmer & Muskens 1995, Elliott 2020), and most importantly (ii) a *doubly indexed* entry for the distributivity operator. The idea behind our proposal is that $\delta_{x,x'}$ is keyed to both the refset $x$, which determines the domain of distributive quantification as in standard DPlL, but also the maxset $x'$. Consider (8).

(8) [Two of these three students]$^{x,x'}$ didn't write a$^{y}$ paper.
$\epsilon_{x'} \wedge M_{x'}(Stu(x')) \wedge \epsilon_{x \subseteq x'}$
$\wedge M_{x \subseteq x'}(\delta_{x,x'}(\neg(\exists_y(Pap(y) \wedge 1(y) \wedge Wri(x,y))))) \wedge 2(x)$

$\delta_{x,x'}(\phi)$ does two things (see (14) below for the formal definition): (i) like standard DPlL distributivity, it checks that $\phi$ holds of each member of the refset $x$; (ii) it splits the input state into substates keyed on members of the maxset $x'$, and updates each with a *privileged tautology* $\phi \cup \neg\phi$, where $\cup$ is Groenendijk & Stokhof's (1991) *program disjunction*, which pools outputs. In dynamic semantics, tautologies can be informative:

$\exists_y P(y) \cup \neg\exists_y P(y)$ *conditionally* introduces a dref $y$, depending on whether or not there is a $P$. Since our bilateral entries validate DNE, the same holds when $\phi$ is itself a negated existential: $\neg\exists_y P(y) \cup \neg\neg\exists_y P(y) \equiv \neg\exists_y P(y) \cup \exists_y P(y)$. This is illustrated in Figure 1 for (8), where $s_1, s_2$ didn't write any papers, and $s_3$ wrote $p_1$ and $p_2$. Step-by-step: (i) $s_{1..3}$ are introduced as the maxset $x'$, (ii) $\epsilon_{x \subseteq x'}$ proposes subsets of the maxset as the refset $x$, and $M_{x \subseteq x'}$ keeps only the *maximal* subset that passes the test imposed by distributivity, here $\{s_1, s_2\}$; $2(x)$ then checks its cardinality, (iii) the resulting state is split by elements of the maxset, and each substate is updated by the privileged tautology, (iv) the privileged tautology conditionally introduces paper drefs only relative to $s_3$. If a subsequent sentence re-accesses $G_{x'=s_3}$, then $y$ will clearly be available as a dref.

Scope maximization (as in van den Berg 1996: 149) does essential work here. Since $x$ is the maximal subset of $x'$ satisfying the scope, the compset consists exactly of those members of $x'$ of which the scope is *false*. (a) Hence the compset members of a negated existential scope each satisfy $\neg\neg\exists_y$, so the tautology is guaranteed to introduce witnesses for them. (b) For a *positive* existential scope, by contrast, compset members satisfy $\neg\exists_y$, a test, so no $y$ is introduced: comp-subordination arises just with negated existential scopes. (c) The *exactly* inference noted above is derived, and non-upward-monotone determiners (*few*, *half*) receive the right truth conditions.

**Formal fragment:** *Basics.* A model is a pair $\langle D, I \rangle$, where $D$ is a set of atomic individuals and $I$ interprets predicates; plural predicates hold of sets of atoms. We fix a dummy object $\star \notin D$. An *assignment* is a total function $g : \mathit{Var} \to D \cup \{\star\}$, where $g(x) = \star$ encodes that $x$ is undefined at $g$ (this is equivalent to van den Berg's use of partial assignments); $g^{[x \to a]}$ is just like $g$ except that it maps $x$ to $a$, and $g_\star$ maps every variable to $\star$. A *state* $G$ is a set of assignments; the initial state is $\{ g_\star \}$. The value of a variable $x$ at $G$ (the 'column' $x$), and the substate of $G$ where $x$ is $a$ (the 'rows' where $x$ is $a$), are defined as follows:

(9) $G(x) := \{ g(x) \mid g \in G, g(x) \neq \star \}$ $\qquad G_{x=a} := \{ g \in G \mid g(x) = a \}$, for $a \in D \cup \{\star\}$

Each formula $\phi$ has a positive and a negative update, $[\![\phi]\!]^G_+$ and $[\![\phi]\!]^G_-$, each mapping a state $G$ to a set of non-empty output states. $\phi$ *fails* at $G$ (relative to a polarity) iff this set is empty. $\phi$ is a *test* iff, whenever it succeeds at $G$, its only output is $G$ itself.

*Atoms and conjunction.* Atomic formulas are collective tests (10a,b); the condition $G(x) \neq \emptyset$, common to both polarities, ensures that an atom is undefined (neither true nor false) if its argument has no value at $G$. $n$-ary relations are analogous, e.g., $\langle G(x), G(y) \rangle \in I(\mathit{Wri})$. Conjunction (10c) is relational composition; we leave its negative update unspecified, as it plays no role in what follows.

(10) a. $[\![P(x)]\!]^G_+ = \{ G \mid G(x) \neq \emptyset, G(x) \in I(P) \}$
b. $[\![P(x)]\!]^G_- = \{ G \mid G(x) \neq \emptyset, G(x) \notin I(P) \}$
c. $[\![\phi \wedge \psi]\!]^G_+ = \bigcup \{ [\![\psi]\!]^H_+ \mid H \in [\![\phi]\!]^G_+ \}$

*Introducing drefs.* Random assignment (11a) assigns a non-empty plurality $X$ to $x$, independently of the other variables. Subset assignment (11b) chooses a non-empty subset $X$ of the values of $x'$: rows whose $x'$-value is in $X$ set $x$ to that value, and all other rows

set $x$ to $\star$, so all dependencies are preserved (van den Berg 1996: 137). Crucially, rows outside the refset are $\star$-marked rather than discarded, which is what keeps the compset available. Cardinality (11c) is an atom-like test; proportional determiners (*half*, *most*) are analogous tests comparing $|G(x)|$ with $|G(x')|$ (cf. van den Berg 1996: 149), and we illustrate with a cardinal. Following van den Berg (1996: 141), maximization (11d) is kept separate from random assignment, as in $\epsilon_{x'} \wedge M_{x'}(Stu(x'))$: $M_x(\phi)$ keeps those outputs of $\phi$ for which no rival assignment to $x$ yields an output with a larger value for $x$. $M_{x\subseteq x'}$ (11e) is the analogue for subset assignment, where the rivals re-run $\epsilon_{x\subseteq x'}$, and is used as in $\epsilon_{x\subseteq x'} \wedge M_{x\subseteq x'}(\psi)$. Since $\delta_{x,x'}$ never changes the $x$-column, and succeeds only if the scope holds of every member of $x$, the surviving refset is the set of *all* members of $x'$ of which the scope holds. We leave the negative updates of these operators unspecified.

(11) a. $[\![\epsilon_x]\!]^G_+ = \{\, \{\, g^{[x\to a]} \mid g \in G, a \in X \,\} \mid \emptyset \neq X \subseteq D \,\}$

b. $[\![\epsilon_{x\subseteq x'}]\!]^G_+ = \{\, G_X^{x\subseteq x'} \mid \emptyset \neq X \subseteq G(x') \,\}$, where
$G_X^{x\subseteq x'} := \{\, g^{[x\to g(x')]} \mid g \in G, g(x') \in X \,\} \cup \{\, g^{[x\to\star]} \mid g \in G, g(x') \notin X \,\}$

c. $[\![n(x)]\!]^G_+ = \{\, G \mid G(x) \neq \emptyset, |G(x)| = n \,\}$
$[\![n(x)]\!]^G_- = \{\, G \mid G(x) \neq \emptyset, |G(x)| \neq n \,\}$

d. $[\![M_x(\phi)]\!]^G_+ = \{H \in [\![\phi]\!]^G_+ \mid \neg\exists G' \in [\![\epsilon_x]\!]^G_+, \exists H' \in [\![\phi]\!]^{G'}_+ : H(x) \subsetneq H'(x)\}$

e. $[\![M_{x\subseteq x'}(\phi)]\!]^G_+ = \{H \in [\![\phi]\!]^G_+ \mid \neg\exists G' \in [\![\epsilon_{x\subseteq x'}]\!]^G_+, \exists H' \in [\![\phi]\!]^{G'}_+ : H(x) \subsetneq H'(x)\}$

*Negation and existential quantification.* Following Krahmer & Muskens (1995) and Elliott (2020), negation simply swaps polarities (12a), which immediately validates DNE: $[\![\neg\neg\phi]\!]^G_\pm = [\![\phi]\!]^G_\pm$. The positive update of $\exists_y\phi$ is random assignment followed by $\phi$ (12b); its negative update is a test which succeeds just in case the positive update fails (12c).[1] Since negative $\exists$ is a test, $\neg\exists_y\phi$ never introduces drefs; but $\neg\neg\exists_y\phi$ introduces exactly the drefs that $\exists_y\phi$ does.

(12) a. $[\![\neg\phi]\!]^G_+ = [\![\phi]\!]^G_- \qquad [\![\neg\phi]\!]^G_- = [\![\phi]\!]^G_+$

b. $[\![\exists_y\phi]\!]^G_+ = [\![\epsilon_y \wedge \phi]\!]^G_+$

c. $[\![\exists_y\phi]\!]^G_- = \{\, G \mid [\![\exists_y\phi]\!]^G_+ = \emptyset \,\}$

*Program disjunction.* Groenendijk & Stokhof's program disjunction pools the outputs of its disjuncts (13); we leave its negative update unspecified. Given (12a), the privileged tautology $\phi \cup \neg\phi$ returns the outputs of both the positive and the negative update of $\phi$. It therefore succeeds whenever $\phi$ is defined, and it introduces whatever drefs the true polarity of $\phi$ introduces.

[1] This is a simplification: the full bilateral entry requires $\phi$ to be false for every choice of witness, which would allow undefinedness to project through $\exists$, but would also require the negative update of conjunction, which we leave unspecified.

(13) $[\![\phi \cup \psi]\!]^G_+ = [\![\phi]\!]^G_+ \cup [\![\psi]\!]^G_+$

*Distributivity.* Our doubly indexed distributivity operator is given in (14), where $\phi[x/x']$ is the result of replacing free occurrences of $x$ in $\phi$ with $x'$. If every member of the refset makes $\phi$ true, each maxset substate $G_{x'=b}$ is updated with the privileged tautology; one output $H_b$ is picked per substate, and these are glued back together, along with the rows where $x'$ is undefined, recasting van den Berg's (1996: 145) $\delta_x$ in terms of sets of outputs. The substitution (cf. van den Berg 1996: 149) is needed because $x$ is $\star$ in compset substates; on refset substates $\phi[x/x']$ is equivalent to $\phi$, so $\delta_{x,x'}$ differs from $\delta_x$ only in also updating the compset. Its negative update is left unspecified.

(14) $[\![\delta_{x,x'}(\phi)]\!]^G_+ = \{G_{x'=\star} \cup \bigcup_{b \in G(x')} H_b \mid$
$H_b \in [\![\phi[x/x'] \cup \neg\phi[x/x']]\!]^{G_{x'=b}}_+$ for each $b \in G(x')\}$
if $\forall a \in G(x) : [\![\phi]\!]^{G_{x=a}}_+ \neq \emptyset$; otherwise $\emptyset$

**Uniqueness judgements:** Recall that a sub-population of speakers find comp-subordination degraded in a context that contradicts uniqueness. We hypothesize that these speakers have uniqueness judgments for cases of anaphora involving double negation more generally, including in so-called 'bathroom disjunctions':

(15) a. %It's not true that John didn't buy a sage plant;
he bought 8 others along with it!
b. %Either John didn't buy a sage plant, or he bought 8 others along with it.

This leaves open whether double-negation elimination wrt anaphora is appropriate for all speakers; we speculate that the variation lies in the formulation of the privileged tautology, following Gotham (2019).

**Discussion:** Complement subordination aligns with a broad range of anaphoric phenomena suggesting the following generalization (adapted from Mandelkern 2022; Chatain 2025): an anaphoric pronoun indexed $x$ may be used if (i) there is a co-indexed indefinite antecedent, and (ii) a witness to the indefinite antecedent is entailed in the pronoun's local context. In the case of complement subordination, the relevant notion of 'local context' is provided by the notion of *distributive update*—the co-indexed indefinite antecedent introduces the *paper* witness $y$ just in those substates corresponding to students who wrote papers. Static accounts of anaphora and negation (Mandelkern 2022, Chatain 2025, Spector 2026) exist, but to our knowledge none covers quantificational subordination.

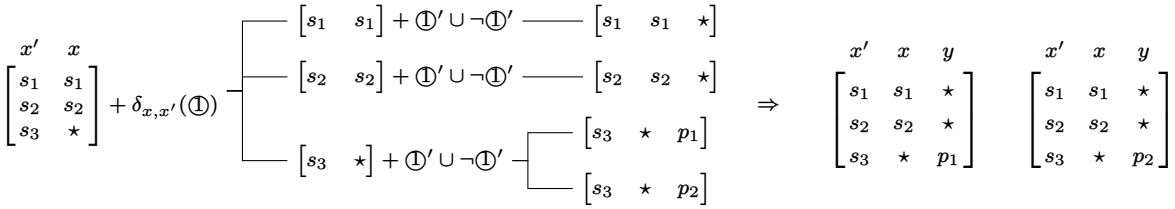



Figure 1: $\epsilon_{x'} \wedge M_{x'}(Stu(x')) \wedge \epsilon_{x \subseteq x'}$
$\wedge M_{x \subseteq x'}(\delta_{x,x'}(① \neg\exists_y(Pap(y) \wedge 1(y) \wedge Wri(x,y)))) \wedge 2(x)$ where $①' := ①[x/x']$

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# From Dependent Anaphora to Paycheck Pronouns in Static Orthodox First-Order Logic

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**Abstract.** The Skolemization-based approach to anaphora advocated building logical forms (formulas) with not yet resolved pronouns, and later conjoining the result of their resolution (coindexing). The proposal is static, simply-typed, minimalist, intuitionistic, with the orthodox quantification, binding and scope. Crucially, Skolem-like pronoun terms, like ordinary Skolem terms, depend on the variables in scope.
We extend this approach to more interesting and complicated cases of pronominal anaphora: dependent anaphora, paycheck pronouns, and binding reconstruction. All these cases of 'higher-order' anaphora arise naturally, as a consequence of variable dependence of the pronoun terms.

## 1 Introduction

The paper [6] proposed a non-dynamic account of pronominal anaphora, based on the conventional first-order logic with the orthodox quantification, binding and scope. It is inspired by and extensively relies on *intuitionistic* Skolemization. First, the approach lets one use one's favorite syntax-semantics interface to obtain logical forms (formulas), treating pronouns as a black-box, without any prior coindexing. In the logical formulas, the pronouns are to be represented by Skolem-like function symbols. One may then use one's favorite pragmatic theory to resolve the pronouns, based on the obtained logical forms. Finally, the approach lets one conjoin to the logical formulas the result of the resolution (coindexing).[1] Although coindexing is delegated to pragmatics, the logical formulas constrain the coindexing, helping the resolution and delivering predictions, of unavailability of particular antecedents.

The present paper extends the approach [6] to dependent anaphora and the related phenomena, which are often characterized as *higher-order*, or *intensional* anaphora. The motivating example is "Every boy received a present. Some opened it." On the reading we are interested in, the boys who opened presents opened their own present. In other words, 'it' covaries with the boy even though the scope of the universal does not extend past the first clause. Unexpectedly, the example turned out rather straightforward. Also unexpected were far-reaching connections, to paycheck pronouns. We also touch upon binding reconstruction.

The common refrain (as in donkey anaphora, come to think of it, and cross-disjunctive–clause anaphora, also analyzed here) is that the referent of a pronoun, although may intuitively be clear, is not that easy to pinpoint formally. (It might not even exist: such non-specific readings are the subject of the continuing work.) We shall see that intensions, first-class assignments, 'higher-order' references arise automatically in our framework: the consequence of Skolem-like pronoun terms, like ordinary Skolem terms, being functions of variables in scope.

### Dependent Anaphora

We use the motivating example first to introduce the Skolemization-based approach, and then to analyze dependent anaphora.

[1] This multi-stage process is to be contrasted with the 'resolution-on-the-fly' of DRT [4] and Muskens [7].

Consider (1), whose linear scope reading is straightforwardly expressed by the logic formula (2), which is just as straightforwardly Skolemized as (3).

(1) Every boy received a present.

(2) $\forall x{\in}\mathsf{Boy}.\, \exists y{\in}\mathsf{Present}.\, \mathsf{Received}(y, x)$

(3) $\forall x{\in}\mathsf{Boy}.\, \mathsf{Present}(\mathsf{c}(x)) \wedge \mathsf{Received}(\mathsf{c}(x), x)$

The logic is the standard first-order predicate logic (FOL). The Skolem term $\mathsf{c}(x)$ is the witness for the existential. The Skolem "constant" $\mathsf{c}$ is generally a function symbol, applied to the variables in scope (in our case, $x$). We'll write (3) in the alternative form:

(4) $(\forall x{\in}\mathsf{Boy}.\, \mathsf{Received}(\mathsf{c}(x), x)) \;\wedge\; (\forall x{\in}\mathsf{Boy}.\, \mathsf{Present}(\mathsf{c}(x)))$

The second conjunct effectively says that $\mathsf{c}$ maps boys to presents. One could say $\mathsf{c}$ is of the type $\mathsf{Boy} \to \mathsf{Present}$ – but we won't, preferring to keep the type system simple.

As the continuation of (1), consider (5) whose meaning is represented by (6).

(5) John opened it. (6) $\mathsf{Opened}(\mathsf{f}, \mathsf{john})$

The pronoun is denoted by the Skolem-like *pronoun term* $\mathsf{f}$ (a constant in this case). Like Skolem terms, pronoun terms generally depend on the variables in scope. There are none in this case.

In any model that satisfies (4) and (6), $\mathsf{f}$ has to be interpreted as an element of the model domain. It may be a salient object, with no connection to boys' presents, that the listener is expected to know about: the pragmatic use of pronouns, or exophora [8]. A satisfying model[2] would also have domain elements $j$ for $\mathsf{john}$ and $p$ for a present, such that $j \in \mathsf{Boy}$ and $(j, p) \in \mathsf{Received}$. Then $\mathsf{f}$ may be interpreted (or, resolved) as that $p$. Such identification of the pronoun term with its referent (domain element) can also be expressed syntactically, so to speak – in terms of the logic formula rather than its model: in other words, in terms of the Herbrand model, constructed using the function symbols of the formula itself. The resolution of $\mathsf{f}$ to the present received by $\mathsf{john}$ is expressed by conjoining the equality formula (called resolution restriction in [6]):

$(\forall x{\in}\mathsf{Boy}.\, \mathsf{Received}(\mathsf{c}(x), x)) \wedge (\forall x{\in}\mathsf{Boy}.\, \mathsf{Present}(\mathsf{c}(x))) \wedge \mathsf{Opened}(\mathsf{f}, \mathsf{john}) \wedge \mathsf{f} = \mathsf{c}(\mathsf{john})$

This is the meaning of the discourse (1), (5) upon the resolution of the pronoun. This is the only choice for interpreting the pronoun that does not refer to objects outside the discourse.

Now, suppose the discourse (1) continues as (7), with the meaning (8):

(7) Some opened it. (8) $\forall y{\in}\mathsf{SomeBoys}.\, \mathsf{Opened}(\mathsf{f}(y), y)$

where $\mathsf{SomeBoys}$ is a subset of boys with at least two members. The pronoun term is now in scope of the variable $y$, and $\mathsf{f}$ is a function symbol.

The resolution has to define this function. As specified in [6], the resolution restriction is a closed (universally quantified) equality formula, equating a pronoun term to some other term (which may be just a variable occurring in the pronoun term). For our discourse, the only choice for the resolution in the Herbrand model (i.e., identifying $\mathsf{f}(y)$ with terms built using $y$ and constants or function symbols mentioned in the formulas) gives:

(9) $(\forall x{\in}\mathsf{Boy}.\, \mathsf{Received}(\mathsf{c}(x), x)) \wedge (\forall x{\in}\mathsf{Boy}.\, \mathsf{Present}(\mathsf{c}(x))) \wedge$
$\forall y{\in}\mathsf{SomeBoys}.\, \mathsf{Opened}(\mathsf{f}(y), y) \;\wedge\; \forall y.\, \mathsf{f}(y) = \mathsf{c}(y)$

which means that whoever opened the present opened their own present.

[2] Let's assume the universal has existential import.

**Paycheck pronouns**

(10) John deposited his paycheck but Bill spent it.

Here, the understood meaning is that Bill spent his own paycheck rather than John's paycheck. In that case, there is no proper linguistic antecedent for 'it', which is the puzzle. The meaning of the sentence, treating 'it' as a black box (as a pronoun term $\mathsf{f}_i$, to be precise) can be expressed as (11) and then Skolemized as (12).

(11) $(\exists x{\in}(\mathsf{Paycheck} \cap \mathsf{BelongTo}(\mathsf{f}_h)).\, \mathsf{Dep}(x, \mathsf{john})) \ \wedge \ \mathsf{Spent}(\mathsf{f}_i, \mathsf{bill})$

(12) $\mathsf{Dep}(\mathsf{c}_p(\mathsf{f}_h), \mathsf{john}) \wedge (\forall z{\in}\mathsf{Men}.\, \mathsf{Paycheck}(\mathsf{c}_p(z)) \wedge \mathsf{BelongTo}(z, \mathsf{c}_p(z)))$
$\wedge\, \mathsf{Spent}(\mathsf{f}_i, \mathsf{bill})$

The restrictor, or the domain of the existential quantifier in (11) depends on the resolution of 'his'. Therefore, the Skolem term is a function of $\mathsf{f}_h$.

The only choice to resolve $\mathsf{f}_i$ (that is, 'it') in the Herbrand model is to apply $\mathsf{c}_p$ to a suitable man: Bill, viz., $\mathsf{f}_h = \mathsf{john} \wedge \mathsf{f}_i = \mathsf{c}_p(\mathsf{bill})$, or John.

Another common example of paycheck pronouns

(13) Every linguist deposited his paycheck but every philosopher spent it.

is even easier (again, we first show the logical form and then its Skolemization, using $x$ for a linguist and $y$ for a philosopher):

(14) $(\forall x{\in}\mathsf{Ling}.\, \exists u{\in}(\mathsf{Paycheck} \cap \mathsf{BelongTo}(\mathsf{f}_h(x))).\, \mathsf{Dep}(u, x)) \wedge$
$\forall y{\in}\mathsf{Phil}.\, \mathsf{Spent}(\mathsf{f}_i(y), y)$

(15) $(\forall x{\in}\mathsf{Ling}.\, \mathsf{Dep}(\mathsf{c}_p(x, \mathsf{f}_h(x)), x)) \wedge$
$(\forall x{\in}\mathsf{Ling}.\, \forall z{\in}\mathsf{Men}.\, \mathsf{Paycheck}(\mathsf{c}_p(x, z)) \wedge \mathsf{BelongTo}(z, \mathsf{c}_p(x, z))) \wedge$
$\forall y{\in}\mathsf{Phil}.\, \mathsf{Spent}(\mathsf{f}_i(y), y)$

The pronoun resolution is straightforward, giving the intended reading that philosophers spent their own paychecks: $\mathsf{f}_h(y) = y \wedge \mathsf{f}_i(y) = \mathsf{c}_p(y, y)$. To be sure, formally speaking there are other choices for $\mathsf{f}_i(y)$, even in the Herbrand model, for example: $y$, $\mathsf{f}_h(y)$. They are implausible, i.e., unsatisfiable in any model of our world, where $\mathsf{Spent}$ is irreflexive. We should stress again that conjoining resolution restrictions is not the process of pronoun resolution but a mere recording of its result. The resolution itself is to be carried offline, most likely involving world knowledge. This resolution process is out of scope for us. Still, the fact that its result has to be represented in the form of a resolution restriction (conjunction of closed formulas of certain kind) restricts the process and its available choices.

**Dependent anaphora as paycheck anaphora**

One can hardly escape noticing that our analysis of the paycheck pronouns is similar to the dependent anaphora analysis earlier. In fact, the motivating example of dependent anaphora (1) can be rephrased as

(16) Every boy received his own present.

representing the narrow-scope existential determiner in 'a present' as 'his own'. The rephrase, followed by (7), becomes the example of paycheck pronouns.

**A Remark on Binding Reconstruction**

Charlow [2] analyzed binding reconstruction similarly to paycheck pronouns, since both share the 'higher-order' reference nature.

(17) $[\text{His}_i \text{ mom}]_j$, every $\text{boy}_i$ likes $t_j$.

Since we leave the choice of the syntax-semantics interface to the user, our analysis depends on how the chosen interface handles reconstruction. If it is handled syntactically, the obtained logical form for (17) is the same as for "Every boy likes his mom", which is the garden-variety bound-variable anaphora. In semantic reconstruction, by its very definition the landing position is "out of context" for the moved phrase. The moved phrase then must be a function of context. Thus any semantic reconstruction approach invariably ends up with the logical form like $\mathsf{Front}(\lambda u.\,\text{his mom}, \lambda t.\,\forall x \in \mathsf{Boy}.\,\mathsf{Like}(t\,x, x))$.[3] Therefore, the pronoun term for "his", viz. $\mathsf{f}(u)$, has to depend on the context (the variable $u$). The resolution $\mathsf{f}(u) = u$ makes "his" refer to a boy, without the need to postulate the wide scope for the universal.

### Donkey Anaphora and Disjunctive Clauses

Recall the analysis of the conditional donkey anaphora from [6]:

(18) If Sarah owns a donkey, she beats it.

(19) $$(\exists d.\,\mathsf{D}(d)) \to \mathsf{B}(\mathsf{f}_1)$$

where $\mathsf{D}$ is some predicate concerning Sarah and donkeys and $\mathsf{B}$ is about beating. Notably, the consequent is out of scope of the quantifier. The approach [6] relies on *intuitionistically valid* Skolemization: an existentially-quantified subformula to Skolemize must not be under negation or at the left-hand-side of an implication. Therefore, we cannot Skolemize (19) as is.

The solution proposed in [6] is based on the observation that for any formulas $\phi$ and $\psi$ we have $\phi \to \psi \;\equiv\; \phi \to (\phi \wedge \psi)$ both classically and intuitionistically. The copy of $\phi$ on the right-hand-side of the implication is intuitionistically Skolemizable.

The same approach applies to negation, treated as an implication to $\bot$.

(20) In this room, there is no window. *It is on the left.

(21) $$((\exists x{\in}\mathsf{Window}.\,\mathsf{InRoom}(x)) \to \bot) \wedge \mathsf{Left}(\mathsf{f}_1)$$

(22) $$\big(((\exists x{\in}\mathsf{Window}.\,\mathsf{InRoom}(x)) \to \mathsf{InRoom}(\mathsf{c}_1) \wedge \bot) \wedge \mathsf{Left}(\mathsf{f}_1)\big) \wedge \mathsf{Window}(\mathsf{c}_1)$$

After applying the trick, (21) is Skolemized as (22), letting us adjoin the resolution restriction $\mathsf{c}_1 = \mathsf{f}_1$. The Skolem constant $\mathsf{c}_1$, and hence $\mathsf{f}_1$, refer to a window. No interpretation in which that window is in the room satisfies the formula, however. On the other hand (treating "or" as exclusive, although this is immaterial):

(23) In this room, either there is no window, or it is on the left.

(24) $$((\exists x{\in}\mathsf{Window}.\,\mathsf{InRoom}(x)) \to \bot) \text{ xor } \mathsf{Left}(\mathsf{f}_1)$$

(25) $$\big(((\exists x{\in}\mathsf{Window}.\,\mathsf{InRoom}(x)) \to \mathsf{InRoom}(\mathsf{c}_1) \wedge \bot) \text{ xor } \mathsf{Left}(\mathsf{f}_1)\big) \wedge \mathsf{Window}(\mathsf{c}_1)$$

Resolving $\mathsf{f}_1$ by identifying it with $\mathsf{c}_1$ is now meaningful.

## 2 Related work

All the considered phenomena are called higher-order: the denotation of a pronoun is not a simple individual (i.e., extension) but 'intension': see the extensive bibliography in [1, 2].

Charlow [2], building on Heim and Kratzer, shows that a higher-order pronoun assignment is just the currying of the ordinary assignment. In contrast, [3] used a dynamic approach for intensions. They are not that different: both are essentially

[3] Although it looks like a second-order formula, it can be encoded, with some awkwardness, in FOL.

dynamic binding (Charlow's approach is an environment-passing realization of dynamic binding). The latter [1] fully explicate and develop this overarching idea.

Our analysis of binding reconstruction is in the same spirit as Charlow's. But the higher-order reference arises naturally: the consequence that the pronoun appears in the 'variable' context and hence must vary with it.

E-type/D-type approaches to anaphora consider pronouns as a sort of a definite description. That definiteness is also the source of the approach's many problems: sometimes pronouns are not that definite (The bishop sentences come to mind), as discussed in detail in [5, Eq. (50)]. On our account, in contrast, pronouns are sort of *indefinite*, which come with with no uniqueness requirements.

At some points close but overall contrasting, even diametrically different approach is Steedman's [9], putting forth a theory of quantification in Combinatory Categorial Grammar. Steedman treats all indefinites and other non-universal NPs, as well as pronouns, as Skolem terms – actually, first as so-called unspecified Skolem terms, which at some point get specified, and made dependent on the (universally quantified) variables in scope at that point. The basis of Steedman approach is a CCG, i.e., syntactic derivation. We, on the other hand, work on the level of logical forms. It should be stressed that unspecified Skolem terms of Steedman have no logical meaning (no model-theoretic interpretation), and neither does the specification procedure. In our approach, Skolem terms and pronoun terms (which are logical constants/function symbols applied to variables in scope) have the standard model theoretic meaning (as expounded in [6]). Resolution restrictions, and the process of conjoining them, likewise has the meaning of the standard logical conjunction. One of the main differences is our use of intuitionistic Skolemization. It implies that not all existentials are Skolemizable: only those in 'positive' contexts. Incidentally, that means conditionals are not required to be classical implications (which they, arguably, are not).

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# A CDRT Analysis of the Indefinite Interpretation of Russian Pronouns as Predicate Anaphora

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**[Data and question:]** Russian anaphoric pronouns have an indefinite interpretation: they may be interpreted as **arbitrary individual(s)** that satisfy the property contributed by the antecedent, rather than as the same individual(s). In (1A), *oni* is interpreted as an arbitrary group of children not playing in *this kindergarten*.

(1) *V èt-om detsk-om sadik-e {A deti$_i$/B rebënok$_i$/C deti$_i$} sejčas*
in this child's-SG.LOC garden-SG.LOC child-{A PL/B SG/C PL}.NOM now
*igra{A-jut/B-et/C-jut}, a v t-om detsk-om sadik-e*
play-PRS.{A 3PL/B 3SG/C 3PL}, and in that child's-SG.LOC garden-SG.LOC
*{A **oni**$_j$/B ?**oni**$_j$/C #**on**$_j$} sejčas sp{A-jat/B-jat/C-it}.*
{A 3PL/B 3PL/C 3SG}.NOM now sleep-PRS.{A 3PL/B 3PL/C 3SG}.
A: 'In this kindergarten children$_i$ are playing now, and in that kindergarten children$_j$ are sleeping now.'
B: ? 'In this kindergarten a child$_i$ is playing now, and in that kindergarten children$_j$ are sleeping now.'
C: # Intended: 'In this kindergarten children$_i$ are playing now, and in that kindergarten a child$_j$ is sleeping now.'

This indefinite interpretation is also attested in corpus data, as shown in (2), taken from the Russian National Corpus. Here, the antecedent of the pronoun *ego* is the NP *nov-yj fonarik* 'new torch', even though this NP describes the torch the addressee was going to buy, whereas *ego* refers to the torch the speaker bought.

(2) *Kazhetsja, vy š-li kupi-t' seb-e*
Apparently, you.PL.NOM go.IPFV-PL.PST buy.PFV-INF self-DAT
*nov-yj fonarik? Ja uže kupi-la **ego***
new-M.SG.ACC torch.M.SG.ACC? I.NOM already buy.PFV-F.PST it.M.ACC
*na obratn-om put-i.*
on reverse-M.SG.LOC way-M.SG.LOC.
'You were on your way to buy a new torch, right? I already bought one on my way back.'

This phenomenon cannot be accounted for by a straightforward application of the existing E-type or dynamic analyses, both of which capture only the English-like, definite interpretation of anaphora. Note that Russian pronominal anaphora can also receive a definite interpretation; in this sense, Russian pronouns are ambiguous.

The indefinite interpretation exhibits two interesting patterns. First, indefinite anaphora can **cross the negation boundary** as in (3): the pronoun *ego* in the second clause successfully refers back to *iPad* in the negated first clause.

(3) *U Ivan-a net ajpad-a$_i$, a Bill kupi-l **ego**$_j$ včera.*
by Ivan-GEN not.be iPad-M.SG.GEN but Bill.NOM bought-M **him** yesterday
'Ivan doesn't have an iPad, but Bill bought one yesterday.'

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This phenomenon is also found in corpus data. In (4), taken from the Russian National Corpus, the pronoun *ego* takes as its antecedent *priglasitel'n-yj bilet* 'invitation card', which is in the scope of negation.

(4) *Poskol'ku nikto* ne *sobira-l-sja* *podnasi-t'* *Mari-i*
Since anyone.NOM not gather-M.SG.PST-REF present-INF Marija-DAT
*priglasitel'n-yj* *bilet* *na bljudečk-e,* *ona*
invitation-M.SG.ACC card.M.SG.ACC on saucer-N.SG.LOC, she.NOM
*kupi-la* ***ego*** *u* *francuzsk-ikh* *ustroitel-ej*
bought.PFV-F.PST it.M.ACC from French-PL.GEN organizer.PL.GEN
*bal-a,* *...*
ball-M.SG.GEN, ...
'Since nobody was going to give an invitation card to Marija on a silver platter, she bought one from the French organizers of the ball, ...'

If we are to analyze the indefinite interpretation in parallel with ordinary anaphoric expressions within a dynamic framework, this would be problematic, since negation is externally static in dynamic semantics.

Second, indefinite anaphora shows a **plural-singular asymmetry**: anaphora from a plural to a singular antecedent is much more acceptable than the reverse, which is totally unacceptable. The sentences in (1B-C) show this contrast. This constraint distinguishes Russian pronouns from English anaphoric *one* (as in *some children are sleeping, but one is playing*), since the antecedent of *one* is free from such number constraints.

The goal of this paper is to explore the possibility of accounting for the indefinite interpretation by extending a dynamic framework. A pronoun with an indefinite interpretation refers only to the kind expressed by the noun, rather than to the individual(s) itself. Thus, a theory that can capture this interpretation must allow reference to the kind itself. However, since dynamic frameworks only allow pronouns to refer to discourse referents (henceforth, drefs) corresponding to individuals, they need to be extended so that a noun introduces, in addition to an ordinary dref for individuals, a dref that corresponds to the kind the noun expresses. We will call this kind-level dref a *predicate dref* to distinguish it from an ordinary dref, or *individual dref*. A Russian pronoun is ambiguous between a definite and an indefinite interpretation, depending on which dref it refers to.

[**Proposal:**] The system this paper proposes is an extension of Compositional DRT (Muskens, 1996). The basic types are $s_{ind}$, $s_{pred}$, $e$, and $t$. A full state $i$, which is updated by utterances, is a pair of an individual state $i_{ind}$ (type $s_{ind}$) and a predicate state $i_{pred}$ (type $s_{pred}$), thus of type $s_{ind} \times s_{pred}$.

We will use abbreviations $\mathbf{s} := s_{ind} \times s_{pred}$, $\mathbf{e} := \langle s_{ind}, et\rangle$ and $\mathbf{t} := \langle \mathbf{s}, \mathbf{s}t\rangle$. Drefs have two types: indefinite drefs $u$'s of type $\mathbf{e}$ and predicate drefs $\gamma$'s of type $\langle s_{pred}, \mathbf{et}\rangle$. As shown in Table 1, the individual and predicate states determine the set of individuals assigned to each individual dref and the predicate assigned to each predicate dref, respectively.

In this system, the NP *cars*, for instance, introduces two drefs: an individual dref $u_{\mathbf{e}}$ for **the set of cars introduced by this specific NP** and a predicate dref $\gamma_{\langle s_{pred}, \mathbf{et}\rangle}$ for **the property of being cars**. The idea echoes variable-free semantics

| | | | | | |
|---|---|---|---|---|---|
| $i_{ind}$ | $u_1$ | $u_2$ | $u_3$ | $u_4$ | $\cdots$ |
| | $\{a\}$ $(= u_1(i_{ind}))$ | $\{b\}$ $(= u_2(i_{ind}))$ | $\{a, b\}$ $(= u_3(i_{ind}))$ | $\{c\}$ $(= u_4(i_{ind}))$ | $\cdots$ |
| $i_{pred}$ | $\gamma_1$ | $\gamma_2$ | $\gamma_3$ | $\gamma_4$ | $\cdots$ |
| | $P_1$ $(= \gamma_1(i_{pred}))$ | $P_2$ $(= \gamma_2(i_{pred}))$ | $P_3$ $(= \gamma_3(i_{pred}))$ | $P_4$ $(= \gamma_4(i_{pred}))$ | $\cdots$ |

Table 1: An example full state $i = \langle i_{ind}, i_{pred} \rangle$

(Jacobson, 1999; Shan, 2002), where pronouns refer to the predicates themselves rather than the individuals introduced by the antecedent.

The fusion of two drefs is realized by an operator $\oplus$, as defined below.

$$\lambda i_{\mathbf{s}}.(u_1 \oplus u_2)(i) := \lambda i_{\mathbf{s}}.u_1(\pi_1(i)) \cup u_2(\pi_1(i))$$
$$\lambda u_{\mathbf{e}}.[(\gamma_1 \oplus \gamma_2)\{u\}] := \lambda u_{\mathbf{e}}.[u_1]; [u_2]; [u = u_1 \oplus u_2]; [\gamma_1\{u_1\}]; [\gamma_2\{u_2\}]$$
$$\text{where } \lambda u.\gamma\{u\} := \lambda u.\lambda i.\lambda j.i = j \wedge \gamma(\pi_2(j))(u)(i)(j)$$

The individual dref fusion follows PCDRT (Brasoveanu, 2007); the predicate dref fusion is defined in parallel. While $\gamma\{u\}$ means that $u$ has the property associated with $\gamma$, $(\gamma_1 \oplus \gamma_2)\{u\}$ means that $u$ fuses two individual sets, one with the property associated with $\gamma_1$ and the other with the property associated with $\gamma_2$.

For instance, the NP *bicycles and cars* introduces an individual dref which corresponds to the set of individuals consisting of at least one bicycle and one car. It simultaneously introduces a predicate dref corresponding to the property that any sets consisting of multiple cars and bicycles have.

**[Analysis of Russian pronouns:]** Although Russian lacks overt articles, we assume the presence of covert articles that attach directly to N-heads, as in (5), which represents the structure of *tri déti* ('three children').

(5) $[_{\text{NP}}$ tri $[_{\text{N}}$ $\varnothing_{\text{indef}}$ déti $]]$

The covert articles correspond to the type-shifters proposed by Chierchia (1998). $\varnothing_{\text{indef}}$ introduces both an individual and a predicate dref, where $\gamma$ is associated with the noun to which $\varnothing_{\text{indef}}$ attaches.

$$\varnothing_{\text{indef}} \rightsquigarrow \lambda P_{\mathbf{et}}.\lambda P'_{\mathbf{et}}.[u]; [P(u)]; [\gamma | \gamma = P]; [P'(u)]$$

A pronoun can refer to either an individual or a predicate dref, as shown below (*oni*: plural; *on*: singular). Predicate-referring pronouns induce the indefinite interpretation; individual-referring ones give the English-like definite interpretation.

$$\texttt{oni}_u \rightsquigarrow \lambda P_{\mathbf{et}}.[P(u)] \qquad \texttt{oni}_\gamma \rightsquigarrow \lambda P_{\mathbf{et}}.[u]; [\bigoplus_{1 \le m \le |u|} \gamma\{u\}]; [P(u)]$$
$$\texttt{on}_u \rightsquigarrow \lambda P_{\mathbf{et}}.[\mathbf{atom}\{u\}]; [P(u)] \qquad \texttt{on}_\gamma \rightsquigarrow \lambda P_{\mathbf{et}}.[u]; [\gamma\{u\}]; \mathbf{Atom}(\gamma); [P(u)]$$

$\mathbf{atom}(u)$ is an atomicity predicate (Brasoveanu, 2007), meaning that $u$ is singular, and $\mathbf{Atom}(\gamma)$ is a predicate singularity operator that requires $\gamma$ to take only singular inputs. The semantic markedness of singular items (Sauerland et al., 2005) is realized by this predicate. Between the two individual-referring pronouns, the only difference is the insertion of $\mathbf{atom}(u)$.

Predicate-referring *oni* introduces a new individual dref corresponding to the set of individuals, each of which satisfies the predicate associated with $\gamma$. Note that the second bracket splits $u$ into $|u|$ subsets and apply $\gamma$ to each. Similarly, predicate-referring *on* introduces the individual dref $u$ satisfying $\gamma$, but further requires $\gamma$ to be a singular predicate, guaranteeing the singularity of $u$.

The composition of (1A) proceeds as follows.

(6) a. $[[_{\text{NP}}\ [_{\text{N}}\ \varnothing_{\text{indef}}\ \text{child-PL}\ ]^{u,\gamma}][_{\text{VP}}\ \text{playing}\ ]]$ b. $[[_{\text{NP}}\ \text{they}_{\gamma}^{u'}\ ][_{\text{VP}}\ \text{sleeping}\ ]]$

First, following Brasoveanu (2007), we use an abbreviation as follows:

$$\lambda u_{\mathbf{e}}.R\{u\} = \lambda u_{\mathbf{e}}.\lambda i_{\mathbf{s}}.\lambda j_{\mathbf{s}}.i = j \wedge R_{et}(u(\pi_1(i)))$$

Then, the translation of each predicate is as in the formulas below:

$\texttt{children} \rightsquigarrow \lambda u_{\mathbf{e}}.child\{u\}$ $\texttt{playing} \rightsquigarrow \lambda u_{\mathbf{e}}.play\{u\}$ $\texttt{sleeping} \rightsquigarrow \lambda u_{\mathbf{e}}.sleep\{u\}$ The

first sentence in (6a) is composed as follows:

$$\varnothing_{indef}\ \text{child-PL} \rightsquigarrow \lambda P'_{\mathbf{et}}.[u];[child\{u\}];[\gamma|\gamma = child];[P'(u)]$$
$$(6a) \rightsquigarrow [u];[child\{u\}];[\gamma|\gamma = child];[play\{u\}]$$

The second sentence in (6b) is composed as follows:

$$(6b) \rightsquigarrow [u'];[\bigoplus_{1\leq m\leq |u'|} \gamma\{u'\}];[sleep\{u'\}]$$

Since $\gamma(\pi_2(i)) = child$, the full composition is equivalent to the following:

$$[u];[child\{u\}];[\gamma|\gamma = child];[play\{u\}];[u'];[\bigoplus_{1\leq m\leq |u'|} child\{u'\}];[sleep\{u'\}]$$

The pronoun $oni_{\gamma}$ introduces an individual dref $u'$ which refers to a set of children. Since $u'$ is distinct from $u$, the two sets of children need not be identical.

**[Negation in Russian:]** The translation of the Russian negation particle *net* is defined so that negating a sentence with DRS $D$ **preserves the individual state while still updating the predicate drefs** introduced in $D$. This can be formalized by updating $\pi_1(i)$ and $\pi_2(i)$ separately.

$$\sim D := \lambda i_{\mathbf{s}}\lambda j_{\mathbf{s}}.\ \underbrace{\neg\exists k_{\mathbf{s}}.D(i)(k)}_{D \text{ is } \textit{false} \text{ in } i} \wedge \underbrace{D^{\star}(i)(j)}_{\text{the introduction of predicate-anaphoric drefs is conveyed to the output}}$$

where $D^{\star}$ is defined recursively as follows:

$$[R\{u_1,\ldots,u_n\}]^{\star} := [\lambda i.R(u_1(i),\ldots,u_n(i)) \vee \top];[u]^{\star} := \lambda i\lambda j.i = j;$$
$$[\gamma|\gamma = P]^{\star} := [\gamma|\gamma = P];(D_1;D_2)^{\star} := (D_1^{\star};D_2^{\star})$$

$\texttt{ne} \rightsquigarrow \lambda P_{\mathbf{et}}\lambda u_{\mathbf{e}}.\sim P(u)$

This accounts for the external dynamicity of negation with respect to the indefinite interpretation, as observed in (3).

[**Pl. vs. sg.:**] Following Sauerland et al. (2005) again, we will assume that only the singular suffix marks the number features of the dref that a predicate applies to.

$$\texttt{-SG} \rightsquigarrow \lambda P_{\mathbf{et}} \lambda u_{\mathbf{e}}.[P(u)]; [\mathbf{atom}(u)] \qquad \texttt{-PL} \rightsquigarrow \lambda P_{\mathbf{et}} \lambda u_{\mathbf{e}}.[P(u)]$$

When the predicate dref introduced by a plural noun is substituted for $\gamma$ in $on_\gamma$, the update fails, since it does not satisfy the singularity constraint of $on_\gamma$ ($[\gamma\{u\} \rightarrow \mathbf{atom}\{u\}]$). The reverse, however, does not hold, since $oni_\gamma$ does not have any constraint on $\gamma$. This explains the contrast in (1B-C).

[**Comparison with other approaches:**] Many extensions of dynamic semantics have been proposed where the negation is partially externally dynamic (Hofmann, 2019; Elliott, 2020, a.o.). Nevertheless, in these systems, the interpretation of pronouns referring to the indefinite in the negation is still definite (e.g., *the iPad that Bill didn't buy* in (3)), motivating further extensions like ours.

One could also propose an extension of Elbourne's (2001) E-type analysis such that Russian pronouns can represent a covert *indefinite* article. This analysis accounts for the indefinite reading, but requires supplementary assumptions to explain the contrast in (1B-C). The discussion of the plausibility of this and other approaches is left for future work.

[**Conclusion:**] This paper accounts for the various aspects of indefinite interpretations of Russian pronouns, by extending the framework so that it includes variable-free-semantics-like predicate drefs. This system also captures indefinite pronouns in other languages including English: the anaphoric *one* can be analyzed similarly to Russian predicate-referring pronouns (without the strong singularity restriction), and English *it* is used indefinitely in limited cases. One future direction is to capture the cross-linguistic patterns of indefinite anaphoric expressions.

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# Formalizing Perspectives

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## 1 Perspectives

Many people have talked about perspectives in semantics and pragmatics, in a wide range of contexts. Most recently, the influential work of Elizabeth Camp (Camp 2013, 2017, 2018, a.m.o) has sparked a substantial amount of research on insinuation, framing and related phenomena that makes use of the particular notion of perspective she favors. Here is a quote from Camp (2013) to give a flavor of the idea.

> A perspective is representational, insofar as it provides a lens for interpreting and explaining truth-conditional contents, but it need not involve a commitment to any specific content. Likewise, a perspective typically motivates certain feelings as appropriate to feel toward its subject, but it is not itself a feeling.

Here is a second quote (also from Camp 2013), which clarifies what she takes perspectives to do in a bit more detail.

> The notion of a perspective is fairly intuitive but rarely spelled out. On my understanding, perspectives are modes of interpretation: open-ended ways of thinking, feeling, and more generally engaging with the world and certain parts thereof [...]. Above all, perspectives are ongoing dispositions to structure ones thoughts, along at least two dimensions. First, a perspective involves dispositions to notice and remember certain types of features rather than others, so that those features are more prominent or salient in ones intuitive thinking, and have more influence in determining ones classifications [...]. Second, a perspective involves dispositions to treat some classes of features as more central than others, in the sense of taking those features to cause, motivate, or otherwise explain many others [...]; a good measure of centrality is how much else about the subject one thinks would change if that feature were removed.

This kind of view has been highly influential. But Camp has never proposed a formal treatment of the notion of perspective she has in mind, which limits the usefulness of perspectives, especially in formal work in linguistics and philosophy. The aim of this paper is to fill this gap in conjunction with other considerations about perspective that have appeared in various literatures.

Before turning to concrete realization, what might we want a perspective to do from the linguistic side in addition to the sorts of things discussed above? A lot, actually. Perspectives

should determine such things as the content of deictic expressions – *left, right* (Oshima, 2006) – and perhaps even such things as the reference of indexicals like *I, you* and *here* (Kaplan, 1989). They should provide a 'center' for expressions like subjective predicates and epistemic modals which require judges (Stephenson, 2007; Potts, 2007; MacFarlane, 2011). They should also have something to say about the kinds of beliefs that a perspective-holder might have that play into their judgements and inferences. How can we put all these things together? The next section, §2, makes a proposal. The idea will be to start by formalizing Campian perspectives, and then to pair them with a way to make sense of centering, indexicality and deictics: namely, a body. §3 shows how the result might apply to some classical cases of perspectivality, namely insinuative content, framing, slurs, and deictics (in this extended abstract, this bit is just a promissory note). §4, finally, concludes.

# 2 A proposal

From the above, we need perspectives to do at least the following. They must structure our attention in such a way that we notice some things and not others, and such that we take some things to be more central than others. They must also say something about beliefs regarding matters relating to the perspective. The result must then be paired with a notion of center in order to enable resolution of indexical and deictic content.

I will do this in two steps. The first involves a formalization of Camp. The claim will be that Campian perspectives involve several elements: a valuation function, an ideology, and an attentional regime, and so consist of 3-tuples $Per = \langle V, \iota, \mathfrak{ar} \rangle$. The second step centers such perspectives, via what I will call *centering embodiments* – bodies – which project (in effect) Kaplanian contexts. The resulting objects allow us to make sense of an array of phenomena relating to perspectives.

## 2.1 Campian perspectives

In their most abstract form, Campian perspectives can be formalized as consisting of valuations, ideologies, and attentional regimes: $Per = \langle V, \iota, \mathfrak{ar} \rangle$. This means that perspectives consist of (i) ways of assigning truth, (ii) possibly non-truth-tracking ideological beliefs and valuations of objects in the world and (iii) ways of structuring attention. Each is detailed in the rest of this subsection.

### 2.1.1 Truth

The valuations needed for perspectives are simple and classical: a function $V$ mapping each proposition to a value in $\{T, F, ?\}$, for 'true' 'false' and 'indeterminate'. This gives a way to tie perspectives to worldmaking. Note that these valuations are the same kind which are used by McCready (2015) to compute the reliability of testimonial sources; in this way, perspectives as formalized here connect directly to judgements about other agents and the kind of trust one should have in them. I cannot consider these issues here in detail, but there is a great deal of work to be done in this domain.

### 2.1.2 Background

The second element of perspectives are ideologies: ways of making sense of the world that may or may not correspond to actual fact. In this sense, they are different from valuations, which model actual states of the world (with respect to particular bits of content). Here I adopt the simple model of ideologies of Henderson and McCready (2024), on which they consist of pairs $\langle \rho, \mathcal{B} \rangle$ where *rho* is a function which models preferences by assigning affective values to individuals (and individual-typed objects derived from properties and the like) and $\mathcal{B}$ is the 'basis' of the ideology, a set of propositions outlining its core beliefs. Henderson and McCready discuss the fact that particular instantiations of an ideology might differ on non-core beliefs, and propose using the set of propositions common to all instantiations; I adopt this view here.

One key feature of ideologies in perspectives is their capacity to support inferences. If a proposition $\varphi \rightarrow \psi$ is part of $\mathcal{B}$, and the speaker learns $\varphi$, they will naturally conclude $\psi$ on this ideological basis; this feature already models Camp's idea of perspectives as functioning in part to structure thoughts and privilege certain kinds of features above others in decision and explanation. There are questions here about what happens when ideological 'belief' – $\Pi_2(\iota)$ – and belief proper, as encoded by $V$, conflict. Plausibly, however, in cases of conflict, the inferences supported by $\Pi_2(\iota)$ takes precedence to those supported by the valuations of $V$. Along these lines, it is an open question how ideological beliefs relate to the kinds of reliability computations discussed by McCready (2015); I will consider this briefly in the talk.

### 2.1.3 Tendencies

The question of how to define an attentional regime can be viewed, in its simplest form, as requiring a mechanism of possibility or state exclusion. This is straightforward enough: we can simply use a function $\mathfrak{ar}$ that takes a set of worlds and maps to another such set ($\mathfrak{ar} : \mathcal{P}(W) \mapsto \mathcal{P}(W')$). The idea is to apply $\mathfrak{ar}$ to an information state and return those worlds in the information state that satisfy the attentional criteria imposed by the perspective. This in turn can be defined as follows: define $\mathcal{A} : Imp \mapsto \{\mathfrak{ar} | \mathfrak{ar} : \mathcal{P}(W) \mapsto \mathcal{P}(W')\}$, so $\mathcal{A}$ is a selection function which takes objects $Imp : \langle \mathcal{B}, AP \rangle$ consisting of pairs of sets of propositions (here: ideological bases, specifically that in $\Pi_2(Per)$) and sets of properties (those deemed attentionally significant) and uses them to determine a particular $\mathfrak{ar}$ which functions as a way to restrict attention. The functions $\mathfrak{ar}$ should satisfy certain properties: for instance, the worlds it selects should verify the propositions in $\mathcal{B}$. Note that Camp's discussion of dispositions to make certain inferences over others also falls out from this, in conjunction with the ideology which is the second element of perspectives.

## 2.2 Centering perspectives

This all seems fine. Campian perspectives thus have the form $Per = \langle V, \iota, \mathfrak{ar} \rangle$ and consist of a valuation function, ideology, and attentional regime. These are highly abstract objects and they don't yet do all the work we want perspectives in a general sense to do; specifically, they don't do anything to determine the reference of indexicals or deictic expressions. For this we need to augment perpectives *Per* with something else; specifically, we need to center them. In a way, this corresponds to Kaplanian treatments of indexicals: they have abstract meanings 'the speaker' and concrete ones 'the speaker of the current context'. Similarly, perspectives can

be filled out by giving them a way to interact with perspective-holders, and with the current discourse context. I turn to this task now.

Here is a thesis: Kaplanian contexts are generated from a body, namely the body of a speaker: a *centered body*. The speaking agent is the 'I'; the individual that embodied agent directs their speech toward is the 'you(s)'; the place of the body the 'here'; and so on. This picture also directly gives us a notion of a judge: it's completely natural that the tastes of the centered body determine whether sentences including subjective predicates feel true or not, and that such feelings of truth are assessment-sensitive (MacFarlane, 2016), and so forth. We can adopt the model of embodiment of McCready (2025) for the representation, so embodiments have the form $b = \langle s, m \rangle$, where $s$ is a sensorium and $m$ a spacetime mapping of the body's volume; this model is very simple, but suffices for our purposes here. Let us now take these embodiments, which determine deictic elements, judges, speakers and so forth, and pair them with perspectives, giving a notion of *centered perspective*. Centered perspectives then have the form $CP = \langle Per, b \rangle$. They are capable of doing the work of framing, ideological positioning, and deictic placement that we want instantiated, centered perspectives to do. The first element is as above, and the centering embodiment $b$ projects a Kaplanian context with all its features, including a placement in space that yields the kind of rich spatial representations argued for by Oshima (2006).

# 3 Applications.

This framework has many applications. We can of course treat all the classic Campian uses of perspectives: for insinuation (defined as the introduction of content in a kind of 'backdoor' manner, whether by specific kinds of discourse moves or by lexical items or phrases like her 'mantras'). They can also be used for the analysis of slurs, and for the enrichment of models of ideology like that of Henderson and McCready. Perhaps they can even provide us with a way to model the resonance of Beaver and Stanley (2023) in a fully formalized manner outside the pure Bayesianism of that work. Further, because of the presence of embodiments, there is the possibility of tying interpretation to the specific embodiments of speaker and hearer (interpreter); there is also the possibility of restricting possible perspectives to individuals with particular embodiments, in a way that arguably can directly lead to a way of thinking about standpoints, in the abstract and in the instantiated sense of 'embodying a standpoint' (see e.g. Stoetzler and Yuval-Davis 2002; Saint-Croix 2020). In the talk I will briefly discuss a few such applications; these will be spelled out in more detail in the actual talk. I will consider slurs, in terms of the perspectives they instantiate and how that relates to embodiment (Camp, 2013; Davis and McCready, 2020); I will briefly discuss the role of the body in determining deictic and indexical elements; and I will discuss how these two features can be brought together in a particular formulation of standpoint epistemology. I hope thereby to demonstrate the usefulness of the proposed formalization of perspectives.

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# Caring about answers

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Questions are powerful rhetorical devices. Not only is there a long tradition of using questions as a way to structure discourse (see Hamblin 1970 for pointers), but the act of asking a question offers multiple options to the savvy speaker. For example, in his *Sophistical Refutations* Aristotle already identified the fallacy of the "many questions" in which asking a certain question commits the person answering it to a certain proposition (which would be analyzed as a presupposition in modern terms). In another domain, authors like Anscombre and Ducrot (1981) discuss the argumentative profile of questions, and highlight how the use of polar questions patterns with that of their negative answers.

That role of questions in conversation is however not fully recognized, nor accounted for, in contemporary semprag theories, nor even within argumentation theory, in which questions are routinely described as not having any particular argumentative property besides setting the topic being discussed (van Eemeren et al., 2014). In other words, implicitly or not, such works assume a dialectic setting in which agents seek to determine the truthful answer to questions that have so far received no answer. This can be seen in Austin (1962)'s felicity conditions for *bona fide* questions (e.g. the fact the speaker does not know the answer/wants to know the answer), or in works like that of Stalnaker (1978) or Roberts (2012) who explicitly endorse the view that the primary goal of discourse is "communal inquiry", i.e. determining the state of the world), or even in work that address questions that are not clearly inquisitive, either because they're rhetorical (their answer is already clear), exam-like (their answer is obviously known by the speaker), or because it is clear that no participant in the conversation is in a position to know the answer (see Roberts 2024 for discussion of the latter, including an examination of Betteridge's Law that tangentially approaches the phenomena of interest to us).

In this work we wish to account for part of the rhetorical import of questions. Before entering into this issue, we give a bit of background on questions. Questions are classically understood as introducing a partition on the space of possibilities corresponding to their possible answers (Hamblin, 1973); their denotations are thus the set of the possible answers to the question, where those answers are understood to be mutually exclusive, resulting in a partition. The aim of a question act is then to locate the questioner in one of the elements of this partition, or, otherwise stated, to obtain an answer to the question asked. Pragmatically speaking, it is assumed that the discourse context provides a 'question under discussion' (QUD). A QUD can be explicitly available (via a speech act of asking a question) or inferred from context in some other way (currently not well understood). The QUD can be used to determine such things as relevance, defined as the degree to which the content of an utterance resolves the QUD (cf. van Rooij 2003). An ideal response from the perspective of relevance is then one which completely resolves the QUD; an ideal question-answer pair is one in which the question introduces a QUD, and

the answer fully resolves it. This is the idealized model of 'communication-as-communal-inquiry' discussed in the above paragraph.

But this idealized model, even as an idealization, fails to make sense of a number of the properties of questions and their answers. In this paper, we want to consider two of these, namely the issue of *stakes* and the issue of *topicality*. To illustrate, consider the following two examples.

Issues differ in what is at stake in them. Some issues are low-stakes: they maybe don't matter much, or only matter in a highly local way. Other issues are high-stakes: their answer is really important, perhaps a matter of life or death for whole groups of people or the world itself. An example of a low-stakes situation is one in which discourse participants discuss their personal tastes, which matter only to the individuals involved (in most contexts). For example, we might be discussing whether the fruit durian is tasty. Different agents will have varying opinions about this question, but ultimately the stakes of the question are low: telling you that I believe the mouthfeel of durian is like the combination of sewage and pus will probably not profoundly affect how much you enjoy it (if you do); it is likely to only determine what we choose to buy jointly at the market. This might matter a lot to us in the moment, and maybe for longer periods of time; but it won't matter much to anyone else.

On the other hand, questions like the ones in (1) come with greater stakes.

(1) a. Is the estimation of AI water usage exaggerated?
b. Is AI water usage less than other industries?

In many different ways, the question of AI water usage has important repercussions for the environment and the communities directly impacted by the construction of data centers. Excessive water usage means potentially insufficient water for other human purposes, and for the environment and ecosystems in general ; construction of many data centers can be expected to have large impacts on the availability of water, on environments local to the data centers, and on the general climate and atmosphere, given their polluting nature (Li et al., 2025). Because questions about water usage impact whether data centers are constructed at all, and so play into larger issues, the stakes of this question are high. Its answer matters a lot, to a lot of people, and in ways that impact the possibility of certain kinds of lives. For example though the construction of a data center might benefit certain well-off communities, it will negatively impact the lives of the, typically already marginalized, communities living around the data center.

Another aspect of the questions in (1) is how they fit in a more general discursive strategy. By asking a question, the speaker is presenting them as worth discussing. In the case at hand, the question of water consumption to power AI data centers is presented as relevant to a bigger discussion about data centers. Presumably, a person asking these questions would take a negative answer (e.g. in the form of pointing out that AI uses less water than agriculture, as is routinely done in such discussions) as evidence in favour of building data centers. Here, the stakes are about how resolving the question helps resolve higher questions, e.g. about the relevance and usefulness of AI in general, and about the pros and cons of reliance on AI given the environmental and social costs.

This paper considers this set of issues from the standpoint of what is relevant and what is settled, and what consequently is worth talking about. Here, we take our inspiration from the work of Kelp (2011); the basic idea of this work is that one fundamental function of knowledge is to resolve questions. This means that opening a question implies that the answer to it is unknown. That seems fine, but it is less fine to the degree that stakes

matter in a conversation. We draw the conclusion that, perhaps paradoxically, the more important something is, the more it turns out to be counterproductive to keep reopening questions relating to it. This is the initial lesson to be drawn from combining stakes and a 'settledness' picture about questions. Of course, though, one must be vigilant about this conclusion (cf. Sperber et al. 2010 on epistemic vigilance about reliability and trust); we cannot trust blindly in the answers to questions that are handed to us, but, sometimes, need to reopen them.

Let us give a bit more background on the Kelp view. On this picture, knowledge is an 'inquiry terminator': it serves to close lines of inquiry, treating whatever question is involved as settled and therefore no longer worthy of discussion. For instance, my statement that I know it's raining outside is meant to stop the whole line of inquiry concerning the question of rain; otherwise put, it settles the QUD and makes it no longer something to address. Kaufmann and McCready (2013) used this observation to treat adverbs like *totally* on their speech-act modifying uses as expressively introducing knowledge statements, and thereby settling questions. But, of course, like any other linguistic act this is merely a proposal which can be ignored, and one can continue to treat the question as unsettled, or simply reopen it if that seems necessary. This backdrop informs the analysis of high- and low-stakes questions and their settling we now introduce.

To formally approach the notion of the stakes of a question, we consider the epistemically accessible downstream consequences of the possible answers to the question. When these downstream consequences differ little across possible answers, and to a small number of people, the questions is a low-stake one. When consequences differ drastically, for a large number of people, the question is high-stakes. We can measure consequences in terms of a standard utility function $U_a(s)$ which gives the payoff for an agent $a$ should $s$ be true. One way to formally measure the stakes of a question $q$ is to compute the vector $utils(q)$ of the sums of utilities for all parties $a_i$ impacted by the question for each possible answer $s_j$ to $q$:

$$(2) \qquad utils(q) = [\textstyle\sum_i U_{a_i}(s_0), \sum_i U_{a_i}(s_1), \ldots, \sum_i U_{a_i}(s_k)].$$

To determine the stakes of $q$, we look at the standard deviation of the elements in $utils(q)$. In a low-stakes setting, that standard deviation will be small: all answers to the question will yield overall utilities that are close to their average value. A high-stakes situation will see values much more dispersed around the mean, which can be due to both (i) the utilities associated with particular answers simply having bigger values (e.g. being denied access to water has more dire consequences than having durian on the table, which is reflected in using larger values), and (ii) having more people affected by the answer (e.g. whole towns as opposed to two people).

Another, complementary, way to determine the stakes of a question is its relationship with an overarching QUD. Simons et al. (2010) propose that a question is relevant to a QUD iff it has an answer which contextually entails a partial or complete answer to the QUD. Using example (1) above, understood as addressing the larger question about the usefulness and relevance of AI development, one can determine that the stakes of (1) is related to the stakes of the super question. We propose that the stakes associated with a question are higher if answering that question has the potential to reduce the stakes of its super question. So if a possible answer to a sub-question is such that it reduces the space of possible answers to the super-question in such a way that the super-question has lower stakes, then the sub-question is high-stakes relative to the super-question.

Reframing is thus making a claim about the stakes of a question not being what they

were presented to be (explicitly or not).

Considering the stakes of a question also gives us a way to determine when it's acceptable to 'just ask questions'. As mentioned above, asking a question is an indication that it is not settled. In low-stakes situations this is of no consequence since setting for a different answer will not have significant consequences. In high-stakes situations the potential for change is much stronger. The incentive to reopen high-stakes question comes from agents who have a direct interest in changing, or refusing, the agreed-upon answer. This reopening is sometimes necessary, but also can have a disingenuous and self-serving quality; here, as elsewhere, epistemic and social vigilance are required, in ways that have implications for notions of (de)platforming and free speech which we will elaborate on in the full paper.

As a closing remark, we note that the proposed perspective can be used as a way to formalize a concept like the Overton window (Youvan, 2024). Instead of placing opinions within that window, one can think of it as containing questions. Low-stakes questions are all placed inside the window, i.e. are fair to discuss. High-stakes, non-resolved, questions are also within the window since resolving them has important consequences. What lies outside the window are high-stakes questions to which answers have already been provided. Extending the Overton window would thus be an exercise in reopening already settled, high stakes question.

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# French gym bros are bad roommates: an attempt to characterize the semantics of personae

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## 1. Introduction

The goal of this work is to try and layout the possible meanings that can take personae. For Eckert (2008), stylistic meaning is understood as personae which can be defined as linguistic behavior signaling the belonging of a speaker to a community of practice. Similar to other problems coming from social meaning, it is difficult to represent the semantic meaning of this type of expression, but they do seem to be able to combine themselves to create bigger expressions. For example, in a recent conversation, a colleague explained to us why she had to move: (1) A : *I had to move.* B: *How so?* A: *My roommates were gym bros.* B: *Oh damn.* A: *And they were French.* B: *Oh damn!!!*[1] Here, the idea is that French gym bros are worse roommates than each of their part. To characterize this type of construction, this work is organized as follows. First, we must define building blocks of personae. More specifically, we will borrow from the third wave of sociolinguistics and works from formal semantics and pragmatics to characterize the parts that compose this notion. This will help us define how linguistics production can carry social meaning. Secondly, we will introduce the different formalizations proposed to account for personae and their meaning. Basically, the core proposal is that persona meaning can be understood as a tuple: < $\mathfrak{D}$, $\mathfrak{Q}$, $\mathfrak{A}$, $\mathfrak{T}$ > where $\mathfrak{D}$ is a dimension that shows the degree of association of a person to a persona, $\mathfrak{Q}$ is a bundle of dimensions that characterize a persona, $\mathfrak{A}$ is the affect coming with a persona and $\mathfrak{T}$ is the set of topoi that comes with it. This mapping will help us navigate the ideological space raised by a persona label.

Most research on style comes from third-wave sociolinguistics and gender/queer studies. In this research, a person's identity is performed in various ways. In doing so, individuals construct their identities through language by using various sociolinguistic variables to signal specific selves that allow them to be associated with groups. This identity work is characterized both by how a person presents themselves and by how they perceive others. Through these representations, McConnell-Ginet (2011) notes that an individual can signal attitudes, interests, abilities/skills, responsibilities, rights, identifications with others, historical contexts, and projected futures. All these elements can manifest themselves both through sociolinguistic variables such as lexical choices or phonetic variations and through certain conversational choices. (McConnell-Ginet, 2011). For Eckert (2008), those variables are elements composing style which are personae: "one way or another, every stylistic move is the result of an interpretation of the social world and of the meanings of elements within it, as well as a positioning of the stylizer with respect to that world". Those definitions are helpful because they allow us to see what kinds of meaning a persona can transmit. Generally, in pragmatics, these expressions are defined as signals that are associated with a message. Their interpretations are represented using game theory (see Burnett, 2019, 2022 for more details). Nevertheless, those types of formalizations leave us a bit hungry for more details surrounding the meaning of personae. On top of that, trying to find the meaning of persona with labels coming from natural language forces us to account for the semantics of those labels. Keeping this in mind, the following sections

[1] Thanks to Maeva Sillaire for the example

provide a way to link the characteristics listed by McConnell-Ginet (2011) to other work in semantics.

2. The geometrical space of persona

Following the adaptation by Burnett (2020) of the work of Gärdenfors (2004, 2014), we will assume that persona can be represented as Voronoi tessellation inside of conceptual spaces. More specifically, Gärdenfors (2004, 2014) proposed to represent concept in a geometrical manner where they are zones in a multidimensional space. Those dimensions are based on phenomenological properties. Burnett (2020) used this framework to represent persona through the tuple <D, sim, PERS, μ > where *D* stands for dimensional space, sim is the relationship of the points inside of *D*, *PERS* are the personae and $\mu$ is the affective value for a persona. Building on this representation, the goal is to map more thoroughly the dimensions of space associated with personae. Voronoi tessellations segment this space and each cell contains a centroid point. Those points represent prototypical representations of a category that are treated here as proxies for personae.

3. 𝔇 is about labeling

Kennedy & McNally (2010) highlight the difficulty of accounting for the ambiguous nature of a color. From one context to another, a color adjective can affect the truth value of a statement. Here, the idea is to note the similarities between the behavior of terms used to label colors and that of personae. In both cases, we are dealing with linguistic elements that can be both gradable and non-gradable at the same time. More specifically, you must have a specific property to be able to grade it. An object is either green or not, but, when it is, it can also be greener than another. The same holds for of personae. You can either be a gym bro or not, but if you are, you may be more or less than others. In both cases, it would be strange to say that a red object is greener than another blue object. Similarly, we wouldn't say that someone who has no association with gyms nor physical activities is more of a gym bro than someone else. The following subsection revisits that argument by applying it to the concept of persona. Like color adjectives, labels characterizing personae are ambiguous. For example, someone could say (2) and using a similar level of measure in (3).
(2) These leaves are too green.
(3) Your roommates are too gym bro for me.

So, we can represent this first dimension as:

(5) Being French ↔ Not being French
(6) Being a Gym Bro ↔ Not being a Gym Bro

For color predicates, Kennedy & McNally (2010) hypothesize that this type of ambiguity stems from an element correlated with the mention of a color, which allows us to indicate that an object is more or less similar to a specific color. More specifically, they note that a color predicate can have two meanings: COLOR QUANTITY and COLOR QUALITY. COLOR QUANTITY refers to a subjective measure that indicates the extent to which an object is a specific color as was explored in this section. COLOR QUALITY refers to values associated with dimensions that characterize a color, such as the degree of hue, saturation, and brightness. This dual interpretation also applies to personae, where

PERSONA QUANTITY refers to the degree to which an individual embodies a particular identity, and PERSONA QUALITY depends on the specific dimensions evoked by a speaker within a given context.

4. 𝔔 is for quality dimensions

To be able to catch the meaning of a persona you should be able to access the cultural background needed to see it. Social meaning is highly indexical. Thus, to be able to grasp it, you need to have some kind of connection with meaning shared within a group. Labeling personae creates a problem where if we want to pinpoint its meaning we are bound to overshoot and catch the meaning of the label. We must see it as a feature and not a bug. The choice of a label gives us information about how the speakers represent the persona labeled. If 𝔇 gave us labeling through PERSONA QUANTITY dimension, 𝔔 can give us PERSONA QUALITY dimensions. Fo example, someone might say that *Amélie is* more a French film than *Brice de Nice* because the former could carry a more *romantic vibe* stereotypically associated with French aesthetics than the second one. Drawing on the formalization by Kennedy and McNally (2010), we can represent their semantics as in (9), where there is a specific property, $P_i$, that applies to *Amélie*, and it is correlated (*cor*) with being *French*.

(7) *Amélie is a french movie.*

(8) $P_i$ *(Amélie)* ∧ cor($P_i$, *french*)

(9)quant(french)(Amélie) ≻ stnd(quant(french))

(10)qual(french)(Amélie) ≻ stnd(qual(french)

The PERSONA QUALITY dimension comes from shared belief around persona labels. For instance, stereotypically in certain circles, Gym Bros tend to be associated with toxic masculinity and the French with arrogance. So 𝔔 gives us :

(11) High degree of toxic masculinity ↔ Low degree of toxic masculinity

(12) High degree of arrogance ↔ Low degree of arrogance

5. 𝔗 is for topoi

Personae and topoi are closely linked together. Noble et al. (2020) characterize this relationship like this: "*Upon recognizing the evoked topos, an interlocutor may draw certain conclusions about the speaker, namely that they are the kind of person who reasons in this way.*" Following Aristotle, they define topoi as information shared by a community on which it is possible to construct an argument. They also build upon Ducrot (1983) who wrote that topoi are the link between statements making two propositions coherent: "topoi are not part of factual knowledge, but part of 'ideology', that is the agent's conception of acceptable ways to make inferences". For Henderson and McCready (2024), ideology can be defined as two things: a value, negative or positive, associated with behaviors, practices and/or groups of people, and a set of truth-conditional propositions representing beliefs. Following this, we put the two on different dimensions. Conceptual representations for a specific persona can vary from speaker to speaker and from context to context. Therefore, 𝔗 is based only on the latter and the 𝔄 will be built upon the affective values. For our mapping of conceptual spaces, 𝔗 will be dimension(s) associated with the degree of belief composing the representation of a persona. If we go back to (1), neither French person or Gym Bros are homogenous groups sharing specific ideologies or belief points but,

according to the speaker of (1), their prototypical representations both tend toward the probability of some topoi. In (1), gym bros can signal topoi related to conservative ideologies especially surrounding beliefs gravitating around misogynistic gender roles. As all nationalistic prototypical representations, French ideologies can encompass vast and different things going from guillotine to Marine Le Pen.
(13) High degree of belief in misogynistic gender roles ↔ Low degree of belief in misogynistic gender roles
(14) High degree of belief in far-right ideologies ↔ Low degree of belief in fari-right ideologies

6. 𝔄 is for affect

Color predicates and personae differ in one important respect. Even though both linguistic elements characterize membership in a category with prototypical representations, the choice of a label associated with a persona affects our perception of it and signals the position of the speaker using it. For example, "cheap" and "thrifty" may essentially describe the same persona, but these two labels do not carry the same connotation. As a result, they have distinct interpretations. This emotional association is explored in this section. As McCready and Davis (2017) pointed out, slurs can invoke complex social dynamics. The meaning of this category of words depends on the identity of the person using it and the person targeted by it. Here, I want to make the case that using labels for personae do similar things but to a lesser extent. The difference between a slur and a label for a persona is the relative harm that the first can impose on someone[2]. All slurs have the potential to be harmful, which is not necessarily the case for persona. Going back to (1), it is possible for someone who uses both labels to be positive about it or even use it to argue for staying in her appartement. Nonetheless, in (1), *French* and *gym bros* are both understood as signaling negative feelings but also a specific social dynamic. In this case, *French* was uttered by a French person to non-French people and *gym bros* was uttered by a non-gym bro to non-gym bro. In both cases, if we take the same categorization from McCready and Davis (2017), even if the speaker is French, the label was used in a complicity manner since they both argue for the "moving out of the appartement situation". We can understand this statement by saying something like "I am from this group, but *not* like this prototypical representation of members of that group".
(15) Positive feeling toward gym bros ↔ Negative feeling toward gym bros
(16) Positive feeling toward French people ↔ Negative feeling toward French people

7. Compositionnality in the conceptual spaces

The framework put forth is full of problems and limitations, but it can help us see how new and inventive labels and their combinations can raise up new meaning. For example, with this tuple, we can infer the association of French and gym bros by combining the results

[2] This might be able to explain why some people even when they use "neutral" label still sound slur-adjacent as this dialogue from Widow's Bay (2026) shows :
*Rosamary: Oh no good news here. Dead baby. Dead baby. Lesbian.*
*Patricia: Can you please stop saying lesbian?*
*Rosemary: I can't say that now?*
*Patricia: It's the way you're saying it.*

from each of their part. By doing so, we can see how speaker B perceives the composition of meaning surrounding *French gym bros* where the values of both tuples associated with each expression is combined to create a new one. Firstly, for $\mathfrak{D}$, both labels, French and Gym Bros, mean that the roommates manifest characteristics that make them belong to these two categories. Secondly, for $\mathfrak{Q}$, this association is shared by adhering to some dimensions that come from representations of these categories inside of the speaker's mind. Thirdly, for $\mathfrak{A}$, the affects associated with that representation are mostly negative. Thus, for the speaker, gym bros and French are used as negative labels for these two personae. The speaker is stating that she doesn't like the history of conversational moves generally made by those personae. Finally, for $\mathfrak{T}$, this affect and this reputation also depend on the topoi, the set of beliefs, associated with these types of personae, namely that gym bros tend to show toxic aspects of masculinity and that French people can be arrogant[3]. We could switch the predicate and see the emergence of similar patterns. Those all depends on prototypical representation and stereotypes. Thus, one of the questions that remain touches the overgeneralisation issue: is it a bug or a feature? People seem to be able to accommodate a lot of possible meanings. Can or should we account for this?

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[3] It also seems that for some people, seeing people coming from the same place as you in other settings is a bad thing.

# Disjunctive Anaphora in Dependent Type Semantics and its Automated Theorem Prover

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## 1 Introduction

Dependent Type Semantics (DTS: Bekki, 2014; Bekki and Mineshima, 2017) is a verificationist theory of natural language meaning grounded in Martin-Löf Type Theory (Martin-Löf, 1984), in which truth reduces to the inhabitation of a type and anaphora resolution to proof search. Its account of accessibility is proof-theoretic and strictly compositional: the right-hand component of a $\Sigma$-type or a $\Pi$-type may refer to a proof of the left-hand component, whereas proofs under a universal quantifier or a negation remain inaccessible, reproducing the constraints observed for anaphora (Karttunen, 1976; Groenendijk and Stokhof, 1991; Kamp and Reyle, 1993).

A natural question is what DTS predicts for *disjunction*, which has long resisted a uniform treatment in dynamic semantics (cf. Hofmann, 2019; Elliott, 2023). In dependent type theory, disjunction corresponds to the *disjoint union type* $A+B$, which—unlike $\Pi$- and $\Sigma$-types—licenses no dependency between its constituents. Our first claim is that this single structural fact, together with the standard elimination rule (+E), already derives the core accessibility profile of disjunction, including the puzzle of Rothschild (2017), with no additional machinery.[1]

Our second claim is methodological. DTS is computationally implementable: type checking, type inference, and proof search for dependent type theory can be used to decide entailment, in the tradition of automatic verification via implementation (Bos et al., 2004; Chatzikyriakidis and Luo, 2014; Mineshima et al., 2015; Abzianidze, 2015; Hu et al., 2019). Combining the CCG parser *lightblue* (Bekki and Kawazoe, 2016; Tomita et al., 2025)[2] with `wani`, an automated theorem prover for DTS (Daido and Bekki, 2020), yields the pipeline

sentences → CCG parsing → DTS semantic composition → type checking (= anaphora/presupposition resolution) → automated theorem proving → inference results.

We extend `wani` with disjoint union types and evaluate the analysis on a new FraCaS-style dataset of disjunctive-anaphora problems, on which it predicts every item correctly. We are aware of no other implemented system that resolves anaphora to disjunctive antecedents.

## 2 Disjunctive Anaphora in DTS

**Basic paradigms.** Disjunctions of the form $A + B$ behave as internally and externally static in default contexts. A pronoun inside $B$ cannot access an antecedent in $A$, as in (1).

*This work was conducted independently and does not reflect the views or positions of Amazon Web Services.

[1]The bathroom sentence (cf. Karttunen, 1976; Krahmer and Muskens, 1995), in which the antecedent is an indefinite under a negation inside the first disjunct, concerns the interaction between disjunction and negation and is discussed, together with a comparison with Elliott (2023), in the full paper. For an analysis of bathroom sentences in an earlier version of DTS, see Bekki (2013).

[2]`https://github.com/DaisukeBekki/lightblue`

(1) Either [a woman]$^1$ walked in or #she$_1$ sat down.

Since the semantic representation $A$ of the first disjunct is not part of the context in which the well-formedness of $B$ is established, internal staticity follows immediately.

Likewise, a pronoun in the subsequent discourse cannot access an antecedent in either disjunct, as in (2a) and (2b).

(2) a. Either [a woman]$^1$ walked in or John sat down. #She$_1$ smiled.
b. Either John sat down or [a woman]$^1$ walked in. #She$_1$ smiled.

Type checking the second sentence of (2a) requires a proof of $C \equiv (x : \mathsf{entity}) \times \mathbf{female}(x)$ in a context whose only relevant assumption is $u : A + B$, where $A$ is the type of *a woman walked in* and $B$ that of *John sat down*. Since $C$ does not depend on $u$, $A + B \vdash C$ holds if and only if both $A \vdash C$ and $B \vdash C$ hold: from $u : A + B \vdash t : C$ we obtain $x : A \vdash t[\iota_1(x)/u] : C$ and $y : B \vdash t[\iota_2(y)/u] : C$ by substitution, and the converse is (+E) itself. In the anaphora resolution for (2a), $A \vdash C$ holds, since $\mathbf{woman}(x)$ entails $\mathbf{female}(x)$, but $B \vdash C$ does not: $B$ provides no female entity. Hence no such proof exists in this context.[3] The symmetric case, in which only $B \vdash C$ holds, is (2b). This is the proof-theoretic account of external staticity: anaphora into a disjunction requires a proof of the anaphoric type from *each* disjunct, which is exactly what the disjunctive antecedents in (3) below provide.

**Disjunctive antecedents.** Under certain conditions, however, a pronoun *can* reach into a disjunction, as in (3) (Groenendijk and Stokhof, 1991).

(3) a. [[A professor] or [an assistant professor]]$^1$ will attend the meeting of the university board.
b. She$_1$ will report to the faculty.

Here *she* picks out whichever individual—professor or assistant professor—will attend the meeting. Generalizing, an anaphoric link into $A + B$ is available exactly when *both* $A$ and $B$ supply an antecedent of the required kind. That the same pronoun is blocked in (2a) but licensed in (3) shows that disjunction is neither purely externally static nor purely externally dynamic, which casts doubt on the static/dynamic dichotomy as a classificatory notion for E-type anaphora.

DTS derives (3) with no additional mechanism: the disjunction occurs in the *premise* of the inference, so the standard rule (+E) applies directly, and $A \vdash C$ together with $B \vdash C$ yields $A + B \vdash C$. Proof search for *she* succeeds using the background knowledge in (4), corresponding to *Every professor is female* and *Every assistant professor is female*.

(4) a. $\mathsf{pf} : \left(u : \left[\begin{array}{l} x : \mathsf{entity} \\ \mathbf{prof}(x) \end{array}\right]\right) \to \mathbf{female}(\pi_1 u)$ b. $\mathsf{af} : \left(u : \left[\begin{array}{l} x : \mathsf{entity} \\ \mathbf{aProf}(x) \end{array}\right]\right) \to \mathbf{female}(\pi_1 u)$

**Rothschild's (2017) puzzle.** The strongest evidence for the proof-theoretic account is (5): an antecedent inside one disjunct becomes accessible once the subsequent sentence assumes the negation of the other disjunct.

(5) a. Either it's a holiday or [a customer]$^1$ will come in.
b. And if it's not a holiday, they$_1$ will want to be served.

Formally the discourse is the sequence $A + B,\ \neg A \to C$, so the type-checking context for $C$ is $A + B, \neg A \vdash C : \mathsf{type}$. It follows from the standard rules for disjoint union types that whatever is entailed by $B$ is entailed in this context: if $B \vdash (x : \mathsf{entity}) \times \mathbf{human}(x)$, then

[3] In general, $A \vdash C$ does not imply $A + B \vdash C$. Let $A = \bot$, $B = \top$, and $C = \bot$: $\bot \vdash \bot$ holds, but if $\bot + \top \vdash \bot$ held, substituting the closed proof $\iota_2(()) : \bot + \top$ would yield $\vdash \bot$, contradicting the consistency of the theory.

Figure 1: Proof Search of (5b)

$$\dfrac{v : \mathbf{holiday}_e(today) + \left[\begin{array}{l} u : \left[\begin{array}{l} x : \mathsf{entity} \\ \mathbf{customer}(x) \end{array}\right] \\ \mathbf{WCI}_e(\pi_1 u) \end{array}\right] \quad \mathcal{D}_P \qquad \begin{array}{c} w : \neg\mathbf{holiday}_e(today) \\ \mathcal{D}_{N_1} \end{array} \qquad \mathcal{D}_{N_2}}{\mathsf{unpack}_v^{\lambda z.\left[\begin{array}{l} x : \mathsf{entity} \\ \mathbf{human}(x) \end{array}\right]} \left(\lambda h.\mathsf{case}_M(w(h)), \lambda h.(\pi_1\pi_1 h, \mathsf{ch}(\pi_1 h))\right) : \left[\begin{array}{l} x : \mathsf{entity} \\ \mathbf{human}(x) \end{array}\right]}\,(+E)$$

Figure 2: Proof Search of (5b) $\mathcal{D}_{N_1}$

$$\dfrac{\dfrac{\dfrac{\dfrac{\overline{h : \mathbf{holiday}_e(today)}^{1} \quad w : \neg\mathbf{holiday}_e(today)}{w(h) : \bot}\,(\Pi E)}{\mathsf{case}_M(w(h)) : \left[\begin{array}{l} x : \mathsf{entity} \\ \mathbf{human}(x) \end{array}\right]}\,(EFQ)}{\mathsf{case}_M(w(h)) : \left(\lambda z.\left[\begin{array}{l} x : \mathsf{entity} \\ \mathbf{human}(x) \end{array}\right]\right)(\iota_1(h))}\,(CONV)}{\lambda h.\mathsf{case}_M(w(h)) : (h : \mathbf{holiday}_e(today)) \to \left(\lambda z.\left[\begin{array}{l} x : \mathsf{entity} \\ \mathbf{human}(x) \end{array}\right]\right)(\iota_1(h))}\,(\Pi I),_1$$

$A + B, \neg A \vdash (x : \mathsf{entity}) \times \mathbf{human}(x)$, by (+E) with $\neg A$ closing the left case. Figure 1 shows the proof `wani` finds: one application of (+E), whose left case $\mathcal{D}_{N_1}$ (Figure 2) is closed by (EFQ) on $\neg\mathbf{holiday}_e(today)$ and whose right case $\mathcal{D}_{N_2}$ supplies the customer. This accounts for the accessibility of *a customer* to *they* in (5b), a configuration that is problematic for most dynamic theories.

# 3 `wani` and the Elimination Rule

`wani` is an automated theorem prover for a fragment of DTS with Π-types, Σ-types, equality types, and disjoint union types. It performs depth-first proof search combining *backward* inference, which decomposes a goal into subgoals, with *forward* inference, which saturates the context by applying rules from premises to conclusions. Forward inference is bounded by the context and hence safe, though restricted to selected rules such as (ΣE) and (=I); backward inference supplies the flexibility needed for complex proofs but may diverge, and is therefore limited by a maximum depth.

Disjoint union types require care. (+F) and (+I) implement the standard rules directly (Figure 3), but (+E) resists direct implementation: its conclusion leaves the motive $\lambda x.X$ almost unconstrained, so there are infinitely many instantiations, making the rule unsuitable for forward inference and explosive in unrestricted backward inference. In `wani`, (+E) is therefore applied in backward inference *only* when selected forward inference rules have exposed a disjoint union type $A + B$, either directly or as the result type of a Π-type, e.g. $(x : C) \to A + B$. Three situations trigger this: (i) $A + B$ arises directly by forward inference; (ii) forward inference yields $(x : C) \to A+B$; (iii) (ΣE) extracts $A+B$ from a Σ- or Π-type, e.g. from $(x : A + B) \times C$. Whenever such an expression emerges, (+E) generates subgoals including one that explicitly requires deriving $A+B$; failure of that subgoal discards the step, which prevents false positives arising from assuming the conclusion of a conditional without establishing its premise. At the pipeline level, the empirical evaluation in the next section tests whether this restriction is practically too strict for natural language inferences.

Figure 3: Disjoint union type rules in DTS. The condition to the right of (+E) is a side condition that triggers the rule in backward search, not a subgoal; $\vdash_F$ marks what forward inference has already exposed.

$$\frac{\Gamma \vdash A : \mathsf{type} \quad \Gamma \vdash B : \mathsf{type}}{\Gamma \vdash A + B : \mathsf{type}}\ (+\mathrm{F}) \qquad \frac{\Gamma \vdash a : A}{\Gamma \vdash \iota_1(a) : A + B}\ (+\mathrm{I}) \quad \frac{\Gamma \vdash b : B}{\Gamma \vdash \iota_2(b) : A + B}\ (+\mathrm{I})$$

$$\frac{\Gamma \vdash L : A + B \quad \Gamma \vdash P : (x : A + B) \to \mathsf{type} \quad \Gamma \vdash M : (x : A) \to P(\iota_1(x)) \quad \Gamma \vdash N : (x : B) \to P(\iota_2(x))}{\Gamma \vdash \mathsf{unpack}_L^P\,(M, N) : P(L)}\ (+E) \qquad \begin{array}{c} \Gamma \vdash_F L : A + B \\ \text{or} \\ \Gamma \vdash_F L' : C \to A + B \end{array}$$

# 4 Experiments and Evaluation

Table 1: Results per problem

| Problem | Description | Depth used | Time (s) | Expected | Observed |
|---|---|---|---|---|---|
| D01 | Internally Static | 9 | 0.17 | Other | Other |
| D01c | Control experiment for D01 | 2 | 0.33 | Unknown | Unknown |
| D02-a | Externally Static (Left) | 9 | 16.60 | Other | Other |
| D02-ac | Control experiment for D02-a | 2 | 0.35 | Unknown | Unknown |
| D02-b | Externally Static (Right) | 9 | 16.50 | Other | Other |
| D02-bc | Control experiment for D02-b | 2 | 0.37 | Unknown | Unknown |
| D03 | Accessible across both clauses | 7 | 3.02 | Unknown | Unknown |
| D05 | Rothschild's (2017) puzzle | 7 | 2.63 | Unknown | Unknown |
| D05c | Control experiment for D05 | 9 | 15.27 | Other | Other |

Since no benchmark for disjunctive anaphora exists, we built a new FraCaS-style dataset[4] of nine problems instantiating the paradigms of Section 2: internal staticity (D01), external staticity in both orders (D02-a/b), disjunctive antecedents (D03), and Rothschild's configuration (D05). D01, D02-a/b, and D05 are each paired with a minimally different conjunctive or unmodalized control (D01c, D02-ac, D02-bc, D05c) carrying the *opposite* expected label, so that no constant response can satisfy both members of a pair. The aim is a controlled diagnostic, not large-scale benchmarking. We employ a processing pipeline tailored for solving the JSeM benchmark: premises and hypotheses are parsed by CCG into UDTT (DTT with unspecified terms); anaphora resolution is then carried out by type checking, which runs a proof search for each unspecified term. The labels must accordingly be read as metrics of *semantic well-formedness* rather than of entailment. Successful type checking yields a well-formed representation and, where no entailment holds, the label *Unknown*; failed type checking yields *Other*. For (5), for instance, resolution of *they* succeeds—it is correctly linked to *a customer*—while the hypothesis is not entailed, so *Unknown* is the expected and observed output. All nine items were parsed successfully and type checking gave the predicted result in every case (9/9; Table 1); `wani` applies (+E) exactly where Section 2 predicts. Figure 4 shows the proof diagram `wani` generates for D03. In *Unknown* cases, reported times include entailment proof search running to the depth limit, though anaphora resolution itself always terminated within the limit per depth. For *Other* cases (type-checking failure), processing times are prolonged because *lightblue* backtracks between type- and kind-checking across nested formations (e.g., $\Sigma$-types), repeatedly re-executing identical anaphora queries——an optimization issue currently being addressed via architectural refinements that does not affect predicted labels. To control search space, the derivation outputs for each pipeline step (parsing, type checking, proof search) were restricted to a single top candidate, with a maximum depth of 9 for both checking stages. On these items, the restriction on (+E) in Section 3 does

[4] `https://github.com/DaisukeBekki/JSeM/tree/anaphora/data/anaphora`

Figure 4: A proof diagram generated by `wani` for item D03

$\Gamma \equiv$

| | |
|---|---|
| Entity | type |
| **woman**,**faculty**,**professor**,**AP**,**meeting** | $(v_p : \mathsf{entity}) \to (v_{p+1} : \mathsf{entity}) \to \mathsf{type}$ |
| **reportTo**,**attend** | $(v_q : \mathsf{entity}) \to (v_{q+1} : \mathsf{entity}) \to (v_{q+2} : \mathsf{entity}) \to \mathsf{type}$ |
| **ap** | $(v_{ap} : \mathsf{entity}) \to (v_{ap_1} : \mathsf{entity}) \to (v_{ap_2} : \mathbf{AP} v_{ap_2} v_{ap_1}) \to \mathbf{woman} v_{ap_2} v_{ap_1}$ |
| **p** | $(v_p : \mathsf{entity}) \to (v_{p_1} : \mathsf{entity}) \to (v_{p_2} : \mathbf{professor}(v_{p_2})(v_{p_1})) \to \mathbf{woman}(v_{p_2})(v_{p_1})$ |
| $u_0$ | $\mathsf{entity}$ |
| $u_1$ | $\left[\begin{array}{l} u_{f_1} : \mathsf{entity} \\ \left[\begin{array}{l} u_{f_2} : \mathsf{entity} \\ \left[\begin{array}{l} u_{f_3} : \mathbf{faculty}(u_{f_2})(u_{f_1}) \\ T \end{array}\right] \end{array}\right] \end{array}\right]$ |
| $u_2$ | $\heartsuit$ |

$$\heartsuit_a \equiv \left[\begin{array}{l} u_{\heartsuit_{a_1}} : \left[\begin{array}{l} u_{\heartsuit_{a_2}} : \mathsf{entity} \\ \left[\begin{array}{l} u_{\heartsuit_{a_3}} : \mathsf{entity} \\ \left[\begin{array}{l} u_{\heartsuit_{a_4}} : \mathbf{professor}(u_{\heartsuit_{a_2}})(u_{\heartsuit_{a_3}}) \\ \top \end{array}\right] \end{array}\right] \end{array}\right] \\ \left[\begin{array}{l} u_{\heartsuit_{a_5}} : \left[\begin{array}{l} u_{\heartsuit_{a_6}} : \mathsf{entity} \\ \left[\begin{array}{l} u_{\heartsuit_{a_7}} : \mathsf{entity} \\ \left[\begin{array}{l} u_{\heartsuit_{a_8}} : \mathbf{meeting}(u_{\heartsuit_{a_6}})(u_{\heartsuit_{a_7}}) \\ \top \end{array}\right] \end{array}\right] \end{array}\right] \\ \left[\begin{array}{l} u_{\heartsuit_{a_9}} : \mathsf{entity} \\ \left[\begin{array}{l} u_{\heartsuit_{a_{10}}} : \mathbf{attend}(\pi_1 u_{\heartsuit_{a_5}})(\pi_1 u_{\heartsuit_{a_1}})(u_{\heartsuit_{a_9}}) \\ \top \end{array}\right] \end{array}\right] \end{array}\right] \end{array}\right] \quad \heartsuit_b \equiv \left[\begin{array}{l} u_{\heartsuit_{b_1}} : \left[\begin{array}{l} u_{\heartsuit_{b_2}} : \mathsf{entity} \\ \left[\begin{array}{l} u_{\heartsuit_{b_3}} : \mathsf{entity} \\ \left[\begin{array}{l} u_{\heartsuit_{b_4}} : \mathbf{AP}(u_{\heartsuit_{b_2}})(u_{\heartsuit_{b_3}}) \\ \top \end{array}\right] \end{array}\right] \end{array}\right] \\ \left[\begin{array}{l} u_{\heartsuit_{a_5}} : \left[\begin{array}{l} u_{\heartsuit_{a_6}} : \mathsf{entity} \\ \left[\begin{array}{l} u_{\heartsuit_{a_7}} : \mathsf{entity} \\ \left[\begin{array}{l} u_{\heartsuit_{a_8}} : \mathbf{meeting}(u_{\heartsuit_{a_6}})(u_{\heartsuit_{a_7}}) \\ \top \end{array}\right] \end{array}\right] \end{array}\right] \\ \left[\begin{array}{l} u_{\heartsuit_{a_9}} : \mathsf{entity} \\ \left[\begin{array}{l} u_{\heartsuit_{a_{10}}} : \mathbf{attend}(\pi_1 u_{\heartsuit_{a_5}})(\pi_1 u_{\heartsuit_{a_1}})(u_{\heartsuit_{a_9}}) \\ \top \end{array}\right] \end{array}\right] \end{array}\right] \end{array}\right]$$

$$\heartsuit \equiv \heartsuit_a + \heartsuit_b \quad t_l \equiv \lambda l_1. \left[\begin{array}{l} l_2 : \mathsf{entity} \\ \left[\begin{array}{l} l_3 : \mathsf{entity} \\ \mathbf{woman}(l_2)(l_3) \end{array}\right] \end{array}\right]$$

$$t_m \equiv \lambda m_1.(\pi_1\pi_1 m_1, (\pi_1\pi_2\pi_1 m_1, \mathbf{p}(\pi_1\pi_2\pi_1 m_1)(\pi_1\pi_1 m_1)(\pi_1\pi_2\pi_2\pi_1 m_1))) \; t_n \equiv \lambda n_1.(\pi_1\pi_1 n_1, (\pi_1\pi_2\pi_1 n_1, \mathbf{AP}(\pi_1\pi_2\pi_1 n_1)(\pi_1\pi_1 n_1)(\pi_1\pi_2\pi_2\pi_1 n_1)))$$

$$\dfrac{\Gamma \vdash_F u_2 : \heartsuit \quad \dfrac{}{\Gamma \vdash u_2 : \heartsuit}\,(\mathrm{Var}) \quad \dfrac{}{\Gamma \vdash t_l : (x_{tl_1} : \heartsuit) \to \mathsf{type}}\,(\mathrm{III}) \quad \dfrac{}{\Gamma \vdash t_m : (x_{tm_1} : \heartsuit_a) \to t_l}\,(\mathrm{III}) \quad \dfrac{}{\Gamma \vdash t_n : (x_{tn_1} : \heartsuit_b) \to t_l}\,(\mathrm{III})}{\Gamma \vdash \mathit{unpack}^{t_l}_{u_2}(t_m, t_n) : \left[\begin{array}{l} x_{01} : \mathsf{entity} \\ \left[\begin{array}{l} x_{02} : \mathsf{entity} \\ \mathbf{woman}(x_{01})(x_{02}) \end{array}\right] \end{array}\right]}\,(+\mathrm{E})$$

not compromise predictions. Note that the reported execution times may vary depending on the time limits and the hardware environment.

**Scope and validation.** While nine constructed items do not establish broad coverage of disjunctive anaphora, this suite serves as a targeted proof of concept, demonstrating that our structural predictions are borne out end to end. To complement this evaluation on linguistic examples, unit-level test cases verifying that expected terms are correctly derived under specified contexts and types are available in our open-source repository.[5]

# 5 Conclusion

We have given a proof-theoretic analysis of E-type anaphora involving disjunction in DTS, deriving both the static profile of $A + B$ and the cases—disjunctive antecedents and Rothschild's puzzle—in which anaphora reaches inside a disjunction, from the standard rules for disjoint union types alone. By implementing the analysis end to end, from CCG parsing to automated theorem proving, we bring disjunctive anaphora within reach of a working system: existing implemented inference systems handle disjunction but not anaphora into it, and the accounts that address disjunctive anaphora directly (Rothschild, 2017; Hofmann, 2019; Elliott, 2023) have not been implemented. A semantic theory accompanied by an implementation is more falsifiable than one verified by hand, and we offer this work as a case study in that methodology.

[5] `https://github.com/hinarid/wani-example`

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# Two ways to be a singer: eventive and dispositional readings in perspective semantics

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**Introduction.** The agentive noun *singer* is systematically ambiguous (Alexiadou and Schäfer, 2010). On its more salient, *dispositional* reading, sentence (1) says that Olga has some standing propensity to sing, which is compatible with her not singing at the time of utterance, and even, on some construals, with her not having ever sung. On another reading, which we call the *eventive* reading, sentence (1) is true exactly when Olga is singing, i.e. when Olga is the agent of an actual singing event. The eventive reading surfaces clearly, for instance, in the following situation: in a karaoke bar, *the singer suddenly stopped* can felicitously be uttered when someone, who is not a singer in the dispositional sense (i.e. has no particular disposition to sing) but who happens to be the agent of an ongoing singing event, suddenly stops.

(1) Olga is a singer.

Correspondingly, (1) accepts two paraphrases involving the verb *to sing*: the eventive (2a) and the dispositional (2b).

(2) a. Olga is singing.
b. Olga sings.

Our goal is to provide a semantic analysis of nouns such as *singer* that:

- captures both the eventive and the dispositional readings of sentence (1);
- derives the tight link between the noun *singer* and the verb *to sing*, rather than stipulating it.

To derive this link in the case of dispositional sentences, we work within *perspective semantics*, a framework we have been developing (de Groote and Bernard, 2025) and which we introduce below.

**Perspective semantics.** In a seminal paper, Davidson (1967) posited that action verbs should be interpreted as containing a hidden argument corresponding to the event that they describe. Among other things, this move allowed him to provide a logical account of the entailment relations that exist between sentence (3a) and each of sentences (3b), (3c), and (3d).

(3) a. Jones buttered the toast in the bathroom at midnight.
b. Jones buttered the toast in the bathroom.
c. Jones buttered the toast at midnight.
d. Jones buttered the toast.

One of the goals of perspective semantics is to give an account of adnominal modification comparable to the way in which event semantics accounts for adverbial modification. In particular, it is meant to provide a purely logical account of the entailment relation existing between sentences (4a) and (4b), while avoiding the problems usually associated with an intersective treatment of subsective adjectives such as *skilful*.

(4) a. Mary is a skilful surgeon.
b. Mary is a surgeon.

Just as a verb lexicalises a predicate of *events* in (neo-Davidsonian) event semantics, a noun lexicalises a predicate of *perspectives* in perspective semantics. A perspective is intuitively a way of viewing an individual — Marie Curie *as a scientist*, Marie Curie *as a woman*, Marie Curie *as the 1903 Nobel laureate* are three perspectives on one individual. Formally, we posit a relation $\succ$ between perspectives and individuals, with $p \succ x$ read as "$p$ is a perspective on $x$", and we analyse (4b) with a logical form of the shape $\exists p.\,(\mathit{surgeon}\,p) \wedge (p \succ \mathit{Olga})$. Sentence (4a) is then analysed as $\exists p.\,(\mathit{surgeon}\,p) \wedge (\mathit{skilful}\,p) \wedge (p \succ \mathit{Olga})$.

Perspectives are the nominal counterparts of events, and the motivation is the same intensional flavour that motivates events. Adverbial modification is non-intersective: that Olga sings gracefully and dances does not entail that she dances gracefully, because *gracefully* predicates of the singing event, not of Olga. Adjectival modification patterns alike: that John is a graceful singer and a dancer does not entail that he is a graceful dancer, because *graceful* predicates of the singer-perspective, not of John. Perspectives give the nominal case the same event-style mediation between a head, its modifiers, and its subject, so that the analyses developed for verbs transfer to nouns and vice versa. Our perspectives are conceptually close to Fine's (1982) qua-objects, that distinguish between Socrates qua philosopher and Socrates qua Greek person, and to the "perspectives" of frame semantics (Fillmore and Baker, 2009), on which a buying and a selling are two perspectives on one transaction. Our perspectives are *perspectives on* an individual, and so differ from the point-of-view notion of Lasersohn (2016).[1]

**Eventive sentences.** Ignoring tense and aspect, the standard event-semantic analysis (Davidson, 1967; Parsons, 1990) of (2a) is (5), and the classical analysis of (1) is $(\mathit{singer}\ \mathit{Olga})$. When (1) is interpreted eventively (as in the karaoke situation), we believe that it does not involve any perspective but leads to the same formula as (2a), i.e. (5). In other words, we take the eventive reading of the noun *singer* to denote $\lambda x.\,\exists e.\,(\mathit{sing}\,e) \wedge (\mathsf{agent}\,e\,x)$.

(5) $\exists e.\,(\mathit{sing}\,e) \wedge (\mathsf{agent}\,e\,\mathit{Olga})$

Let us now turn to adjectival and adverbial modification. First, when *singer* is interpreted eventively, the adjective *beautiful* in *Olga is a beautiful singer* is ambiguous (Maienborn, 2020): it is either Olga or her singing that is said to be beautiful, corresponding to analyses (6a) and (6b) respectively. Second, we analyse *Olga is dancing beautifully* with formula (7) as is standard in event semantics.

(6) a. $\exists e.\,(\mathit{sing}\,e) \wedge (\mathsf{agent}\,e\,\mathit{Olga}) \wedge (\mathit{beautiful}\,\mathit{Olga})$
b. $\exists e.\,(\mathit{sing}\,e) \wedge (\mathsf{agent}\,e\,\mathit{Olga}) \wedge (\mathit{beautiful}\,e)$

(7) $\exists e.\,(\mathit{sing}\,e) \wedge (\mathsf{agent}\,e\,\mathit{Olga}) \wedge (\mathit{beautiful}\,e)$

**About** agent **and** *-er*. The noun *singer* is tied to the agent role: a singer (eventive) is one who is the agent of a singing. This is not general. A *grinder*, for instance, may be the agent *or* the instrument of a grinding (Rappaport Hovav and Levin, 1992), so we cannot interpret *-er* morphology systematically as, for instance, $\lambda P.\,\exists e.\,(P\,e) \wedge (\mathsf{agent}\,e\,x)$. We assume instead that

[1] Perspectives often feel similar to states. However, not all states might be perspectives, and not all perspectives are states. More precisely, we believe that some events are perspectives on transactions, movements, or other kinds of changes (although the present abstract does not deal with these) as well as that some states are perspectives on individuals.

a learner acquires the appropriate interpretation for *-er* nominals lexeme by lexeme. In the case of ambiguous nominals, one possible implementation assumes that the lexicon contains two entries: in the case of the noun *grinder*, for example, both $\lambda x.\, \exists e.\, (\mathit{grind}\, e) \wedge (\mathsf{agent}\, e\, x)$ and $\lambda x.\, \exists e.\, (\mathit{grind}\, e) \wedge (\mathsf{instrument}\, e\, x)$.

**Dispositional sentences.** We assume that Olga being a singer, in the dispositional reading, corresponds to the existence of a singer perspective on Olga: if Olga is a singer, then she can be seen as a singer (and vice versa). We further assume that this dispositional meaning of the noun *singer* is derived from the event predicate lexicalised by the verb *to sing* via an operator Disp of type $\langle\langle v,e\rangle, \langle\langle v,t\rangle, \langle v,t\rangle\rangle\rangle$. The first argument of this operator is a thematic role, its second an event predicate, its value a perspective predicate. $\mathsf{Disp}(\mathsf{agent})(\mathit{sing})$, for instance, is the predicate holding of a perspective $p$ on individual $x$ if $x$ has a disposition for being the agent of singing events.

Thus, we analyse both (1) (dispositional) and (2b) as (8).

(8) $\exists p.\, (\mathsf{Disp}\, \mathsf{agent}\, \mathit{sing}\, p) \wedge (p \succ \mathit{Olga})$

Because *Olga sings beautifully* means that Olga has a disposition for singing beautifully (i.e. for being the agent of beautiful singing events), we analyse this sentence as (9), using $P \sqcap Q$ for the pointwise conjunction $\lambda x.\, (Px) \wedge (Qx)$ of two predicates $P$ and $Q$. Concerning *Olga is a beautiful singer* where the noun *singer* is read dispositionally, we analyse it as either (10a) or (10b) depending on whether *beautiful* is interpreted as applying to Olga herself or to her disposition to sing.

(9) $\exists p.\, (\mathsf{Disp}\, \mathsf{agent}\, (\mathit{sing} \sqcap \mathit{beautiful})\, p) \wedge (p \succ \mathit{Olga})$

(10) a. $\exists p.\, (\mathsf{Disp}\, \mathsf{agent}\, \mathit{sing}\, p) \wedge (p \succ \mathit{Olga}) \wedge (\mathit{beautiful}\, \mathit{Olga})$
b. $\exists p.\, (\mathsf{Disp}\, \mathsf{agent}\, \mathit{sing}\, p) \wedge (p \succ \mathit{Olga}) \wedge (\mathit{beautiful}\, p)$

The equivalence between *Olga sings beautifully* and *Olga is a beautiful singer* (under the relevant reading) is then captured by the following meaning postulate:

(11) $(\mathsf{Disp}\, \mathsf{agent}\, \mathit{sing}) \sqcap \mathit{beautiful} = \mathsf{Disp}\, \mathsf{agent}\, (\mathit{sing} \sqcap \mathit{beautiful})$

As before, *-er* morphology in dispositional reading cannot be interpreted uniformly as $\lambda V.\, \lambda x.\, \exists p.\, (\mathsf{Disp}\, \mathsf{agent}\, V\, p) \wedge (p \succ x)$ because agent is not always the relevant thematic role. The ambiguity of the noun *grinder* can be seen as a lexical ambiguity between (12a) and (12b).

(12) a. $\lambda x.\, \exists p.\, (\mathsf{Disp}\, \mathsf{agent}\, \mathit{grind}\, p) \wedge (p \succ x)$
b. $\lambda x.\, \exists p.\, (\mathsf{Disp}\, \mathsf{instrument}\, \mathit{grind}\, p) \wedge (p \succ x)$

Finally, let us mention that we do not attempt in this abstract to define what the relevant notion of disposition amounts to: a dispositional singer may sing often, rarely, or not yet at all, and while the quantificational core of Disp is presumably that of the generic operator GEN (Krifka et al., 1995), the exact implementation is orthogonal to our present concerns.

**Compositionality.** The semantic analysis of nouns and adjectives that we propose in this abstract can be given a compositional treatment. To this end, Champollion's (2015) quantificational theory of events can be used to address quantification and scope. We do not have enough

space in this extended abstract to present this approach in full detail, but we give instead a simplified version of it, where noun phrases are interpreted as functions from individuals to sets of perspectives:

(13) a. $[\![singer]\!]_{eventive} = \lambda x.\lambda e.(sing\, e) \wedge (\mathsf{agent}\, e\, x)$
b. $[\![singer]\!]_{dispositional} = \lambda x.\lambda p.(\mathsf{Disp}\, \mathsf{agent}\, sing\, p) \wedge (p \succ x)$
c. $[\![beautiful]\!]_{intersective} = \lambda n.\lambda x.\lambda p.(n\, x\, p) \wedge (\mathsf{beautiful}\, x)$
d. $[\![beautiful]\!]_{non\text{-}intersective} = \lambda n.\lambda x.\lambda p.(n\, x\, p) \wedge (\mathsf{beautiful}\, p)$

**Conclusion.** Perspective semantics is a recent framework that gives a logically transparent account of adnominal modification, in particular by subsective adjectives (such as *skilful*), by mirroring the treatment event semantics gives to adverbial modification. The present work deepens the analysis of *-er* nominals (such as *singer*) in this framework and does so in a way that strengthens the parallel between the nominal and the verbal domains. Our proposal, which can be given a fully compositional treatment, captures both the eventive and the dispositional readings of *-er* nominals and, for the dispositional reading, derives the interpretation of the noun from the interpretation of the base verb via a Disp operator that is motivated by the difference in interpretation between simple present sentences (such as *Olga sings*) and present progressive sentences (*Olga is singing*).

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# Aristotle's Substructural Sequent Calculus (Extended Abstract)

Kohei Kishida

## 1. Introduction

A textbook treatment of Aristotle's syllogistic, his logical theory of categorical syllogisms, is to translate categorical sentences into modern first-order logic and to show the syllogistic to be sound with respect to classical logic, in the sense that syllogisms endorsed in the syllogistic are both valid and provable in classical logic.[1] For instance, "every $x$ is $y$; no $y$ is $z$; therefore no $x$ is $z$" is translated as "$\forall v\,(Xv \supset Yv)$; $\forall v\,(Yv \supset \neg Zv)$; therefore $\forall v\,(Xv \supset \neg Zv)$". It is sometimes noted that Aristotle uses some existential assumption so that "every $x$ is $y$" implies "some $x$ is $y$".

Some scholars find this reconstruction unsatisfactory, however, since it involves too much machinery that is foreign to Aristotle—Boolean connectives and quantifiers, among others. They have therefore proposed reconstructions with formalisms that are more faithful to Aristotle's, in which they take categorical sentences as atomic sentences (or negations thereof). Let us write

| | | | | |
|---|---|---|---|---|
| $Axy$ | for | "Every $y$ is $x$" | or | "$x$ belongs to all $y$" in Aristotle's way of phrasing, |
| $Exy$ | for | "No $y$ is $x$" | or | "$x$ belongs to no $y$", |
| $Ixy$ | for | "Some $y$ is $x$" | or | "$x$ belongs to some $y$", |
| $Oxy$ | for | "Some $y$ is not $x$" | or | "$x$ does not belong to some $y$". |

Following Aristotle, they deem that $Axy$ and $Oxy$ are negations to each other; so are $Exy$ and $Ixy$; $Exy$ and $Eyx$ are equivalent; so are $Ixy$ and $Iyx$; and $Axy$ and $Exy$ imply $Ixy$ and $Oxy$, respectively.[2] Since Łukasiewicz's [7] seminal work, there have been Corcoran's [4] and Smiley's [11] natural-deduction systems, Martin's [9] sequent calculus, and more recently, a natural deduction in the framework of natural logic by Pratt-Hartmann and Moss [10].

These reconstructions agree with the textbook treatment in taking Aristotle's logic as based on classical validity, and prove such valid inferences as "$\varphi$, therefore $\varphi$" or "$\varphi$ and $\chi$, therefore $\varphi$". One problem is that Aristotle rejects them. As he defines it,

> A [good] syllogism is an argument in which, certain things being posited, *something other than what was laid down* results by necessity because these things are so.[3]

He also says that we fail to have a good syllogism when "either there will be no syllogism, or there will not be one with respect to the proposed subject, or *one will be postulating the initial thesis*."[4] These remarks clearly rule out "$\varphi$, therefore $\varphi$" and "$\varphi$ and $\chi$, therefore $\varphi$".[5]

This exclusion makes sense when we consider a role that Aristotle expects syllogisms to play: note that he uses the word "because" in his definition of syllogism quoted above; by taking advantage of this "because", Aristotle entrusts a syllogism "$\varphi$ and $\chi$, therefore $\psi$" with the role of a scientific explanation that "$\psi$ *because* $\varphi$ and $\chi$". In this model, "$\varphi$, therefore $\varphi$" would constitute a bad explanation that "$\varphi$ because $\varphi$". Contemporary philosophers, using the modern logic of validity, take the "because" in scientific explanation as based outside logic: they think "$\varphi$ because $\varphi$" is bad for some non-logical (epistemic, pragmatic, etc.) reasons since, in the logic of validity, $\varphi \vdash \varphi$ is a perfectly good inference. But for Aristotle, this "because" is the essential element of logic that makes a good syllogism good in the first place. The overall goal of this article is to

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[1] See, e.g., Chapters 5 and 6 of Copi [3], 161–213, and Unit 12 of Klenk [6], 225–248.

[2] Aristotle never states it as a rule that $Exy$ implies $Oxy$. See *An. Pr.* I.2, 25a1–27. Also see the final paragraph of Section 2.

[3] *An. Pr.* I.1, 24b18–20. Emphasis mine. For *An. Pr.* I, I use the translation by Striker [13].

[4] *An. Pr.* I.24, 41b7–9. Emphasis mine.

[5] The same interpretation of these and other passages is found in Frede [5], 20f., Barnes [2], 487–491, Striker [13], 78–81, and Malink [8], footnote 32. For instance, here is Striker: "Taking all of Aristotle's comments together, then, we can say that he defines a syllogism as a valid deductive argument with at least two premisses that are different from the conclusion, all of them being used to derive the conclusion" ([13], 81).

demonstrate that this conception of logic, the logic of "because", can be realized as a modern formal theory by formalizing Aristotle's own set-up of the syllogistic.

1.1. **Syllogistic Figures.** Previous researchers were certainly aware of the need to somehow rule out $\varphi \vdash \varphi$ and $\varphi, \chi \vdash \varphi$. They claimed that it was achieved with the help of the syllogistic figures:

**Definition 1.** An inference is said to be in the *first figure* if its sentences are categorical ones and if it has the form $-xy, -yz \vdash -xz$ (or $-yz, -xy \vdash -xz$). The *second*, *third*, and *fourth figures* are given by the forms $-yx, -yz \vdash -xz$; $-xy, -zy \vdash -xz$; $-yx, -zy \vdash -xz$, respectively.

Aristotle himself states that "It is also clear [. . .] that all the [good, two-premise, and categorical] syllogisms are through the aforementioned figures."[6] This rules out $\varphi \vdash \varphi$ and $\varphi, \chi \vdash \varphi$, which are not in any of the four figures. In fact, the aforementioned researchers, in their reconstructions of the syllogistic, typically make[7]

**Assumption 1.** Let $\varphi, \chi, \psi$ be any categorical sentences each of which has two different terms.[8] Then Aristotle endorses $\varphi, \chi \vdash \psi$ iff it is in one of the four syllogistic figures and it is valid, or "valid$_\exists$" with the aforementioned existential assumption.

This is what Corcoran [4], for instance, means when saying "the Aristotelian system is seen to be complete in the sense that every valid argument expressible in his system admits of a deduction within his deductive system; i.e., every semantically valid argument is deducible".[9] But we should note that, here, an inference is deemed inexpressible if not in the figures.

I argue that it would not be faithful to Aristotle to explain that $\varphi \vdash \varphi$ and $\varphi, \chi \vdash \varphi$ fail to be good syllogisms *because* they fail to be in the figures. His definition of good syllogism, along with other statements he makes, rules out $\varphi \vdash \varphi$ and $\varphi, \chi \vdash \varphi$ not for the reason of the figure breakdown but of a breakdown in the "because" that makes good syllogisms good.[10] Moreover, Aristotle's statement quoted above on good syllogisms being in the figures is made long after he lays out his proof system. We therefore take the statement as Aristotle's metatheorem, rather than a part of his definition of his system, so that $\varphi \vdash \varphi$ and $\varphi, \chi \vdash \varphi$ are "expressible in his system" while the system still rejects them for substantial logical reasons. Thus, it has yet to be elucidated how Aristotle's logic of "because" avoids proving $\varphi \vdash \varphi$ or $\varphi, \chi \vdash \varphi$.

## 2. Aristotle's Sequent Calculus

Aristotle defines a *perfect syllogism* as a syllogism that "needs nothing other than what has been stated [as premises] to make the necessity [for the conclusion to follow] evident."[11] They are

[6] *An. Pr.* I.28, 44b7–8.

[7] Many interpreters disagree with Assumption 1, however. See the final paragraph of Section 2.

[8] In this abstract we limit our attention to sentences with two different terms. Aristotle does discuss sentences with two terms repeated, and we also discuss how to treat them in the full paper.

[9] [4], 85. Smith [12], in Section 5, also says that the syllogistic "is in fact the theory of inferences of a very specific sort", namely, inferences in the four figures, rather than inferences that include $\varphi \vdash \varphi$ and $\varphi, \chi \vdash \varphi$.

[10] One pathway that has been tried to connect the syllogistic figures and the "because" is through a variable-sharing condition that characterizes the figures. Thom [14] states that "By relevance I mean the sharing of variables among members" ([14], 27), referring to the fact that variable sharing is a necessary condition of good inferences in relevance logic [1]. This then connects the figures as characterized by variable sharing to the "because" as a sort of relevance. Note, however, that variable sharing and the "because" in Aristotle's definition embody two a priori different notions of relevance. While the former is a syntactic notion, the latter may be called derivational: similar to the idea that drives relevance logic, this notion concerns using premises in deriving a conclusion (also see footnote 5 for Striker's [13] interpretation). It therefore needs demonstrating that the syntactic notion and Aristotle's derivational one agree extensionally. In the case of relevance logic, it is a non-trivial result to prove that a derivationally relevant inference must also be syntactically, variable-sharingly relevant, but this is not to *define* derivational relevance to have variable sharing as a necessary condition. One may see our results as similarly establishing variable sharing and the figures to be an extensionally necessary condition of derivational relevance or the "because".

[11] *An. Pr.* I.1, 24b23–24.

the following syllogisms in the first figure:

(1) $Axy, Ayz \vdash Axz$, (2) $Exy, Ayz \vdash Exz$, (3) $Axy, Iyz \vdash Ixz$, (4) $Exy, Iyz \vdash Oxz$.

Aristotle then introduces notions of *perfection* and *reduction*:

> It is evident too that all imperfect [but good] syllogisms are perfected through the first figure [i.e. perfect syllogisms]. For they are all brought to a conclusion either ostensively [directly] or through the impossible, and in both cases the first figure comes about.[12]

For instance, the imperfect syllogism $Ixz, Ayz \vdash Ixy$ is perfected by reduction to the perfect $Exy, Ayz \vdash Exz$. Our key idea is that we can regard this reduction precisely as a sequent-calculus derivation of the imperfect from the perfect, as in

$$\dfrac{\dfrac{}{Exy, Ayz \vdash Exz}}{Ixz, Ayz \vdash Ixy}$$

Indeed, we do not mean this sequent calculus to be a metatheory on what Aristotle does: instead, we maintain that this *is* what Aristotle does. Let's take an example of a proof by Aristotle:

> (i) Again, if $y$ belongs to all $z$ and to no $x$, $z$ will belong to no $x$. (ii) For if $y$ belongs to no $x$, neither does $x$ belong to any $y$; (iii) but it was assumed that $y$ belongs to all $z$; (iv) therefore, $x$ will belong to no $z$—for the first figure has come about again. (v) And since the privative [negative] premiss converts, neither will $z$ belong to any $x$ [. . .].[13]

This *is* the following derivation, in which two arrows and an equality sign are provided as reading aids.

$$\dfrac{\dfrac{}{Exy, Ayz \vdash Exz}}{Ayz, Eyx \vdash Ezx}$$

The sentence (i) is, typical of Aristotle's proof style, him first stating what is to be proven, i.e., the bottom sequent or syllogism. Starting the proof with a "For", (ii) converts an antecedent along the arrow on the left. (iii) repeats the other antecedent, along the equality sign. (iv) applies the top sequent, a perfect syllogism. (v) then converts the consequent along the arrow on the right.

Aristotle admits extending derivations recursively: he reduces the perfect syllogisms (3) and (4) to imperfect ones and then to (2), as in[14]

$$\dfrac{\dfrac{\dfrac{}{Exy, Ayz \vdash Exz}}{Ayz, Eyx \vdash Ezx}}{Ayz, Izx \vdash Iyx} \qquad \dfrac{\dfrac{\dfrac{}{Exy, Ayz \vdash Exz}}{Eyx, Ayz \vdash Exz}}{Eyx, Ixz \vdash Oyz}$$

We sum up the key idea and formalize what Aristotle does by

**Definition 2.** A sequent calculus $\mathbf{A}_2^{\mathbf{a}}$ has the axioms (1)–(4) (in which $x$, $y$, $z$ are all distinct) and the following rules, where $(\oplus, \otimes) = (E, E), (I, I), (A, I), (E, O)$ and $\neg\varphi$ is the negation of $\varphi$ (e.g., $Ixy$ for $\varphi = Exy$).

Conv $$\dfrac{\varphi_1, \ldots, \varphi_n, \otimes xy, \chi_1, \ldots, \chi_m \vdash \psi}{\varphi_1, \ldots, \varphi_n, \oplus yx, \chi_1, \ldots, \chi_m \vdash \psi} \qquad \dfrac{\varphi_1, \ldots, \varphi_n \vdash \oplus xy}{\varphi_1, \ldots, \varphi_n \vdash \otimes yx}$$

Contra $$\dfrac{\varphi_1, \ldots, \varphi_n, \varphi, \chi_1, \ldots, \chi_m \vdash \psi}{\varphi_1, \ldots, \varphi_n, \neg\psi, \chi_1, \ldots, \chi_m \vdash \neg\varphi}$$

Comm $$\dfrac{\varphi_1, \ldots, \varphi_n, \varphi, \chi, \chi_1, \ldots, \chi_m \vdash \psi}{\varphi_1, \ldots, \varphi_n, \chi, \varphi, \chi_1, \ldots, \chi_m \vdash \psi}$$

[12] *An. Pr.* I.7, 29a30–33.

[13] *An. Pr.* I.5, 27a9–12. I have numbered the sentences.

[14] *An. Pr.* I.7, 29b1–25.

We then have a variety of proof-theoretic results. The most immediate one may be the property that sequents in any derivation in $\mathbf{A}_2^{\mathbf{a}}$ have exactly two premises (from which it follows that $\varphi \vdash \varphi$ is not provable), since the axioms do while the rules preserve the number of premises. One may note that, despite this property of $\mathbf{A}_2^{\mathbf{a}}$, the rules as they are presented above admit an unbounded number of premises. This is primarily to emphasize that the always-two-premises property arises from the set of axioms: if the system also had $\varphi \vdash \varphi$ as an axiom, the rules would not prevent us from deriving e.g. $Axy \vdash Iyx$. (Another reason is that, while we focus on the two-premise case in this paper—hence the subscript "2" in "$\mathbf{A}_2^{\mathbf{a}}$"—we envisage an extension that has the cut rule and proves sequents with more than two premises.)

Aristotle's own observations can also be established, such as that every provable sequent is in the figures (which implies that $\varphi, \chi \vdash \varphi$ is not provable) or that (3) and (4) are derivable.[15] Results that may be of interest to commentators include the eliminability of the subcase of Contra in which either $\varphi$ or $\psi$ is an $I$- or $O$-sentence, a subcase that Aristotle never uses. The most important result, for $\mathbf{A}_2^{\mathbf{a}}$ to be a good reconstruction of Aristotle's syllogistic, may be

**Theorem 1.** *Let $\varphi$, $\chi$, $\psi$ be any categorical sentences each of which has two different terms. Then $\mathbf{A}_2^{\mathbf{a}}$ proves $\varphi, \chi \vdash \psi$ iff Aristotle endorses it (in the sense of Assumption 1).*

One may note that this invokes Assumption 1—whereas many scholars disagree with it due to two types of syllogisms that it says Aristotle endorses but that he may actually not: namely, those in the fourth figure and the so-called subalternate ones. Nonetheless, adding suitable sets of restrictions to $\mathbf{A}_2^{\mathbf{a}}$, such as prohibiting $(\oplus, \otimes) = (E, O)$ in Definition 2 as well as the aforementioned $I$-/$O$-subcase of Contra, gives us weaker systems that prove all provable sequents of $\mathbf{A}_2^{\mathbf{a}}$ except the subalternate ones or except the subalternate ones and those in the fourth figure.

## 3. Aristotle's Substructural Logic

To study in exactly what way Aristotle's logic of "because" is non-classical, one obvious way is to regard $\mathbf{A}_2^{\mathbf{a}}$ as a substructural logic and indeed a relevance logic of some sort, and to compare it to the classical sequent calculus. $\mathbf{A}_2^{\mathbf{a}}$ has commutativity, but not weakening, contraction, or even identity (it lacks cut, but it is to limit our focus to the two-premise case). It is not hard to see that weakening and identity constitute a breakdown in the "because". Nonetheless, due to the thin structure of $\mathbf{A}_2^{\mathbf{a}}$ as a sequent calculus (no sentential connectives, the always-two-premises property, etc.), not all of its relevance aspects are immediately clear. It is helpful to shed light on these aspects from different angles, by extracting natural deduction and semantics from $\mathbf{A}_2^{\mathbf{a}}$.

To extract a natural deduction from $\mathbf{A}_2^{\mathbf{a}}$, we need the machinery of relevance logic. In particular, we use Anderson and Belnap's [1] method of annotating Fitch-style proofs: not only do scope markers indicate on which assumptions a line of a proof *may* depend, but we annotate each line with a set of indices indicating on which assumptions it *does* depend. This idea is implemented by the rules in Figure 1, which are the natural-deduction counterparts of (1)–(4), Conv, and Contra. The indices then enable us to set, for instance, the following relevance-logical constraint.

(5) The conclusion must actually depend on all the premises. Formally, if $H$ is the set of indices for the premises, then the index set of the conclusion must be $H$.

This rules out the left proof below of $Exy, \chi \vdash Exy$ while we can accept the right proof.

| | | |
|---|---|---|
| 1 | $Exy_{\{1\}}$ | hyp |
| 2 | $\chi_{\{2\}}$ | hyp |
| 3 | $Eyx_{\{1\}}$ | Conv, 1 |
| 4 | $Exy_{\{1\}}$ | Conv, 3 |

| | | |
|---|---|---|
| 1 | $Ayz_{\{1\}}$ | hyp |
| 2 | $Eyx_{\{2\}}$ | hyp |
| 3 | $Exy_{\{2\}}$ | Conv, 2 |
| 4 | $Exz_{\{1,2\}}$ | Perf, 1, 3 |
| 5 | $Ezx_{\{1,2\}}$ | Conv, 4 |

[15] See Smith [12], Subsection 5.5, for Aristotle's own observations.

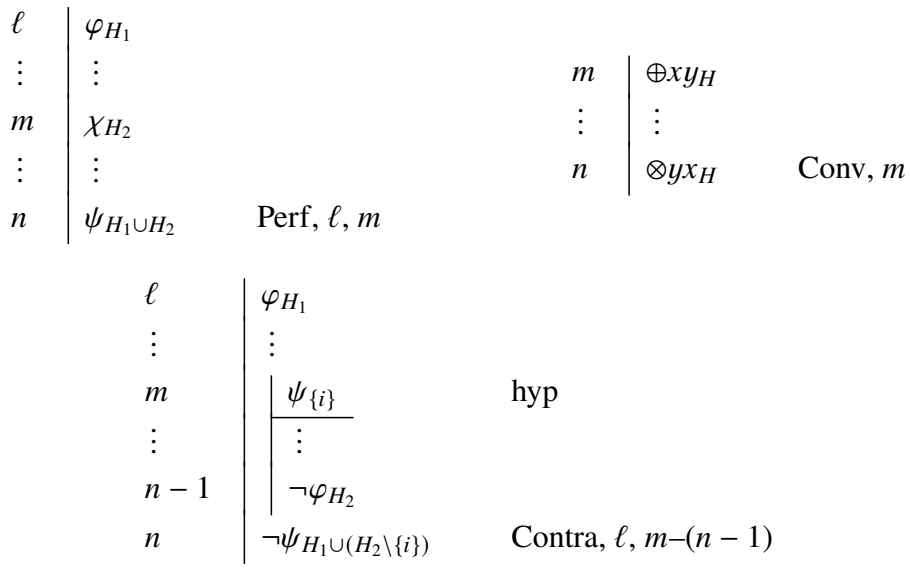



FIGURE 1. The rules of $\mathbf{FA}_2^{\mathbf{a}}$. For Perf, $\varphi, \chi \vdash \psi$ or $\chi, \varphi \vdash \psi$ is an instance of one of (1)–(4). In Conv and Contra, $(\oplus, \otimes)$ and $\neg$ are as in Definition 2.

We then use a bit of structural proof theory and arrive at

**Definition 3.** A system $\mathbf{FA}_2^{\mathbf{a}}$ of Fitch-style natural deduction has (1)–(4), Conv, and Contra of Figure 1 as its rules and is subject to the following constraints (6)–(9) in addition to (5).

(6) The proof must use Perf at least once.
(7) In Contra, $i \in H_2$, i.e., the conclusion of the subproof must depend on the assumption of the subproof.
(8) In Perf and Contra, $H_1 \cap H_2 = \varnothing$. I.e., in Perf, there must not be an assumption on which the two antecedents both depend, and in Contra, there must not be an assumption on which the conclusion of the subproof and its negation before the subproof both depend.
(9) The proof has at most two premises.

**Theorem 2.** *Let $\varphi$, $\chi$, $\psi$ be any categorical sentences each of which has two different terms. Then $\mathbf{FA}_2^{\mathbf{a}}$ proves $\varphi, \chi \vdash \psi$ iff $\mathbf{A}_2^{\mathbf{a}}$ proves it.*

Aristotle, in fact, observes the constraint (7) and connects its violation to a breakdown of the "because".[16] The constraints of $\mathbf{FA}_2^{\mathbf{a}}$ can thus help delineate the logic of "because". (We put (9) in place merely in order to restrict our focus on the two-premise case.)

The theorem has one consequence with respect to Aristotle scholars' conventional view that Aristotle's syllogistic is a natural deduction. Note that he states his observation of (7) long after laying out his system, and hence that we should not take (7) as part of how Aristotle's system is defined. His sequent calculus of reduction and perfection therefore plays an indispensable role in achieving the substructural logic of "because".

## 4. Other Results

We have several more results. One is semantics, with a theorem roughly stating that $\mathbf{A}_2^{\mathbf{a}}$ proves $\varphi, \chi \vdash \psi$ iff $\varphi$ and $\chi$ validly entail $\psi$ but neither $\varphi$ nor $\chi$ alone does while $\varphi$ and $\chi$ are consistent with each other. The consistency of the premises is another relevance-logical aspect of $\mathbf{A}_2^{\mathbf{a}}$. Another result is a string-diagram notation that captures the mathematical structure underlying $\mathbf{A}_2^{\mathbf{a}}$ and $\mathbf{FA}_2^{\mathbf{a}}$ and that shows how proofs in the two systems are essentially the same.

[16] *An. Pr.* II.17, 65b9–12.

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# The fine-grained modal semantics of English *for-to* infinitives

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**Background:** English *for-to* infinitives are well known to have a modal semantics under some conditions, as brought out by the overtly modal finite paraphrases of sentences like (1)–(2).

(1) There's a book [for you to read] on the table. ≈ … [that you **could/should** read] …

(2) The text is clear enough [for me to read it]. ≈ …[that I **can** read it].

But the fine-grained modal properties of these infinitives are not well investigated. Drawing on and synthesizing my recent work on this topic (especially Grano 2022, 2026), I focus on two case studies that, taken together, give rise to a puzzle. I suggest a possible resolution to this puzzle that paves the way for a unified modal semantics for *for-to* infinitives.

**Case study #1:** English *for-to* infinitives in relative clause function have variable modal force (possibility or weak necessity) and fixed modal flavor (deontic only). As explored by Bhatt (2006); Hackl & Nissenbaum (2012), this variable modal force is subject to a restriction: whereas infinitival relative clauses embedded under weak quantifiers (such as *a* in (1) above) give rise to the variability, infinitival relative clauses embedded under strong quantifiers (such as *the* in (3) below) give rise to a weak necessity reading only.

(3) The book [for you to read] is on the table. ≈ … [that you **should** read] …

Grano (2026) proposes a novel explanation for this pattern according to which infinitival relatives contain a covert gradable modal with a degree-based semantics. Combination with a covert degree operator *pos* (in the sense of Kennedy 2007 and others) yields the weak necessity reading, whereas existential closure of the degree variable yields the possibility reading. Following Diesing (1992), existential closure is available only within VP, and yet strong quantifiers are generated outside VP, explaining the absence of the possibility reading for infinitival relatives embedded under strong quantifiers.

**Case study #2:** Infinitive-embedding *enough* sentences have fixed modal force (possibility only) but variable modal flavor that allows for circumstantial (2), deontic (4), and epistemic (5) readings.

(4) Kim is old enough [to drive]. ≈ … [that she is **permitted** to drive] …

(5) Kim is tall enough [to be the thief]. ≈ … [that she **might** be the thief].

According to one view in the literature, this modality is contributed by the *enough* morpheme (von Stechow et al. 2004 and others), whereas according to another view, the modality is contributed by the infinitive (Meier 2003). Grano (2022) provides novel evidence for the latter view: infinitive-embedding *enough* sentences alternate with finite-clause-embedding counterparts that contain overt modals, as seen in the paraphrases of (2), (4), and (5) above. Grano argues that the simplest overall account of the data is one in which the embedded clause in the *enough* sentence always encodes the modality, whether that be covert in the case of infinitives or sometimes overt in the case of finite embedded clauses.

**Puzzle and possible resolution:** Taken together, the two case studies pose a puzzle: *for-to* infinitives in relative clause function have variable modal force but fixed modal flavor, whereas *for-to* infinitives in complementation with *enough* have fixed modal force but variable modal flavor. Toward a resolution of this puzzle and a unified semantics for *for-to* infinitives, and building on Grano 2022, I suggest that these infinitives function as a modal "elsewhere", compatible with all force/flavor combinations except for epistemic necessity. I furthermore suggest that this is because they stand in grammatical opposition with finite clauses, whose canonical function is assertion, which is a kind of epistemic necessity: a move to update the interlocutors' shared knowledge so that it entails the content of the assertion. Many open questions remain concerning how *for-to* infinitives' "elsewhere" status interacts with their embedding environments to yield more constrained force/flavor combinations.

**Monotonic and non-monotonic confirmation-seeking:**
**A scoreboard analysis of *daroo?* and *daroo-ne?* in Japanese**

**Taro Hiraoka (SOKENDAI)**

**Introduction** We treat the difference between Japanese confirmation-seeking questions *daroo?* and *daroo-ne?* from a formal pragmatics perspective. In the previous descriptive study, these two types of questions are said to check for a gap between interlocutors' knowledge [5]. We show that these two types of questions have different conversational moves — *daroo?* embodies a **monotonic** confirmation-seeking move as a biased polar question, whereas *daroo-ne?* performs a **non-monotonic** confirmation-seeking move, making the speaker's doubt about a discourse-salient proposition explicit. Morphologically, *daroo-ne?* consists of *daroo* and the sentence-final particle *ne*. In this paper, we do not explore the question of whether a compositional analysis is possible, and simply treat *daroo-ne?* as one unit.

**Data** In this section, we introduce two tests: **the adverbs test** and **the responses test**. The former focuses on what kinds of adverbs can co-occur with confirmation-seeking questions; the latter on felicitous responses. The following (1) is the adverbs test, and (2) and (3) are the responses test.

(1) [The adverbs test: checking co-occurrence of some type of adverbs]
   a. {Tabun/Kitto} kore-wa C-no hankachi-{daroo?/#daroo-ne?}
   maybe/certainly this-TOP C-GEN handkerchief-DAROO/DAROO-NE
   "Is this C's handkerchief?"
   b. {Hontoni/Chikatte} kore-wa C-no hankachi-{daroo-ne?/#daroo?}
   really/absolutory this-TOP C-GEN handkerchief-DAROO/DAROO-NE
   "Is this C's handkerchief, really?"

*Tabun* and *kitto* express the speaker's confidence in her own knowledge. So they can be translated as the epistemic modals "maybe" and "certainly". By contrast, *hontoni* and *chikatte* in (1b) show the speaker's doubt about the addressee's assertion. These two types of adverbs modify different targets, and *daroo?* and *daroo-ne?* are compatible with only one type of adverb, as shown in (1).

Next, we examine the responses test as follows.

(2) A: Kore-wa C-no hankachi-{a. daroo?/b. daroo-ne?} B: So-da-yo
this-TOP C-GEN handkerchief-DAROO/DAROO-NE so-COP-SFP
A: "Is it C's handkerchief?" B: "That's right."
A: Yappari so da yo ne ?
as.expected so COP SFP SFP
"As I thought, that's right." (felicitous as a response to (2a) (with *daroo?*), but infelicitous as a response to (2b) (with *daroo-ne?*))

(3) A: Kore-wa C-no hankachi-{a. daroo?/b. daroo-ne?} B: So-da-yo
this-TOP C-GEN handkerchief-DAROO/DAROO-NE so-COP-SFP
A: "Is it C's handkerchief?" B: "That's right."
A: Hontoni?
really
"really?" (felicitous as a response to (3b) (with *daroo-ne?*), but infelicitous as a response to (3a) (with *daroo?*))

In these multi-turn conversational sequences, we can see that different types of responses are felicitous after B accepts A's utterance involving *daroo?* and *daroo-ne?*. Responding with acceptance, as in (2), is only acceptable in the *daroo?* question. Conversely, in (3), expressing

doubt is only acceptable in *daroo-ne?*. This fact suggests that the two types of confirmation-seeking questions have different functions in the conversation.

The two tests show that *daroo?* and *daroo-ne?* instantiate different types of conversational moves. $\varphi$-*daroo?* is a **monotonic** confirmation-seeking move in that the speaker simply poses the question $\varphi$? with her own bias toward a positive answer to it. By contrast, $\varphi$-*daroo-ne?* embodies a **non-monotonic** discourse move of questioning the validity of a previously made claim, thereby indirectly seeking confirmation. In what follows, we formalize this difference in a model of discourse that tracks different states of the discourse in the form of an enriched scoreboard.

**Framework** This section introduces **the conversational scoreboard**, which originated with Lewis [1], as a framework to analyze conversational moves of *daroo?* and *daroo-ne?*. We adopt one type of conversational scoreboard called **the Table model**, which was introduced in Farkas and Bruce [2]. In their model, the conversational scoreboard is defined by the following quintuple (assuming, for simplicity, a conversation with only two interlocutors).

1. The set of propositions to which each participant is individually committed, referred to as $DC_A$ and $DC_B$, indexed by the participant.
2. The Table *S*, which records what is at issue in the conversation.
3. The common ground *cg*, storing propositions that interlocutors are mutually committed to.
4. The projected set *ps*, which represents possible component(s) of common ground.

On this basis, Farkas and Bruce provide an analysis of assertion and polar questions. For a polar question of $\varphi$, for example, the Table changes as follows, assuming an out-of-the-blue context.

(4)

| | (i) Previously | (ii) After A's question $\varphi$? | (iii) After B's answer $\varphi$ |
|---|---|---|---|
| $DC_A$ | $\emptyset$ | $\emptyset$ | $\emptyset$ |
| $DC_B$ | $\emptyset$ | $\emptyset$ | $\emptyset$ |
| Table *S* | $\emptyset$ | $\{\varphi, \neg\varphi\}$ | $\emptyset$ |
| *cg* | $\emptyset$ | $\emptyset$ | $\varphi$ |
| *ps* | $\emptyset$ | $\{\varphi\}$ or $\{\neg\varphi\}$ | $\emptyset$ |

The polar question $\varphi$? means the answer set, $\{\varphi, \neg\varphi\}$, and answering this question is choosing one of them. The proposition $\varphi$ and its negation are placed on the Table after A's question; this reflects the meaning of the polar question $\varphi$?, and the projected set represents the possible future cg, $\varphi$ or its negation (in 4-(ii)). After putting $\varphi$ and its negation, these become the issue that must be resolved. If B answers $\varphi$, this issue is resolved, and $\varphi$ is added to the common ground (in 4-(iii)).

**Analysis 1. *Daroo?* as a proposal** *Daroo?* can be formulated as the following Table (5). A's question $\varphi$ *daroo?* places the two alternatives $\varphi$ and $\neg\varphi$ on the Table (the polar question aspect). At the same time, the discourse is biased toward accepting $\varphi$, since A committed to $\varphi$ itself.

This analysis predicts that if one uses $\varphi$-*daroo?* as a proposal, the speaker makes a commitment to $\varphi$ and this utterance is similar to assertion. The following two tests, (6) and (7), verify this point[1].

[1]The former test is suggested by Misato Ido.

(5)

| | (i) Previously | (ii) After A's question | (iii) After B's acceptance |
|---|---|---|---|
| $DC_A$ | $\emptyset$ | $\varphi$ | $\emptyset$ |
| $DC_B$ | $\emptyset$ | $\emptyset$ | $\emptyset$ |
| Table *S* | $\emptyset$ | $\{\varphi, \neg\varphi\}$ | $\emptyset$ |
| *cg* | $\emptyset$ | $\emptyset$ | $\varphi$ |
| *ps* | $\emptyset$ | $\{\varphi\}$ or $\{\neg\varphi\}$ | $\emptyset$ |

(6) [Context: A and B disputed over the ownership of a handkerchief, and, in the end, A was right.]

A: Hora! kore-wa C-no hankachi-{da/daroo?/#Ø/#daroo-ne?}
see this-TOP C-GEN handkerchief-{DA/DAROO/Ø/DAROO-NE}

da: "See this! This is C's handkerchief."/ daroo? "See this! This is C's handkerchief, right?"

(7) [Context: A witnesses that C dropped the handkerchief, and tells B who is the owner of the handkerchief]

A: Kore-wa C-no hankachi-{da/daroo?/#Ø?/#daroo-ne?}
this-TOP C-GEN handkerchief-{DA/DAROO/Q/DAROO-NE}

da: "It is C's handkerchief."/ daroo?: "Is it C's handkerchief?"

In (6), particle *hora* can be used only with *da* and *daroo?*. In this context, the particle *hora* asks for the addressee's consent for the speaker's assertion, and can co-occur with *da* and *daroo?*; this shows that *daroo?* makes a commitment, whereas a bare polar question (see (4)) does not, and so cannot co-occur with *hora*. In (7), A's witness is enough to commit that the owner of the handkerchief is C, and the data show that the *da* particle, which corresponds to assertion, and *daroo?* show a similar pattern. Based on these observations, we claim that A's question $\varphi$-*daroo?* adds A's discourse commitment ($DC_A$ on (5)) to $\varphi$[2].

So, *daroo?* is a biased polar question, as analyzed by Sudo [7]. In Sudo [7], he suggests that positive polar question uses of *daroo?* imply that the speaker expects a positive answer, regardless of which evidence interlocutors can use. And this analysis is compatible with the previous proposals that the at-issue meaning is a polar question and the not-at-issue meaning expresses the speaker's attitude [3, 4, 8]. In our proposal, the "at-issue" meaning is encoded in the state of the Table, and it follows that the speaker's (biased) attitude is "not-at-issue" given its discourse status as the speaker's own commitment.

This formulation explains our observations. First, in the adverbs test, *daroo?* co-occurs only with the epistemic modality because, based on our proposal, the conversational move of *daroo?* is to put the proposition on the Table with the speaker's commitment, and epistemic modality modifies the strength of that commitment. By contrast, adverbs like *really* are used to challenge the other interlocutor's commitment. So it conflicts with *daroo?*'s commitment-making move.

[2]There exists another option. Malamud and Stephenson [6] propose projected commitments. In their suggestion, projected commitments represent the expected next stage of interlocutors' commitments. Using this, A's *daroo?* puts $\varphi$ on projected commitments, and tells that the speaker wants to commit $\varphi$. This move tells the addressee that the speaker proposes $\varphi$ as her own commitment and needs some confirmation from the addressee. We adopt, however, the original Farkas and Bruce's Table model [2] because *daroo?* in (6) and (7) shows that the speaker has a full commitment. We thank an anonymous reviewer for sharing the Malamud and Stephenson's paper [6].

Second, in the responses test, B's response shows acceptance of A's suggestion, in Table (5)-(iii). Based on A's commitment containing $\varphi$, the speaker is biased toward a positive answer. So, it is infelicitous for A to refuse to accept her original suggestion $\varphi$ after her own question $\varphi?$ is resolved by B's response.

**Analysis 2. *Daroo-ne?* as doubt-marking** Next, *daroo-ne?* expresses the speaker's doubt about the addressee's previous assertion, as in the following Table (8).

(8)

| | (i) Previously | (ii) After A's *daroo-ne?* |
|---|---|---|
| $DC_A$ | $\emptyset$ | $\diamond\neg\varphi$ |
| $DC_B$ | $\varphi$ | $\varphi$ |
| Table $S$ | $\varphi$ | $\{\varphi, \neg\varphi\}$ |
| *cg* | $\emptyset$ | $\emptyset$ |
| *ps* | $\{\varphi\}$ | $\{\varphi\}$ or $\{\neg\varphi\}$ |

Typically, *daroo-ne?* is felicitous if there exists some counterevidence to the previous assertion, and by using *daroo-ne?*, the speaker expresses doubt about the previous assertion on the Table. Consequently, *daroo-ne?* adds $\neg\varphi$ on the Table, as the doubt expressed by the speaker leaves the conversation unresolved as to whether $\varphi$ holds. Moreover, A expresses the possibility of $\neg\varphi$, so she adds "possibly, $\varphi$ is false." to $DC_A$. We express this using the modal operator "$\diamond$" and intend to read it as epistemic possibility, based on the speaker's knowledge and evidence[3].

In this suggestion, we introduce $\diamond\neg\varphi$ rather than $\neg\varphi$. This follows from the following data.

(9) Chigau-yo, kore-wa C-no hankachi-{janai/#daroo-ne?}
differ.PRS-SFP this-TOP C-GEN handkerchief-{COP.NEG-PRS/DAROO-NE}
"That's wrong. This isn't C's handkerchief"

(10) Kore-wa C-no hankachi-{#janai/daroo-ne?}. Moshikasuruto
this-TOP C-GEN handkerchief-{COP.NEG-PRS/DAROO-NE}. maybe
chigau kamo.
differ.PRS might
"Is this C's handkerchief? Maybe it might be different."

In (9), the particle *chigauyo* expresses direct rejection of the previous assertion, and *daroo-ne?* is incompatible with this direct rejection. This shows that putting $\neg\varphi$ on $DC_A$ by *daroo-ne?* is too strong. Moreover, in (10), the following sentence after *daroo-ne?* expresses the possibility of a different owner, which can follow *daroo-ne?* only. Based on these data, we assume that *daroo-ne?* adds $\diamond\neg\varphi$ to $DC_A$ in (8), rather than $\neg\varphi$.

Moreover, this analysis proposes that *daroo-ne?* is doubt-marking toward the addressee's previous commitment rather than knowledge. This point is confirmed by the following data, in which the addressee lies and thereby the addressee's commitment and knowledge come apart.

(11) [Context: A knows that a handkerchief in front of A is not C's. However, A tries to deceive B and assert that the owner of the handkerchief is C.]

[3]We do not express "the speaker has a weaker commitment to $\neg\varphi$", because expressing doubt is neutral whether the speaker commits to the addressee's assertion or not. We can imagine a situation such that the speaker agrees with the addressee's assertion, but what the addressee shows is not enough to confirm her own assertion. So, the speaker expresses doubt and needs more evidence. Our suggestion that *daroo-ne?* makes the speaker's commitment $\diamond\neg\varphi$ is compatible with this neutral situation, because $\diamond$ reads as her own epistemic modal, and can show the doubt since there is not enough evidence even if she agrees with the original assertion.

A: Kore-wa C-no hankachi-da.
this-TOP C-GEN handkerchief-COP
"This is C's handkerchief."

B: C-no hankachi-daroo-ne?
C-GEN handkerchief-DAROO-NE
"Is it C's handkerchief?"

Our model (8) predicts that *daroo-ne?* targets the addressee's previous commitment, not knowledge. The data (11) support this prediction, since *daroo-ne?* shows doubt toward the previous assertion, "This is C's handkerchief," and not the addressee's own knowledge.

Our model explains the previous tests. First, in the adverbs test, *daroo-ne?* can co-occur only with *really* since this question marks the speaker's doubt and the commitment to the possibility of $\neg\varphi$. This is compatible with the fact that *really* marks the speaker's challenge to the addressee's previous commitment. On the other hand, *Daroo-ne?* is incompatible with epistemic modality, which implicitly requires the speaker's (partially) commitment to $\varphi$. Second, in the responses test, A's question adds $\neg\varphi$ to the Table and leaves $\varphi$ unresolved. So, B must either provide evidence to persuade A, or else retract $\varphi$. B's response *that's right* does neither. This leaves A's doubt unresolved, so it would be an infelicitous move for A to accept B's answer in (2). By contrast, A is justified in continuing the discourse by asking *really?* to seek more evidence from B.

So, both questions put $\varphi$ and $\neg\varphi$ on the Table. However, if we look at the conversational moves, the process of putting alternatives on the Table is different — *daroo?* embodies a monotonic conversational move consisting of a suggestion from the speaker to the addressee; *daroo-ne?* is a non-monotonic conversational move involving pushback against the addressee's assertion.

**Conclusion and Further Direction** We have argued that both *daroo?* and *daroo-ne?* are polar questions. However, their conversational moves and the way in which the original polar question is resolved differ, as shown in Tables (5) and (8). So, we extend the previous study [5] by focusing on what kinds of information are needed to satisfy confirmation.

Specifically, we have shown that "confirmation-seeking" can be either monotonic or non-monotonic. In the case of *daroo?*, the speaker simply puts a biased question on the Table, seeking joint commitment on a positive answer to $\varphi$ by adding $\varphi$ to the speaker's commitment. This is how bias emerges in monotonic confirmation-seeking. By contrast, the confirmation-seeking move embodied in *daroo-ne?* is non-monotonic, and takes a more complex form: essentially, with *daroo-ne?* the speaker challenges the previous assertion, raising the possibility that $\varphi$ needs to be retracted. These differences between monotonic and non-monotonic confirmation-seeking acts are systematically reflected in the two tests we have presented above, namely, the adverbs test and the responses test. We have shown that the difference can be captured properly in an enriched model of discourse that tracks not just the Stalnakerian common ground but individual commitments of conversational participants (DC), pending issues (Table), and future directions of discourse (ps).

In this paper, we contrast *daroo?* and *daroo-ne?*. Questions remain: can *daroo-ne?* be analyzed as the composition *daroo* plus the sentence-final particle *ne*? How does the SFP *ne* function in declarative sentences, and how do contextual evidence and doubt-marking use of *daroo-ne?* relate? These questions are beyond the scope of this paper; we leave them for future work.

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# A Minimal Participant-Structure Semantics for Japanese Affixal Designation Terms

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## 1 Introduction and Motivation

In conversational Japanese, personal names are often followed by expressions such as *-san*, *-kun*, and *-chan*, which convey information about the social relations of their referents. Following Oshima (2023), let us call these expressions "affixal designation terms" (ADTs). As with other honorific expressions, their distribution is sensitive to various factors, including gender, age, intimacy, and institutional roles, but no single factor maps uniquely onto a form. The suffix *-kun*, for example, is common with male students and junior male employees, but it is also used for female members of universities, companies, and political institutions. The suffix *-chan* is common with children and close acquaintances but is not restricted to either group.

Oshima (2023) analyzes these patterns by means of honorific values. He proposes two lexical entries for *-kun*: the regular entry requires a male referent, while a marked, gender-neutral entry requires a relation of colleagueship in a broad sense (his (28) and (35), pp. 187, 191). He likewise proposes two entries for *-chan*: an unmarked entry requires a referent who is a child or female, while a marked entry lacks this restriction (his (40) and (43), pp. 193, 195). The analysis captures important distributional tendencies, but it raises the question of whether these tendencies must be encoded in lexical meaning. Indeed, Oshima does not encode other factors, such as intimacy, in lexical meaning.

Lexical multiplication also makes quantified cases less straightforward. Suppose that the speaker $S$ has a male acquaintance named "Tanaka" and a female colleague with the same name, and calls both of them *Tanaka-kun*. If the first use relies on the male entry and the second on the colleagueship entry, cases such as the following raise a question:

(1) a. Futarino Tanaka-kun ga oyako to wa shiranakatta.
two Tanaka-ADT NOM parent.child COMP TOP know.not.PAST
'I didn't know that the two Tanakas were father and daughter.'

b. Dono Tanaka-kun mo ganbatta.
every Tanaka-ADT too did.well
'Every Tanaka did well.'

A mixed reading would require a single occurrence of the suffix to be associated with both entries. A single, gender-neutral entry avoids this requirement.

An anonymous reviewer, however, finds (1a, b) playful and zeugmatic, with *-kun* used in a stretched sense. We can evaluate speakers' intuitions by comparing cases like (1a, b) with non-zeugmatic examples such as the following.

(2) Doukyuusei-no Tanaka-kun to Jinjino Tanaka-kun ga oyako to
Classmate Tanaka-ADT and HR Tanaka-ADT NOM parent.child COMP
wa shiranakatta.
TOP know.not.PAST
'I didn't know that my classmate Tanaka and the Tanaka in HR are father and daughter.'

If the reviewer is right, speakers should hear a contrast between (1a, b) and (2). I find this contrast difficult to hear. These examples can serve as a diagnostic for comparing the analyses.

Example (30) in Oshima (2023, p. 188), abbreviated below as (3), presents a related puzzle.

(3) Kenta-kun wa gookaku shita kedo, Yumi-san wa dame datta.
'Kenta passed the exam, but Yumi did not.'

A married couple is talking about teenage twins with whom they are not close. Oshima analyzes *-san* as expressing a higher honorific value than *-kun*, but he acknowledges that in a case like (3) a speaker can naturally use *-kun* for a male child and *-san* for a female child without having any reason to place the female child higher than the male child. Oshima suggests that Japanese speakers in general avoid assigning low honorific values to non-intimate females. This result is somewhat counterintuitive because the context explicitly holds the couple's relation to the twins constant.

This paper offers an alternative approach based on the participant-structure framework of Portner et al. (2019), which tracks hierarchical relations among individuals. I propose one relational entry for each ADT: *-san* expresses $S \leq R$, *-kun* $S \geq R$, and *-chan* $S > R$, where $S$ is the speaker and $R$ the referent. These entries contain no gender or age features. The analysis retains Portner et al.'s replacement update and adds only a short record of reciprocal address, from which equality and inequality among the individuals are derived. I argue that the simple hierarchical semantics, together with social norms, helps explain typical distributional differences among ADTs. The analysis also predicts a principled contrast between *-kun* and *-chan* in their interaction with sentence-final honorific forms.

# 2 Background

A participant structure is the triple in (4).

(4) A participant structure $P$ is a triple $\langle J, O, h\rangle$, where:
   a. $J$ is an $n$-tuple of individuals, the participants;
   b. $O$ is an ordered set $\langle N, \prec\rangle$;
   c. $h$ is a function from $J$ to subsets of $N$.

(Portner et al., 2019, 16)

The members of $N$ are possible positions in the participant structure. In a two-person structure with $n_0 \prec n_1$, the Korean formal particle *supnita* indicates that the addressee $A$ is equal to or higher than the speaker $S$. Its relevant contribution is stated in (5).

(5) *supnita* [status: $S \leq A$] $= h : h(S) = \{n_0\},\ h(A) = \{n_0, n_1\}$. (Portner et al., 2019, 16)

The singleton assigned to $S$ fixes the speaker at the lower position, while the set assigned to $A$ leaves equality and superiority open. Portner et al.'s update replaces the current value of $h$ with the value contributed by the particle. When another participant becomes the speaker, the assignment is recalculated from the perspective of the new utterance. The values in (5) are therefore not permanent honorific scores assigned to individuals. They are possible positions generated by one utterance. A non-singleton such as $\{n_0, n_1\}$ represents an unresolved weak relation, whereas two singletons at different positions represent a strict relation. For instance, if $h(S) = \{n_0\}$ and $h(A) = \{n_1\}$, the utterance presents $A$ as strictly above $S$. I extend the same mechanism from the addressee $A$ to the referent $R$ of an ADT. A use of an ADT produces an update of $P$.

Like the expressive intervals of Potts and Kawahara (2004), formal orders themselves do not bear rich propositional content about socioeconomic status, institutional roles, seniority, gender, intimacy, respect, contempt, and the like. Given the social norms governing the conversational setting, the hearer can pragmatically infer from a relation such as $S \leq A$ that $A$ outranks $S$ in the company.

# 3 Our Proposal

The three lexical entries are given in (6).

$$\begin{array}{lllll} & \textit{-san} & [\text{status: } S \leq R] & h(S) = \{n_0\}, & h(R) = \{n_0, n_1\} \\ (6) & \textit{-kun} & [\text{status: } S \geq R] & h(S) = \{n_0, n_1\}, & h(R) = \{n_0\} \\ & \textit{-chan} & [\text{status: } S > R] & h(S) = \{n_1\}, & h(R) = \{n_0\} \end{array}$$

Thus, *-chan* imposes a strict relation, while *-san* and *-kun* leave equality open. This distinguishes *-kun* from *-chan* without introducing gender, childhood, or intimacy into either entry.

I suggest that equality can be established by reciprocal address. Mutual *-san*, mutual *-kun*, and mutual *-chan* can all place two participants on equal footing. The generalization extends beyond these ADTs. It is well known that even reciprocal uses of epithets in banter can be understood as symmetric treatment. Equality should therefore be derived from how two people address each other, not stipulated in the lexical entry of one form. The analysis retains only the two most recent reciprocal outputs for a pair. Let $u_1$ and $u_2$ be these updates. In (7), $A \sim B$ denotes equality in the reciprocal ADT exchange.

(7) $A \sim B$ iff $h^{u_1}(A) \cup h^{u_2}(A) = h^{u_1}(B) \cup h^{u_2}(B)$.

The unions in (7) do not update the current $h$; they only compare the last two utterances. Equal unions resolve the pair as equal. I also assume that if both updates support $A \leq B$ and the union for $A$ is a proper subset of the union for $B$, the exchange is instead resolved as $A < B$. Taking the union deliberately abstracts away from the order of the two turns. The comparison asks only whether, across the reciprocal exchange, either participant was assigned a position unavailable to the other.

# 4 Derivations and Discussion

Consider first reciprocal *-san*. The two replacement updates are displayed as columns in (8).

(8)

| | $A \to B$ : *-san* | $B \to A$ : *-san* | $\cup$ |
|---|---|---|---|
| $A$ | $\{n_0\}$ | $\{n_0, n_1\}$ | $\{n_0, n_1\}$ |
| $B$ | $\{n_0, n_1\}$ | $\{n_0\}$ | $\{n_0, n_1\}$ |

$\Longrightarrow \quad A \sim B$

The two row unions are identical, and therefore $A \sim B$. Reciprocal *-kun* and reciprocal *-chan* work in the same way: each person occupies the speaker-side and referent-side positions once, and the two row unions coincide.

The rule also captures the intuition that a *-kun*/*-chan* exchange need not create an inequality. If $A$ calls $B$ *-kun* and $B$ calls $A$ *-chan*, the result is shown in (9).

(9)

| | $A \to B$ : *-kun* | $B \to A$ : *-chan* | $\cup$ |
|---|---|---|---|
| $A$ | $\{n_0, n_1\}$ | $\{n_0\}$ | $\{n_0, n_1\}$ |
| $B$ | $\{n_0\}$ | $\{n_1\}$ | $\{n_0, n_1\}$ |

$\Longrightarrow \quad A \sim B$

The strictness of *-chan* distinguishes the two individual updates, but the reciprocal exchange gives both participants access to the same positions. The pair therefore resolves as $A \sim B$. The

difference between the forms remains visible when either form occurs alone or combines with a marker that imposes the opposite ordering.

Now suppose that $A$ calls $B$ *-san*, while $B$ calls $A$ *-kun*.

(10)

| | $A \to B$ : *-san* | $B \to A$ : *-kun* | $\cup$ | | |
|---|---|---|---|---|---|
| $A$ | $\{n_0\}$ | $\{n_0\}$ | $\{n_0\}$ | $\Longrightarrow$ | $A < B$ |
| $B$ | $\{n_0, n_1\}$ | $\{n_0, n_1\}$ | $\{n_0, n_1\}$ | | |

Both updates support $A \leq B$, while $\{n_0\} \subsetneq \{n_0, n_1\}$. The reciprocal resolution rule therefore excludes equality and yields $A < B$. A *-san*/*-chan* pair yields the same direction because the *-chan* update makes the inequality strict.

Note that the proposal never implies that a single use of an ADT carries content such as "I look up to/down on you." The relation between the two individuals emerges over the course of the exchange. For example, with mutual *-chan*, placing the other person formally lower in each turn amounts to positioning both on the same footing, and given the context, the equality can be understood as a form of camaraderie.

Other honorific expressions can also mark an asymmetry in a reciprocal ADT exchange. A junior colleague may use *Yamada-san* with both subject honorification and the polite sentence-final form *-desu/masu*, while Yamada replies with *Suzuki-san* and a plain verb. The two ADTs are symmetric under (7), while the verb forms mark a difference.

The strict/weak contrast also predicts an interaction with sentence-final honorific forms. Oshima (2023, p. 181, (20b,c)) judges both addressee-directed *-kun* and *-chan* disharmonious with a polite verb, while note 10 reports that *-kun* occurs with polite verbs in some settings, such as when a professor addresses a male student. Suppose, following Portner et al.'s analysis of Korean sentence-final particles, that *-desu*/*-masu* contributes $S \leq A$, and that the ADT referent is the addressee, $R = A$. The three combinations are summarized in (11).

(11)
$$\begin{array}{lll} \textit{-san} + \textit{-desu/-masu}: & S \leq A \,\&\, S \leq A & \Rightarrow S \leq A \\ \textit{-kun} + \textit{-desu/-masu}: & S \geq A \,\&\, S \leq A & \Rightarrow S \sim A \\ \textit{-chan} + \textit{-desu/-masu}: & S > A \,\&\, S \leq A & \Rightarrow \varnothing \end{array}$$

Thus, *-san* is compatible with sentence-level politeness. The *-kun* combination remains consistent because the two weak relations meet at equality. The strict relation contributed by *-chan* rules out this possibility. In my judgment, (12a), a variant of Oshima's (20b), is acceptable in a context where *Sato-kun* is an established form of address. Adding subject honorification in (12b) makes the combination markedly less natural.

(12) a. Sato-kun, reizooko no keeki o tabe-mashita ka?
Sato-ADT fridge GEN cake ACC eat-AddrHon.PAST Q
'Sato, did you eat the cake in the fridge?'

b. #Sato-kun, reizooko no keeki o otabeninari-mashita ka?
Sato-ADT fridge GEN cake ACC SubjHon.eat-AddrHon.PAST Q
'Sato, did you eat the cake in the fridge?'

Both examples contain the addressee honorific *-masu*. In (12b), subject honorification also targets the addressee. If it requires $S < A$ in this use, it removes the equality option available in (12a).

In the quantified examples (1), $R$ varies with the quantified nominal, and the single entry $S \geq R$

can apply to every value. The hearer can draw on the setting and its social norms to infer what this ordering conveys about the speaker's relationship to each Tanaka.

Social norms can group people by gender, age, institutional role, and the like. Having a gender-neutral lexical entry is compatible with gender-sensitive social norms that shape social interactions, including expectations about forms of address. In Japan, some longstanding social norms distinguish boys and girls and may make diminutive treatment more customary for girls. The preference for *-kun* with boys and *-chan* with girls, as documented by Oshima (2023), can reflect such norms.

Addressing all girls with *-san* and all boys with *-kun* can also be a way of maintaining an existing gender boundary. In the participant structure, the corresponding updates assign each girl the same set of possible positions, $\{n_0, n_1\}$, and each boy $\{n_0\}$. Given the social norms of gender separation, the positional differences are interpreted as "social distance."

The proposed semantics leaves room for speakers to change forms of address as they negotiate and renegotiate their social relations. Consider, for example, the practice in some elementary schools of encouraging *-san* for boys and girls alike to counter the traditional gender norms. Using *-san* for all students gives each the same set of possible positions, placing them on equal footing as a single group, at least linguistically, in terms of address.

Finally, the relational entries explain (3) without assigning different honorific values to the twins. The two ADTs contribute $S \geq R_1$ and $S \leq R_2$, yielding $R_1 \leq S \leq R_2$ in the participant structure. In this third-person example, the weak relations allow the twins and the speaker to occupy the same position independently of the reciprocal rule in (7). Reversing the forms (*Kenta-san*, *Yumi-kun*) also permits equality. The reversal can sound odd due to the norms discussed above. In contrast, using *-san* for both twins seems more acceptable in the same context.

# 5 Extensions and Open Questions

The present proposal can be extended to other forms of address and reference. The honorific *-sama* can be treated as the strict upward counterpart of *-san*, placing its referent strictly above the speaker ($S < R$). Alternatively, following Izumi (2026), we could take *-sama* to assign its referent the highest position in the participant structure.

A bare name (*yobisute*) can sound less polite than the same name with *-kun* or *-chan* when an ADT is expected. This effect may arise pragmatically from the absence of the expected suffix. The mutual use of bare names can also signal equal standing, a pattern that an extension of the reciprocal address rule might capture.

# 6 Conclusion

I have proposed a minimal extension of Portner et al.'s participant-structure analysis to Japanese ADTs. The terms *-san*, *-kun*, and *-chan* instantiate $S \leq R$, $S \geq R$, and $S > R$. The analysis uses only one lexical entry for each ADT. The strict meaning of *-chan* also predicts its conflict with addressee-oriented *-desu*/*-masu*, while the weak meaning of *-kun* allows their co-occurrence. A fuller analysis should extend the proposal to other ADTs and their interactions with other honorific expressions.

## Acknowledgements

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# How to Build a Modal:
# A Semantic Typology of Conditional Evaluative Constructions

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**Overview** In this talk, we build on previous analyses of CECs in Japanese and Korean, report novel fieldwork data from two varieties of Yaeyaman, and argue that a compositional analysis of these constructions is not only possible, but in fact derives sometimes subtle differences in the modal force that these constructions encode across constructions and languages. In the case of Yaeyaman, the semantics of focus particles in CECs is seen to correlate with their semantics elsewhere in the language.

**CECs in Korean and Japanese** Japanese and Korean can express modal necessity with a construction built from a conditional, which Kaufmann (2017) calls Conditional Evaluative Constructions (CECs), illustrated in (1a) and (2a). In both languages, the CEC is built parallel to a standard conditional schema, illustrated in (1b) and (2b). In the CEC, both languages employ a so-called 'evaluative predicate' in the consequent of the conditional: *naranai* (lit. 'not-become') in Japanese, and *toy* (lit. 'good') in Korean. The two languages differ in terms of the 'conditional schema' that is used in building the associated CEC; Japanese uses the schema [if $\neg p$ then $\neg q$], while Korean uses the schema [only-if $p$ then $q$].

(1) Japanese: [if $\neg p$ then $\neg q$]

a. hoshinoshouten ni ik-anakere-ba nara-na-i.
PN ALL go-NEG-COND become-NEG-NPST
'You must go to *houshinoshouten.*'

b. hoshinoshouten ni ik-anakere-ba ka-e-na-i.
PN ALL go-NEG-COND buy-POT-NEG-NPST
'If you don't go to *hoshinoshouten*, you can't buy (it).'

(2) Korean: [only if $p$ then $q$]

a. John-un maykcwul-lul masi-eya toy-n-ta.
John-TOP beer-ACC drink-only.if good-PRES-DECL
'John must/should/ought to drink beer.'

b. pap-ul cal mek-eya khi-ka khu-n-ta.
rice-ACC well eat-only.if height-NOM grow-PRES-DECL
'Only if one eats well, he/she grows tall.' Chung (2019)

This raises three related questions. First, are the CECs in these two languages compositionally transparent (i.e. computed transparently from the same resources as the corresponding conditional constructions)? Second, are the CECs in these two languages semantically equivalent? Third, are there other CECs built from different conditional schemas in other languages?

In answer to the first question, Kaufmann (2017) and Chung (2019) pursue a compositional approach for Japanese and Korean CECs respectively. In his analysis of the Korean CEC, Chung (following Herburger 2015) argues for an existential semantics of the 'only if' conditional suffix *-eya*, so that a sentence of the form [p-*eya* q] entails that there are some $p$-worlds that are $q$-worlds, and

that there are no $\neg p$-worlds that are $q$-worlds. Thus, in the Korean CEC, where $q$ is the evaluative predicate *toy* 'good' which, according to Chung, picks out the 'deontically best worlds', the semantics says that no $\neg p$-worlds are best worlds, while at least some $p$-worlds are. Turning to the Japanese CEC, the evaluative predicate in this case is the negated verb *naranai*, which according to Kaufmann picks out the 'bad' worlds. Kaufmann herself proposes a non-quantificational theory of the conditional, but under a quantificational approach, the conditional will need to be given universal rather than existential force. In that way, the schema [if $\neg p$ then $\neg q$], where $\neg q$ = *naranai* = 'bad worlds', is true iff all $\neg p$ worlds are bad worlds.

We tentatively answer the second question in the negative, suggesting that the semantics of the evaluative predicate in Japanese and Korean are different, resulting in a stronger modal meaning for the Japanese CEC than for the Korean CEC, as indicated in the translations above. Kaufmann does not decompose the negative evaluative predicate *naranai* in her analysis. In order to make the analysis fully compositional (i.e. one in which negation on the evaluative predicate is compositionally interpreted), we propose that the positive predicate *naru* picks out the set of 'acceptable' worlds, which includes both optimal 'good/best' worlds and sub-optimal but still 'acceptable' worlds. Negation thus gives us the set of 'unacceptable', i.e. 'bad' worlds. In this way, [if $\neg p$ *naranai*], with a universally interpreted conditional, entails that all $\neg p$-worlds are unacceptable worlds. This in turn generates a stronger modal force than the Korean CEC, which only says that there are no $\neg p$ worlds that are best worlds, but leaves open the possibility that some $\neg p$ worlds are nevertheless acceptable (if sub-optimal) worlds. Further details are left aside here for space reasons, but the general cross-linguistic and cross-construction point is that the modal strength of a CEC can vary with the meaning of the evaluative predicate.

In summary: A compositional analysis of CECs in both Korean and Japanese is possible, although this might require different quantificational force of the conditional in the two constructions, following Herburger. A compositional analysis leaves unanswered why the polarity of the evaluative predicates cannot be flipped in either language, that is, in Japanese the evaluative predicate is always negated, while in Korean, it is always positive. In the next section, we turn to the third question, and present original fieldwork data from Yaeyaman, which allows for both positive and negative evaluative predicates in distinct CEC constructions, one of which is formally parallel and semantically equivalent to that in Japanese, and one of which is distinct from both the Japanese and Korean CEC, and further shows different semantic properties in the two varieties of Yaeyaman.

**New Data: CECs in two varieties of Yaeyaman** In this section, we report novel data from the Miyara and Funauki varieties of Yaeyaman (Southern Ryukyuan, Japonic) that we collected in three fieldwork trips to Ishigaki in the spring and summer of 2026. Both varieties have the equivalent of the Japanese CEC and associated conditional construction, as seen in (3)–(4).

(3) Miyara: [if $\neg p$ then $\neg q$]

a. hosinosyouten=gee hara-naa-kaa naranu.
PN=ALL go-NEG-COND become.NEG
'(If you want to buy cigarettes) You must go to *hoshinoshouten*.'

b. hosinosyouten=gee hara-naa-kaa kaaranu.
PN=ALL go-NEG-COND buy.POT.NEG
'If you don't go to *hoshinoshouten*, you can't buy (cigarettes).'
(≈ you have to go to *hoshinoshouten* to buy cigarettes.)

(4) Funauki: [if $\neg p$ then $\neg q$]

a. taboo koo basyoo=mee hosinosyouten=na iha-na-kkara naranu.
tobacco buy place=TOP PN=LOC go-NEG-COND become.NEG

'When buying cigarettes, you must go to *hoshinoshouten*.'

b. hosinosyouten=na iha-na-kkara kaarun.
PN=LOC go-NEG-COND buy.POT.NEG
If you don't go to *hoshinoshouten*, you can't buy (cigarettes).'
(≈ you have to go to *hoshinoshouten* to buy cigarettes.)

In addition to the Japanese-style CEC, Yaeyaman has another CEC which is not found in Japanese or in Korean, which we term the focus-CEC. The focus-CEC employs the focus marker *du*, which is used throughout the grammar of Yaeyaman and other Ryukyuan languages to mark focus on nominals and other constituents (Davis 2014; Shimoji 2018). In the case of CECs, *du* is attached to a conditional antecedent, with the non-negated evaluative predicate *naru* 'become' or the copula *yaru* in the consequent. As with CECs in Korean and Japanese, the focus-CEC in Yaeyaman is built from a more general conditional construction of the form [if p-*du* then q]. Examples of the focus-CEC and corresponding 'regular' focus conditional are given below for both Miyara and Funauki:

(5) Miyara: [if *p*-*du* then *q*]

a. hosinosyouten=gee hara-ba=du naru.
PN=ALL go-COND=FOC become
'(If you want to buy cigarettes) You must go to *hoshinoshouten*.'

b. hosinosyouten=gee hara-ba=du kaariru.
PN=ALL go-COND=FOC buy.POT
'If you go to *hoshinoshouten* (and nowhere else), you can buy (cigarettes).'

(6) Funauki: [if *p*-*du* then *q*]

a. taboo koo basyoo=mee hosinosyouten=na iha-ba=du yaru.
tobacco buy place=TOP PN=LOC go-COND=FOC COP
'When buying cigarettes, you can/should go to *hoshinoshouten*.'

b. hosinosyouten=na iha-ba=du kaarisu.
PN=LOC go-COND=FOC buy.POT
'If you go to *hoshinoshouten*, you can buy (cigarettes).'

This focus-conditional construction, and its associated CEC, is often translated by consultants into Japanese using the [if ¬p then ¬q] construction, suggesting that the two are close if not identical in meaning. However, our fieldwork shows that in fact the focus-conditional construction is not semantically equivalent in the two varieties of Yaeyaman, as indicated in the translations of the focus-CECs above. In short: the focus-CEC (and focused conditional) is stronger in Miyara than in Funauki.

This difference in strength is made clear in a context where *Hoshinoshouten* is one of multiple shops that sell cigarettes. In this context, the Japanese style [if ¬p then ¬q] CECs and associated conditionals (3)–(4) are infelicitous. This is as predicted given the semantics of these constructions described in the previous section. Turning to the focus-CEC and its associated conditionals, we see a split in the two varieties: only the Funauki focus-CEC and associated focus conditional (6) are felicitous in this context, while the Miyara focus-CEC and focus conditional (5) are infelicitous. In short, Miyara (5) entails that *Hoshinoshouten* is the only shop that one can buy cigarettes, while the corresponding sentences in Funauki (6) leave open the possibility that one can buy cigarettes from other stores as well. This shows that the Miyara focus-CEC has the same modal strength as the CECs in Japanese, while the Funauki focus-CEC is weaker.

**Analysis** We propose that the focus-CEC and its associated conditional in both Miyara and Funauki

are compositionally interpreted. We attribute the variation in modal strength to differing semantics for the focus marker *du* in the two varieties. In brief, Miyara *du* entails exhaustivity while Funauki *du* does not. This difference can be seen in the domain of wh-question-answer pairs. As discussed by Davis (2014), Yaeyaman wh-questions typically have focus marking with *du* on both the wh-phrase and the corresponding noun phrase in the answer. Our fieldwork on Miyara and Funauki has found that *du*-marking has different semantic consequences in answers to wh-questions in the two varieties. In Miyara, use of *du* in the answer entails exhaustivity, and is thus incompatible with a mention-some interpretation. This is illustrated by the contrast between the exhaustive answer in (7), where *du* is obligatory, and the non-exhaustive answer in (8), where *du* is infelicitous. The source of this contrast is affirmed by speaker comments, which state that for the case of (8), you cannot mark the coffee shop with *du* because there are 'many other shops where you can drink coffee.'

(7) Q: 'What did you eat for lunch?'
A: eema-suba=ba=du fai.
yaeyama-soba=BA=FOC eat
'(I) ate Yaeyama soba (and nothing else).'

(8) Q: 'Where can I drink coffee around here?'
A: kafuka=nga(#=du) num-ari-soo.
PN=LOC(#=du) drink-POT-NML
'You can drink (coffee) at *Kafka* (amongst other places).'

In Funauki on the other hand, *du* is compatible with both mention-all and mention-some answers, as shown below:

(9) Q: 'What did you eat for lunch today?'
A: kyuu=me suba(=du) faa-da.
today=TOP soba(=FOC) eat-PST
'Today I ate soba (and nothing else).'

(10) Q: 'Where can I eat Yaeyama soba?'
A: simasobaichibanci=na(=du) faarin=duraa.
PN=LOC(=du) eat.POT=SFP
'You can eat it at *shimasobaichibanchi* (amongst other places)'.

We analyze this contrast by giving *du* in Miyara a focus-sensitive exhaustive semantics. In the case of answers to wh-questions, use of *du* entails that alternative answers are all false. In the focus-CEC and focus conditional, this exhaustivity functions in the same way that 'only' does in Chung's analysis of the 'only if' CEC in Korean. This in turn requires an existential analysis of the conditional. Thus, [if *p*-*du* then *q*] in Miyara entails that at least some $p$ worlds are $q$ worlds, and that no $\neg p$ worlds are $q$ worlds (in simple cases where the alternative to $p$ is $\neg p$). While the compositional strategy of Miyara is analogous to that of Korean, the strength of the resulting CEC is stronger, because of the aforementioned difference in meaning of the evaluative predicate *naru*. As in Japanese, we propose that this predicate picks out the 'acceptable' worlds, and thus Miyara [if *p*-*du naru*] entails that all $\neg p$ worlds are unacceptable (while in Korean, they are only 'not best').

In the case of Funauki, *du* is not exhaustive, and thus does not entail the negation of alternative answers in the question-answer pairs, and in the focus conditional [if *p*-*du* then *q*] does not entail the impossibility of $q$ in $\neg p$ worlds. This leaves us with the question: if *du* does not exhaust alternatives in Funauki, what does it do? In the full talk, we show that *du* gives a 'best choice' interpretation, so that in a focus-CEC it implicates that, while there are possibly other ways to satisfy the evaluative

predicate $q$, the *du*-marked antecedent $p$ is in some sense the 'best' choice. This in turn requires a theory of focus marking that is non-exhaustive but still functions to 'highlight' the focused constituent as being the 'best' option from among its focus alternatives.

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**Dissociating Disjunctive Meaning from Clause-type Restrictions: Evidence from Child Mandarin**

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This study asks whether Mandarin-speaking children acquire the clause-type-sensitive distribution of disjunctive expressions before their adult interpretation. Mandarin lexicalizes standard and interrogative disjunction as ***huòzhě*** (declarative 'or') and ***háishì*** (interrogative 'or'), which have been argued to share an alternative-projecting core but differ in their clausal interpretation (Erlewine 2025). Across three experiments, we show that acquiring disjunction cannot be reduced to acquiring the truth conditions of a Boolean connective; children can acquire its clause-type-sensitive distribution before its adult interpretation stabilizes.

**Background.** Natural-language disjunction contributes more than Boolean truth conditions: Alternative-based approaches treat disjunction as introducing alternatives whose interpretation interacts systematically with clause type (Ciardelli & Roelofsen 2017; Ciardelli, et al. 2019). Mandarin makes this interaction particularly transparent by lexicalizing a distinction that English expresses with a single *or*: ***huòzhě*** occurs in declaratives and polar questions (1a), whereas ***háishì*** canonically marks alternative questions (AltQs, (1b)). On Erlewine's (2025) analysis, the two disjunctors separate the generation of alternatives from their interpretation at the clausal level as they share an alternative-projecting semantic core but differ in how these alternatives are interpreted: ***huòzhě*** is associated with existential closure, yielding a disjunctive proposition, whereas ***háishì*** is canonically interpreted by a question-forming operator Q, yielding an AltQ. The Mandarin split therefore makes it possible to ask separately about the acquisition of alternative generation, their clause-level interpretation, and the resulting truth-conditional and inquisitive content.

(1)a. John hē-le kāfēi ***huòzhě*** chá. (mā?) ***Declaratives/Polar Question***
John drink-$_{PERF}$ coffee or-$_{DEC}$ tea Q
"John drank coffee or tea."/ "Did John drink coffee or tea? $_{L*H–H\%}$"

b. John hē-le kāfēi ***háishì*** chá (*mā)? ***Alternative Question (AltQ)***
John drink-$_{PERF}$ coffee or-$_{INQ}$ tea Q
"Did John drink coffee $_{H*}$ or tea? $_{H*L–L\%}$"

This decomposition creates a striking acquisition puzzle: Mandarin-acquiring children show early adult-like competence with ***háishì***-AltQs (Yan & Luo 2025), yet systematically assign ***huòzhě*** an apparently *conjunctive* interpretation, accepting 'A ***huòzhě*** B' consistently when *both A and B* rather than *only one* disjunct is true (Huang & Crain 2020; Zhu & Chen 2026). This asymmetry raises a key question: **What is 'non-adult' in the grammar of a 'conjunctive' child?** Importantly, a conjunctive response pattern need not imply that children lexicalize disjunction as conjunction. Recent state-based accounts derive such responses while preserving an alternative-generating semantics for disjunction. Klochowicz, Sbardolini & Aloni (2025), for instance, derive conjunctive behavior from restrictions on the information states children entertain rather than from a conjunctive lexical entry. This shifts the acquisition question from whether children 'know OR' to which component of the interpretation of alternatives remains non-adult. Mandarin provides a particularly revealing diagnostic: if children who conjunctivize ***huòzhě*** nevertheless maintain its distributional opposition to interrogative ***háishì***, the developmental bottleneck can be localized downstream of at least part of the lexical and clause-type-sensitive representation of alternatives.

This yields two developmental possibilities: Under an interpretation-first hypothesis, instability in the adult interpretation of ***huòzhě*** extends to the grammatical distinction between standard and interrogative disjunction, predicting unstable distribution of ***huòzhě*** and ***háishì***. Under a representational-dissociation hypothesis, children may already distinguish the two

alternative systems—representing ***háishì*** as interrogative and ***huòzhě*** as standard/non-interrogative—while the mechanisms deriving the adult interpretation of ***huòzhě*** remain non-adult. The representational dissociation hypothesis is naturally expressible in state-based architectures such as Aloni (2022), in which classical truth-conditional behavior, support relative to information states, and further conditions on the use of alternatives constitute distinct components of interpretation. We do not take such an architecture to predict a particular developmental trajectory; rather, it makes precise how non-adult extensional behavior may coexist with preserved alternative structure.

**The current study** tests these alternatives using attitude embedding as an independent diagnostic of clause-type-sensitive selection. Specifically, if children already distinguish the two disjunctors at the clause-type level, the declarative-selecting predicate ***juéde*** 'think' should license ***huòzhě*** but reject interrogative ***háishì***, whereas interrogative-selecting ***xiǎngzhīdào*** 'wonder' should favor ***háishì*** over ***huòzhě***. (see **Table 1**). On the other hand, if the lexical distinction *per se* remains unstable, no systematic embedding contrast should be expected. The critical question is thus whether the same children who interpret ***huòzhě*** conjunctively nevertheless preserve its adult distributional opposition to ***háishì.*** Mandarin, as a language where semantic type constraints hidden in English can be directly observed, thereby provides a particularly transparent test of whether children know how alternative-introducing expressions are distributed with respect to semantic clause type before ordinary disjunction receives its adult extensional interpretation.

| | ***huòzhě*** | ***háishì*** |
|---|---|---|
| ***juéde* 'think'** | ✓ | * |
| ***xiǎngzhīdào* 'wonder'** | * | ✓ |

**Table 1.** Mandarin adult selectional distribution of the two disjunctors under different attitude embedding.

**EXP. 1: Root Interpretation of *huòzhě* and *háishì*.** Sixty-three Mandarin-speaking children (4;2 – 6;8) and 22 adults completed separate *Question–Statement Task* (Zhou & Crain, 2011) blocks for the two disjunctors. Children showed the replicated conjunctive profile for ***huòzhě*** (**Fig. 1**), accepting BOTH substantially more than ONE contexts at every age (4yo: 90% vs. 19%; 5yo: 84% vs. 23%; 6yo: 98% vs. 6%; all $p$ <.001); adults showed the expected inclusive pattern. In contrast, canonical ***háishì***-AltQs were already near ceiling in ONE contexts (96%, 99.6%, 100%), as in **Fig.2**, although younger children had difficulty with implicit BOTH/NEITHER alternatives. Explicitly presenting these alternatives significantly improved performance ($p$ < .001), suggesting difficulty constructing implicit alternatives rather than failure to recognize ***háishì*** as interrogative.

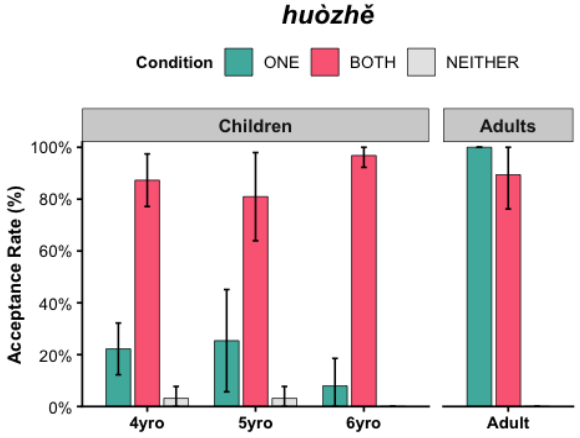



**Fig. 1.** Proportions of 'yes'-responses offered by children and adults to bare-***huòzhě***-sentences under three contexts

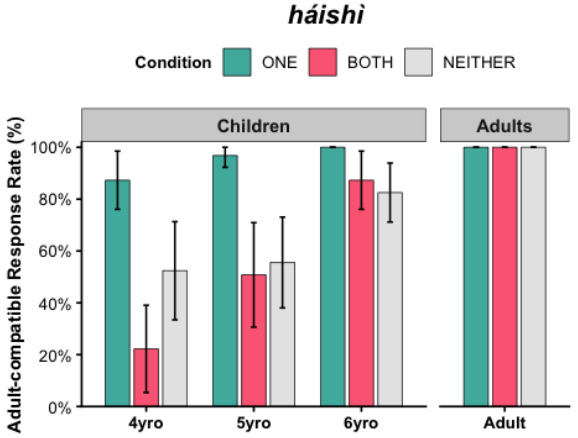



**Fig. 2.** Proportion of adult-compatible-responses offered by children and adults to bare-***háishì***-sentences under three contexts

**EXP. 2: Attitude-embedding Baseline**. To independently assess children's knowledge of the clause-type restrictions imposed by the embedding predicates, participants were asked to choose

between declarative and *wh*-interrogative complements under ***juéde*** 'think' (2a) and ***xiǎngzhīdào*** 'wonder' (2b) via a *Two-speaker Choice Felicity Judgment Task*. First-person attitude subjects were used throughout the experiment to minimize the indirect-question repair available with third-person subjects, and participants were asked to reward the puppet whose utterance they preferred with tokens. Performance with ***juéde*** was already near ceiling across child groups (4yo: 96%; 5yo: 98%; 6yo: 93%), whereas ***xiǎngzhīdào*** showed a clear developmental trajectory (4yo: 63%; 5yo: 62%; 6yo: 88%; adults: 100%), see **Fig. 3**. A binomial mixed-effects model revealed a significant Predicate×Age Group interaction ($\chi^2(3) = 13.54$, $p = .0036$): four- and five-year-olds were significantly more likely to select the adult-compatible complement with ***juéde*** than with ***xiǎngzhīdào*** (both $p < .001$), while the difference was no longer significant at six ($p = .375$). Even the younger children show robust knowledge of declarative selection under ***juéde***, while adult-like interrogative selection under ***xiǎngzhīdào*** emerges more gradually and is largely in place by age six. As this pattern may reflect either incomplete lexical knowledge or independently developing interrogative embedding, instead of assuming adult-like interrogative embedding in all younger children, this baseline allows performance in **Exp. 3** to be interpreted relative to each child's independently measured knowledge of the selecting predicate.

(2)a. Wǒ ***juéde*** [Xiǎoxióng chī-le ***dàngāo/*shénme***].
I think Little.Bear eat-$_{PERF}$ cake /*what
(lit.)'I think Little Bear has eaten a cake/*what.'

b. Wǒ ***xiǎngzhīdào*** [Xiǎoxióng chī-le ***dàngāo/shénme***].
I wonder Little.Bear eat-$_{PERF}$ *cake /what
(lit.)'I wonder what Little Bear has eaten (*a cake).'

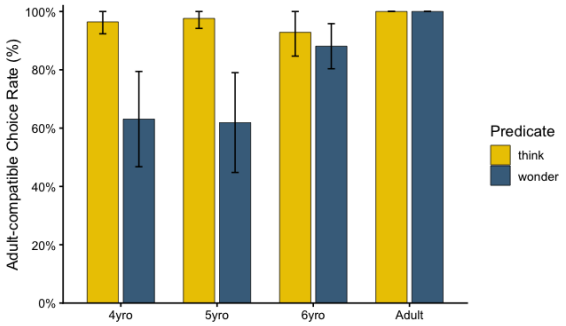



**Fig. 3.** Proportions of adult-compatible-choices offered by children and adults to **declarative/interrogative** complements embedded under *think* and *wonder*

**EXP. 3: Embedded Disjunctions.** The critical experiment follows the exact same paradigm as **Exp. 2**, only differing in crossing the two embedding predicates with the two disjunctors. On each trial, participants chose between minimally contrasting speakers using ***huòzhě*** vs. ***háishì*** under the same embedding predicates, as in (3a) and (3b). Pilot testing revealed substantial working-memory demands when children compared two otherwise identical sentences differing only in the disjunctor. Each choice was therefore followed by an elicited-reconstruction prompt, such as 'Could you repeat what it said?', in which children reproduced the preferred sentence, providing an additional diagnostic of their grammatical preference.

(3)a. Wǒ ***juéde*** Xiǎoxióng chī-le dàngāo ***huòzhě/*háishì*** bǐnggān.
I think Little.Bear eat-$_{PERF}$ cake or-$_{DEC}$/*or-$_{INQ}$ biscuit
(lit.)'I think Little Bear has eaten a cake or a biscuit.'

b. Wǒ ***xiǎngzhīdào*** Xiǎoxióng chī-le dàngāo ***huòzhě/háishì*** bǐnggān.
I wonder Little.Bear eat-$_{PERF}$ cake *or-$_{DEC}$/or-$_{INQ}$ biscuit
(lit.)'I wonder if Little Bear has eaten a cake or a biscuit.'

Selection of the clause-type-compatible ***juéde*+*huòzhě*** combination was high across ages (4yo: 85%; 5yo: 94%; 6yo: 92%), whereas ***xiǎngzhīdào*+*háishì*** was selected less consistently at four and five (60%, 58%) but increased at six (79%; adults: 100% in both conditions), see **Fig. 4**. Crucially, this asymmetry tracked children's independently measured predicate–complement knowledge in **Exp. 2**. Controlling for age and predicate, individual **Exp. 2** performance robustly predicted compatible disjunctor choice in **Exp. 3** in a logistic model with subject-clustered robust standard errors ($\beta$ = 4.71, $SE_{CR}$ = 0.72, $z$ = 6.57, $p$ < .001); there was no evidence that this relationship differed by predicate ($p$ = .934). The subject-level association was particularly strong for ***xiǎngzhīdào*** (Spearman's $\rho$ = .72, $p$ < .001). Children who demonstrated the predicate–clause-type mapping in **Exp. 2** systematically preferred ***juéde*+*huòzhě*** and ***xiǎngzhīdào*+ *háishì*** in **Exp. 3**.

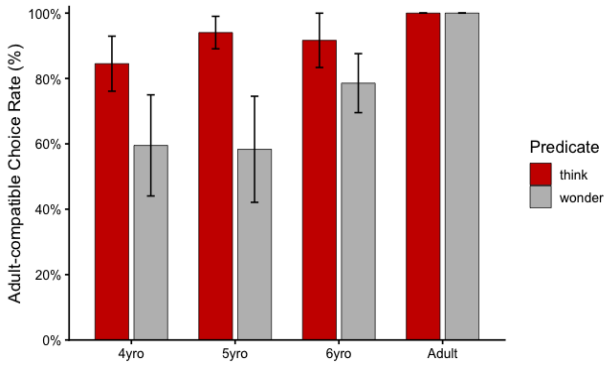



**Fig. 4.** Proportions of adult-compatible-choices offered by children and adults to ***huòzhě*/*háishi***-clauses embedded under *think* and *wonder*

**Discussion.** The results reveal a dissociation between children's interpretation of disjunction and their knowledge of its clause-type-sensitive distribution. Children who assign ***huòzhě*** a *conjunctive* interpretation nevertheless distinguish it from ***háishì***-AltQ and systematically map the two forms onto different embedding environments. Crucially, this distributional knowledge is not merely an age effect: individual knowledge of predicate–clause-type selection (**Exp. 2**) predicts the choice of ***huòzhě*/*háishì*** under the same predicates (**Exp. 3**). The dissociation helps localize what may remain non-adult in conjunctive children. The **Exp. 1** pattern shows that the computation associated with ordinary ***huòzhě*** is not adult-like; it does not, however, entail a wholesale failure to represent alternatives or their clause-type-sensitive distribution. The same children recognize canonical ***háishì***-AltQs, and, conditional on independently established predicate-selection knowledge, systematically distinguish ***huòzhě*** from ***háishì*** under attitude embedding. Thus, whatever mechanism yields conjunctive responses to ***huòzhě*** must be compatible with an already differentiated representation of standard versus interrogative alternatives. This complements state-based accounts of conjunctive child behavior: if conjunctive responses arise from restrictions on information-state construction or evaluation rather than from a conjunctive lexical entry, the Mandarin facts suggest that these restrictions operate downstream of at least part of the lexical and clause-level organization of alternatives. The Mandarin lexical split thus exposes a distinction obscured by English 'or': acquiring the distribution of a disjunctive expression across semantic clause types need not await acquisition of its adult truth-conditional interpretation.

Following Erlewine (2025), ***huòzhě*** and ***háishì*** share an alternative-projecting core: for sentences P and Q, both introduce the alternative set {[[P]], [[Q]]}. They differ in the clausal operator that interprets this set. ***Huòzhě*** is interpreted by existential closure, yielding a declarative disjunction, while ***háishì*** is interpreted by the question operator Q, yielding an alternative question. In a state-based setting (Aloni 2022, for example), where sentences are evaluated relative to information states $s$ (sets of worlds), the two outputs can be stated as in (4):

(4) a. $s \vDash P$ ***huòzhě*** $Q$ iff there are $t$, $t'$ such that $s = t \cup t'$, $t \vDash P$ and $t' \vDash Q$ [−INQ]
b. $s \vDash P$ ***háishì*** $Q$ iff $s \vDash P$ or $s \vDash Q$ [+INQ]

(4a) is the support condition for (split) disjunction in Aloni (2022); under pragmatic enrichment, $t$ and $t'$ must be non-empty. This is the alternative structure $s = t \cup t'$ with $t, t' \neq \varnothing$ referred to above. (4b) is inquisitive disjunction (Ciardelli et al. 2019): a state resolves the question only if it establishes one of the alternatives. Selection by attitude predicates then targets the clause-type feature rather than the disjunctor itself: ***juéde*** requires a non-inquisitive complement and ***xiǎngzhīdào*** an inquisitive one (cf. Theiler, Roelofsen & Aloni 2018). This derives **Table 1**. This decomposition yields three separable components: (i) generating the alternative set, shared by both disjunctors; (ii) the clause-type specification ([±INQ]) that regulates where the set may occur; and (iii) the state-level computation of support in (4a), i.e., how $s$, $t$ and $t'$ are constructed and evaluated. Our data locate the non-adult behavior in (iii). **Exp. 1** shows that the extensional computation of ***huòzhě*** is non-adult, while **Exp. 2–3** show that (i) and (ii) are in place, conditional on independently measured predicate knowledge.

We consider three hypotheses about the source of the conjunctive responses:

$\boldsymbol{H_1}$: the non-adult component includes [±INQ] itself. **Exp. 3** should show no systematic predicate × disjunctor crossover. This is contradicted by our data.
$\boldsymbol{H_2}$: the non-adult component lies in (iii), for instance in restrictions on the information states children construct or evaluate (Klochowicz et al. 2025). Alternative structure and [±INQ] are preserved, so **Exp. 3** should show the crossover, tied to predicate knowledge. This is what we observe.
$\boldsymbol{H_3}$: ***huòzhě*** is lexically conjunctive. **Exp. 3** is also compatible with this, provided children treat a conjunctive ***huòzhě*** as non-interrogative.

**Exp. 3** therefore rules out $\boldsymbol{H_1}$ but does not by itself separate $\boldsymbol{H_2}$ from $\boldsymbol{H_3}$. Separating them requires environments in which ***huòzhě*** retains alternative structure but a conjunctive entry would behave differently, such as polar questions with ***mā*** (1a) or free-choice environments under modals. We leave this to future work.

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# Analysis and Experimental Verification of Weak Crossover in the Double Object and Oblique Dative Constructions

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**Abstract** Competing analyses have been proposed for the hierarchy of the two objects in the English double object and oblique dative constructions. Weak crossover, long used to determine syntactic structure, can in principle adjudicate between them, but the relevant judgments are variable, and no decisive conclusion has been reached. Adopting the methodology of Language Faculty Science, we conduct experiments that control for the factors bearing on such judgments. The results support Larson's classical analysis, while refuting Barker and Shan's continuation-based grammar and Bekki's analysis in Dependent Type Semantics.

## 1 Introduction

Weak crossover (WCO) was first observed for *wh*-movement (Postal, 1971; Wasow, 1972). Its bound variable anaphora (BVA) counterpart, and with it the more stable contrast in (1)–(2), is due to Reinhart (1983): the bound reading of "their mentor" available in (1) is unavailable in (2).[1]

(1) [Every employee]$_i$ showed John their$_i$ mentor.

(2) *Their$_i$ mentor showed John [every employee]$_i$.

Since c-command plays an essential role in determining the availability of the bound reading in (1)–(2), WCO has been taken as evidence that the syntactic structure of natural language is hierarchical, and has also been used to establish the structure of various constructions. In English, two constructions for which competing structural analyses have been proposed are the double object construction (DOC) and the oblique dative construction (ODC).

Larson (1988) and Barker and Shan (2014) place the first object higher than the second (in different ways) and predict WCO in (4) and (6). Bekki (2023), by contrast, pairs CCG syntax (Steedman, 1996, 2000) with DTS and builds the semantic representation along the CCG derivation, in which the verb combines with the first object before the second. The second object therefore takes scope over the first, and WCO is predicted in (3) and (5).[2]

(3) John showed [every employee]$_i$ their$_i$ mentor. *(DOC)*

(4) John showed their$_i$ mentor [every employee]$_i$. *(DOC)*

(5) John showed [every employee]$_i$ to their$_i$ mentor. *(ODC)*

(6) John showed their$_i$ mentor to [every employee]$_i$. *(ODC)*

WCO can thus serve as a test for deciding which of the competing analyses is correct; yet, because speakers' judgments of WCO vary, it has not succeeded in providing strong evidence.

Language Faculty Science (LFS; Hoji, 2015; Hoji et al., 2022), however, has shown that when an experiment excludes speakers for whom BVA can arise from either of two confounding sources[3]—inverse scope taking by the binder, and binder-independent covariation of the bindee— the variation in judgment can be eliminated and BVA becomes completely unacceptable in sentences such as (2) for the remaining

[1]"Their" is intended throughout as the so-called singular *they*.

[2]This is a prediction of the semantics of Bekki (2023), not of CCG as such: in Steedman (2012) the WCO effect arises by a different route, BVA being unavailable whenever the binder cannot take inverse scope.

[3]LFS treats these as sources of BVA that are not based on c-command. We use the neutral term "confounding" because the analyses compared here differ on whether inverse scope taking lies outside the grammar.

speakers. This result has also been replicated by Fukushima et al. (2023).

In the present study we use the LFS methodology to conduct experiments on WCO in the DOC and the ODC, controlled so as to exclude BVA readings that arise from the two confounding sources, and thereby verify which of the competing analyses yields the correct predictions. Specifically, this paper tests the predictions that three of them make for the DOC and the ODC: the continuation-based grammar of Barker and Shan (2014), the analysis of Bekki (2023) in Dependent Type Semantics (DTS; Bekki and Mineshima, 2017), and that of Larson (1988).

## 2 Previous Studies

**Overview** The previous analyses under consideration make different predictions about the availability of BVA readings in WCO configurations. These predictions are primarily based on two factors: first, under what conditions the theory in question holds that BVA is possible, and second, what structure it assigns to the DOC and the ODC. These two factors are related, as all the theories in question connect the possibility of BVA to structure in some way. In particular, all of them make binding depend on whether a potential binder is "structurally higher" than its bindee, although the notion of structural height is formalized differently. C-command is one such formalization, and underlies accounts such as Hoji's LFS (discussed below) as well as Larson (1988). Bekki (2023) imposes no c-command condition: a pronoun is resolved by proof search in its local context, which contains a quantifier's variable only when the quantifier takes scope over the pronoun in the semantic representation. Since that representation is built along the CCG derivation, the effect is again structural. Barker and Shan (2014) explain binding not by c-command but by an order of evaluation defined over layers of continuations. Though known as a linearity-based analysis, it decides the availability of binding on syntactic structures equipped with such layers, so its predictions are structural, albeit not in the sense of LFS. All three thus predict that, once the two confounding sources introduced in Section 1 are controlled (see Section 3), BVA is impossible when the binder is the lower of the two objects and the bindee the higher, but not vice versa; they differ in which object counts as higher.

**Larson (1988)** Working within generative grammar, this analysis assigns the ODC *A shows B to C* the structure in Figure 1.

The DOC *A shows C B*, derived by Dative Shift, has the structure in Figure 2.

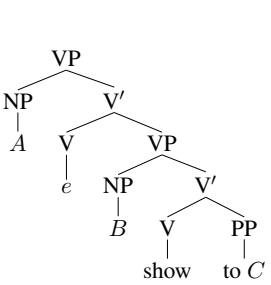



**Figure 1:** The ODC (Larson, 1988)

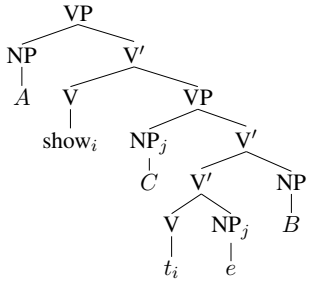



**Figure 2:** The DOC (Larson, 1988)

In Figure 1, B c-commands C, and in Figure 2, C c-commands B.[4] On the standard assumption that a quantifier can bind a pronoun only if it c-commands it (Reinhart, 1983), the first object can bind into the second in both constructions but not vice versa: the BVA reading is available in (3) and (5) and unavailable in (4) and (6).

**Barker and Shan (2014)** This continuation-based analysis predicts that the BVA reading is available for (3) and (5), whereas it is unavailable for (4) and (6). Figure 3 shows the syntactic and semantic derivations of (3) and (4).

The derivation of (3) yields the semantic representation $\forall x.\mathbf{employee}(x) \rightarrow (\mathbf{showed}(John, x, \mathbf{mentorOf}(x)))$. In (4), by contrast, the pronoun precedes the quantifier, so its request for a binder, $DP \triangleright S$, cannot be met on the same layer. Lifting the quantifier to a higher layer, as on the right of Figure 3, lets the words combine into a tower with $S|DP \triangleright S$ above $DP \triangleright S|S$ above $S$. Lowering its inner layer leaves $S|DP \triangleright S$ above $DP \triangleright S$, to which the Lower rule, requiring $A|S$ above $S$, does not apply (this is precisely the configuration that the restriction of Lower to $S$ is designed to exclude), so the BVA reading is not obtained.

[4] A node $a$ c-commands a node $b$ if neither $a$ nor $b$ dominates the other and the first node that dominates $a$ also dominates $b$.

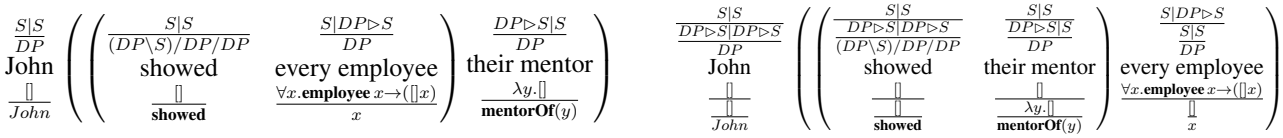



**Figure 3:** Derivations of (3), left, and (4), right, following Barker and Shan (2014)

**Bekki (2023)** This work proposes a proof-theoretic semantics that extends dependent type theory with underspecified types, and determines the accessibility of anaphora by proof search. Assuming CCG as its syntax, it predicts that the subject–object BVA reading is available in (1) and unavailable in (2). For (3) and (5), by contrast, it predicts that the reading is unavailable, and for (4) and (6), that it is available. Figure 4 shows the semantic representations of (3) and (4), using underspecified types.

In the left-hand representation, the underspecified type $u$ lies outside the scope of the universal quantifier, so the variable $w$ is not in its context, and proof search cannot construct a term that depends on $w$. In the right-hand one, $u$ lies within the scope of the universal quantifier, so proof search can resolve it to $w$, which yields the BVA reading.

# 3 Analytical Approach and Experimental Method

In the present experiment, using the LFS methodology introduced below, we replicate the consistent subject–object WCO effect and, in addition, test the predictions that the competing analyses make for the DOC and the ODC.

**Verification by LFS** In what follows, X is the quantificational expression involved in BVA (the *binder*) and Y the anaphoric expression bound by it (the *bindee*). To identify speakers (and combinations of X and Y) that are not subject to the two confounding sources, LFS uses sentences such as the following.

(7) [An employee]$_i$ praised their$_i$ mentor.

(8) Their$_i$ mentor praised [an employee]$_i$.

For sentences such as (7) and (8), the *Coreferential Reading* (Coref) is the reading on which "an employee" and "their" refer to the same individual. LFS uses the rejection of Coref in a sentence such as (8) to exclude choices of Y that allow binder-independent covariation.

(9) Every employee praised two mentors.

(10) Two mentors praised every employee.

For (9) and (10), the *Distributive Reading* (DR) is the reading on which there are two mentors per employee. LFS uses the rejection of DR in a sentence such as (10), a reading available for (9), to exclude choices of X that take inverse scope.

Inattentive speakers must also be excluded. A speaker who is attentive and who rejects the WCO configurations carrying the Coref and DR readings, as in (8) and (10), is one not subject to the two confounding sources, and is predicted to consistently reject BVA in the WCO configurations, as in (2). As LFS emphasizes, the two kinds of prediction are asymmetric. A speaker may reject a grammatical sentence for lack of resources, such as memory, the ability to imagine a suitable context, or the ability to select the lexical items that yield the intended reading, but rejects an ungrammatical one whatever resources are available. Rejection therefore does not falsify a prediction that BVA is available, whereas a single acceptance falsifies a prediction that it is unavailable: the crucial pattern is "several supporting, none contradicting".

**Sentence Types in the Experiment** The structures of the sentences used in this experiment are given in Table 1. A *topicalized equivalent* is a construction in which Y precedes X but, under the reconstruction analysis of generative grammar, X c-commands Y. On that analysis it forms a minimal pair with the corresponding WCO configuration, in which Y likewise precedes X but X does not c-command Y, so that a contrast between the two cannot be due to precedence. XVO[...Y...] as in (1), [...Y...]XVO (its topicalized equivalent), and [...Y...]VOX as in (2) were used to investigate subject–object WCO. SVX[...Y...] as in (3), [...Y...]SVX (its

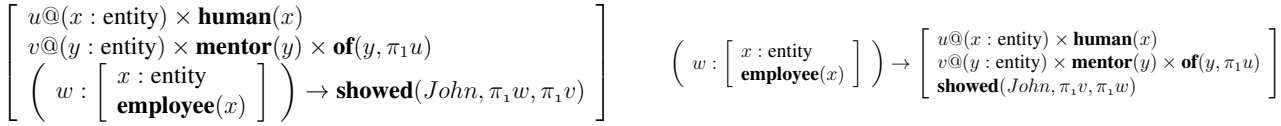


**Figure 4:** Semantic representations of (3), left, and (4), right, using underspecified types, following Bekki (2023)

**Table 1:** Types of sentences used in the experiment

| Type | Form |
|---|---|
| XVO[...Y...] | X showed John [Y's N]. |
| [...Y...]XVO | [Y's N], X showed John. |
| [...Y...]VOX | [Y's N] showed John X. |
| SVX[...Y...] | John showed X [Y's N]. |
| [...Y...]SVX | [Y's N], John showed X. |
| SV[...Y...]X | John showed [Y's N] X. |
| SVXto[...Y...] | John showed X to [Y's N]. |
| [...Y...]SVtoX | [Y's N], John showed to X. |
| to[...Y...]SVX | To [Y's N], John showed X. |
| SV[...Y...]toX | John showed [Y's N] to X. |

**Table 2:** Classification for the two subject–object c-command predictions

| | Supporting | Neutral | Contradicting | Total |
|---|---|---|---|---|
| *The subject c-commands the object* | | | | |
| **Coref-no DR-no** | **7** | **2** | **0** | **9** |
| *Coref-no DR-yes* | *3* | *2* | *3* | *8* |
| Coref-yes DR-no | 22 | 12 | 10 | 44 |
| Coref-yes DR-yes | 14 | 5 | 28 | 47 |
| Total | 46 | 21 | 41 | 108 |
| *The object c-commands the subject* | | | | |
| **Coref-no DR-no** | **2** | **5** | **1** | **8** |
| *Coref-no DR-yes* | *3* | *5* | *2* | *10* |
| Coref-yes DR-no | 2 | 3 | 6 | 11 |
| Coref-yes DR-yes | 10 | 8 | 61 | 79 |
| Total | 17 | 21 | 70 | 108 |

topicalized equivalent), and SV[...Y...]X as in (4) were used to investigate VP-internal WCO in the DOC; and SVXto[...Y...] as in (5), to[...Y...]SVX (its topicalized equivalent), SV[...Y...]toX as in (6), and [...Y...]SVtoX (the topicalized equivalent of SV[...Y...]toX) were used to investigate VP-internal WCO in the ODC.

**Procedure** For each sentence, participants were shown two pictures, A and B, each corresponding to one reading of the sentence: A to the BVA reading and B to a different reading. Such pictures were likewise created for the Coref and DR readings, and each participant was asked, in multiple-choice form, which of the readings they could obtain.

# 4 Experimental Results

For this experiment, 108 native speakers of English were recruited through Prolific (https://www.prolific.com/).

**Replication of Previous Findings** We replicated the previous findings of Plesniak (2022) and Fukushima et al. (2023), according to which speakers who are not subject to the two confounding sources do not accept subject–object WCO configurations in English sentences.

The upper half of Table 2 classifies speakers' judgments of topicalized sentences such as [...Y...]XVO and of subject–object WCO configurations such as [...Y...]VOX as either yes (acceptable) or no (unacceptable). In each table, speakers are classified on the basis of their Coref and DR judgments of the sentences that count as exhibiting WCO under the hypothesis being tested. The rows classify speakers by whether, for Coref and for DR respectively, they reject the WCO configuration.

The columns classify speakers by how their judgments would bear on the predicted acceptability of the BVA reading for the WCO configuration once the two confounding sources are excluded: "Supporting" for those consistent with the prediction and showing a minimal c-command-based contrast (topicalized: yes and WCO: no), "Neutral" for those consistent with it but without such a contrast (topicalized: no and WCO: no), and "Contradicting" for those inconsistent with it (WCO: yes). The crucial rows are in bold (the italicized rows are discussed below).

The Coref-no DR-no row of the upper half corresponds to speakers who reject both Coref and DR in the WCO configuration, and who are therefore not subject to the two confounding sources; this row is predicted to contain no contradicting speakers. In that row, seven speakers support that prediction—that is, that the subject c-commands the object—whereas none contradict it. This replicates the results of the previous studies (Plesniak, 2022; Fukushima et al., 2023).

We further classified the experimental re-

**Table 3:** Classification for the prediction that the first object c-commands the second

| | Supporting | Neutral | Contradicting | Total |
|---|---|---|---|---|
| *DOC* | | | | |
| **Coref-no DR-no** | **6** | **11** | **0** | **17** |
| *Coref-no DR-yes* | *2* | *4* | *2* | *8* |
| Coref-yes DR-no | 5 | 17 | 8 | 30 |
| Coref-yes DR-yes | 11 | 9 | 33 | 53 |
| Total | 24 | 41 | 43 | 108 |
| *ODC* | | | | |
| **Coref-no DR-no** | **2** | **8** | **0** | **10** |
| *Coref-no DR-yes* | *8* | *5* | *2* | *15* |
| Coref-yes DR-no | 2 | 6 | 6 | 14 |
| Coref-yes DR-yes | 15 | 14 | 40 | 69 |
| Total | 27 | 33 | 48 | 108 |

**Table 4:** Classification for the prediction that the second object c-commands the first

| | Supporting | Neutral | Contradicting | Total |
|---|---|---|---|---|
| *DOC* | | | | |
| **Coref-no DR-no** | **0** | **12** | **0** | **12** |
| *Coref-no DR-yes* | *4* | *4* | *3* | *11* |
| Coref-yes DR-no | 2 | 14 | 10 | 26 |
| Coref-yes DR-yes | 7 | 11 | 41 | 59 |
| Total | 13 | 41 | 54 | 108 |
| *ODC* | | | | |
| **Coref-no DR-no** | **3** | **10** | **2** | **15** |
| *Coref-no DR-yes* | *2* | *4* | *4* | *10* |
| Coref-yes DR-no | 2 | 7 | 8 | 17 |
| Coref-yes DR-yes | 5 | 12 | 49 | 66 |
| Total | 12 | 33 | 63 | 108 |

sults under the assumption that the object c-commands the subject. The lower half of Table 2 classifies speakers' judgments under the assumption that [...Y...]VOX is the topicalized sentence and [...Y...]XVO the subject–object WCO configuration.

There is one contradicting speaker in the Coref-no DR-no row, so the assumption that the object c-commands the subject is incorrect. Overall, the results suggest that the subject c-commands the object, but the object does not c-command the subject.

**Verification in the DOC and the ODC, and Analysis with Respect to Bekki (2023) and Larson (1988)** We first classify with respect to the prediction that the first object c-commands the second in the DOC and the ODC. Table 3 classifies speakers' judgments under the assumption that [...Y...]SVX and to[...Y...]SVX are sentences where X c-commands Y and SV[...Y...]X and SV[...Y...]toX are sentences where X does not c-command Y (WCO configurations). In each of the two constructions, several speakers support the prediction that the first object c-commands the second, whereas none contradict it.

Table 4 classifies speakers' judgments under the converse prediction, that the second object c-commands the first, with the two roles interchanged. The "several supporting, none contradicting" pattern does not obtain: in the ODC there are contradicting speakers, so the second object does not c-command the first, while in the DOC no speaker contradicts the prediction but none supports it either. These results support the analysis of Larson (1988), contra Bekki (2023): the former takes the first object to be higher than the second and the latter the reverse, and under controlled conditions only the former prediction is borne out.

**Analysis with Respect to Barker and Shan (2014)** Using the tables above, we test the predictions of Barker and Shan (2014). In their grammar, Coref in a WCO configuration could be derived only if Lower applied to a tower not of the form $A|S$ above $S$, which it does not; DR requires only lifting the quantifier to a higher layer ("roof-lifting"; Barker and Shan, 2014, p. 33), which is available to any quantifier. The grammar thus generates DR but not Coref in the WCO configurations, so speakers whose judgments match this profile—the Coref-no DR-yes rows (italicized)—are predicted to find BVA unacceptable there: the Contradicting cell of each such row should be zero. Instead, those cells hold 3 speakers in the upper half of Table 2, 2 and 2 in Table 3, and 3 and 4 in Table 4; Barker and Shan's (2014) predictions therefore fail under either hypothesis about the hierarchy of the two objects.

# 5 Conclusion

In this paper, we experimentally investigated WCO configurations in the DOC and the ODC using the LFS methodology. The results support the analysis of Larson (1988): in both constructions, the first object is structurally higher than the second. In future work, we would like to extend the comparison to other analyses of English object structure, such as that of Postal (2010).

# Acknowledgments

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**Augustinian Language Learning:**
**What Ostensive Definition Can and Cannot Teach a Small Language Model**

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I am interested in how non-linguistic experience affects language: how much of what a learner knows about word meanings comes from perceiving the world rather than from linguistic input alone. Here is one of the first ever reflections on the role of world perception on word meaning acquisition: "When they (my elders) named some object … I grasped that the thing was called by the sound they uttered" (*Confessions* I.8.13; Augustine of Hippo, 1991). So, according to Augustine, elders point at things and say their names, and the child connects sound to object. Wittgenstein (1953) opened the *Philosophical Investigations* by arguing against this view: ostension cannot be the basis of word learning, because pointing presupposes that the learner already parses the scene into linguistically relevant objects and properties. At the same time, core-knowledge research (Spelke and Kinzler, 2007 a.m.o.) demonstrates exactly this kind of prior in newborns – so, the matter of visual demonstration in language learning is not settled.

In this experiment, I look for effects of visual demonstration in language learning using computational methods, in particular, in neural language models. Before training, a text-only language model is typically assigned random token embeddings, so whatever, for instance, *banana* means must be learned from its distribution in texts. For comparison, I supply the 'visual demonstration': before any text-based training, tokens that label regions in visual data are initialized from a vision encoder's features over those regions; the model is text-only from that point on (cf. Zhuang et al., 2024). When measured on standard benchmarks, the effect of this step is small and constrained to tests that explicitly focus on visual properties of concrete nouns. Interestingly though, representationally, the effect of the visual initialization is not confined to concrete nouns, but is detected even for abstract 'logical' words like *no*, *two* and *many*. So, I propose to look for visual correlates for abstract meanings and find ways to trace them behaviorally.

## Method

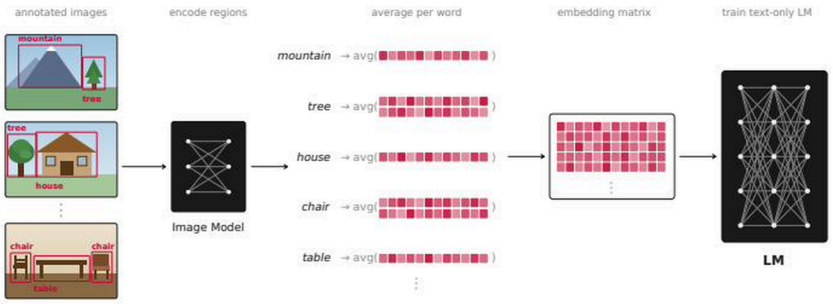



Figure 1: The vision-seeding pipeline. For each token that labels image regions, I encode those regions with a frozen vision model, average the features, and write the result into that token's row of the input embedding matrix. Tokens with no image support stay random.

- **Grounding:** Flickr30k Entities, RefCOCO+, RefCOCOg and THINGS, together 563k region annotations.
- **Encoders:** DINOv3, iBOT and SAM. All three are trained on images alone, so the seeds contain a purely perceptual prior.
- **Models:** DeBERTa-v3-base masked LMs on a ≈9.9M-word corpus (Edman et al., 2024); three BPE vocabulary sizes × three encoders, plus a baseline per vocabulary. The main pair is retrained with three seeds.

Across conditions (vision vs no vision) only the starting embeddings change, so differences can be traced back to the intervention. About 10% of word types label some image region, but they are the frequent ones and cover 85% of running text. Seedability correlates with concreteness (r = 0.46), so we expect ostension to mostly affect concrete nouns.

**Standard evaluation results.** On the BabyLM evaluation suite (Choshen et al., 2026), one task is most systematically affected by the initialization manipulation across all nine vocabulary × encoder configurations and across three random seeds: COMPS (Misra et al., 2023), which tests whether a model prefers a true statement about an object's properties to a false one (+1.30 points). Grammatical acceptability (BLiMP; Warstadt et al., 2020) and the remaining tasks don't show any difference. On an additional benchmark – a version of the Visual-Property Swap benchmark (Lin et al., 2026) rebuilt for my training corpus, with 7,416 minimal pairs such as *A ball is spherical* / *A book is spherical* – the seeded model leads by +2.2 / +2.7 / +2.9 points across seeds, from about 1M words of training to the end.

My attempts to tie this gain to the actual visually seeded material failed. Pairs with seeded nouns gain more (+0.032 vs. +0.01), but seeded nouns are also more frequent, and at matched frequency both kinds of pairs gain roughly the same. Grounding 1,155 further words with generated images does not help either because of low quality of synthetic data. So I can't reliably pinpoint the effect of grounding on the actually grounded tokens.

**Evolution of visual priors throughout training.** After training, each seeded embedding ends up nearly orthogonal to its seed (cosine 0.15 after 100M words). Relative positions largely survive though: words with similar seeds stay similar to each other, even in abstract vocabulary. For a hand-picked set of 64 function words (negation, quantifiers, numerals, articles, connectives, modals), representational similarity (Kriegeskorte et al., 2008) between the seeds and the final embeddings is 0.45, against ≈ 0 for the text-only model over the same words, in all three runs (Figure 2). This is not special to function words: other words seeded from as many images keep their structure about as well. So, I wonder how the visual input encodes negation and other abstract meanings.

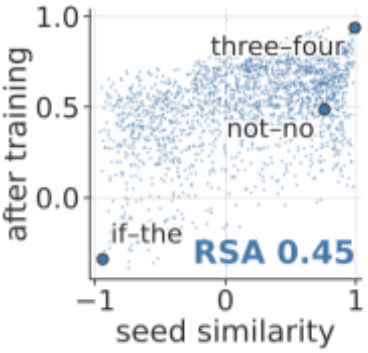



Figure 2: Each dot is a pair of the 64 function words: similarity of the two visual seeds (x) against similarity of the two embeddings after 100M words of training (y).

**Examining visual sources.** The visual seed of a token is the average over the image regions referred to by phrases that contain it. The seed of *no* averages the referents of *no shirt*, *no*

*head*, *no hat*; the seed of *three* averages the referents of *three men*. The token inherits visual correlates of larger phrases. First, one can use the encoder to study the visual correlates of a token: do the regions described by a phrase differ in a consistent direction from regions of the same object classes described without the target token (tested against random sets of the same size and class mix), and which words lie nearest to that direction? Second, we can simply look at the box geometry alone, without encoding. (Encoder-based results turn out pretty much encoder-dependent, so I only report them if at least two of three encoders agree)

**Negation.** Negation is rare in referring expressions: 6,845 of 537k region descriptions (1.3%), 81% of them from RefCOCO+. Its visual content depends on the construction (Table 1).

Table 1: Negated constructions in the grounding data: number of regions, nearest words to the construction's direction, and share of boxes that touch the edge of the photo (the referent is cut off by the frame), for this construction vs. for matched boxes, i.e. boxes of the same object classes in descriptions without negation (e.g. other sheep for *white sheep no head*, Figure 3).

| **Construction** | **n** | **Nearest words (DINOv3)** | **Box touches photo edge vs. matched** |
|---|---|---|---|
| *no / without* + clothing (*no shirt*) | 746 | *shirtless, naked, trunks* | 40% vs. 36% (n.s.) |
| *no / without* + body part (*no head*) | 300 | *partial, cut, barely* | 63% vs. 33% |
| *not visible / can't see* | 1,228 | *partially, barely, cut* | 59% vs. 34% |
| *nothing / nobody on it* | 136 | *empty, chairs, benches* | 48% vs. 45% (n.s.) |
| contrastive *not* (*not the one ...*) | 1,177 | none consistent | 40% vs. 34% |

Two constructions (*no/without* + clothing and *no/without* + body part) have clear and different correlates. *No shirt* referents look shirtless: the missing item visually corresponds to a body part where it's expected. *No head* referents are typically neither headless nor hidden behind something – they are cut off by the edge of the photo. We can see this in the encoder-free check: 63% of these boxes touch the edge, against 33% of matched ones (Figure 3). For the clothing, the boxes touch the edge not more often than in matched ones. *Nothing on it* and *nobody sitting* indicate emptiness where something would be expected. For contrastive *not* (*not the one on the left*) I didn't see consistent visual content (discourse contrast with different salient alternatives in different contexts).

Shared intuition across cases is that something expected is missing. Negative descriptions are used where the positive counterpart is the default (Wason, 1965; Horn, 1989). The visual seed of *no* is dominated by the clothing construction: nearest words are *shirtless*, *naked* and *trunks*.




Figure 3: Referents of negated descriptions. Photos: Flickr30k Entities (left); COCO 514213, CC BY-SA 2.0 (right).

**Numerals and quantifiers.** In Flickr30k Entities (Plummer et al., 2015) each plural phrase is usually linked to one box per individual: *two X* maps to two boxes 87% of the time, *three X* to three boxes 77% of the time. The visual seed of *three* is therefore built from single members of groups of three, so cardinality as such is averaged away (something that I noticed, unfortunately, pretty late in the process). So the visual correlate of quantity is indirect: the larger the numeral, the smaller the box of each individual relative to referents of the same class (Spearman $\rho = -0.99$ from *one* to *ten*; Figure 4). In the encoder, similarity between numeral seeds falls with numeric distance ($r = -0.76$ in SAM and in DINOv3; no effect in iBOT), but box size does not explain this completely. The nearest words for small numerals are *another*, *young*, *family*, large ones are near *squad*, *cheerleaders*, *uniforms*. Intuitively, bigger groups consist of more alike members, so I would be curious to see whether / how it makes sense to connect visual quantity with individuation levels, but so far I haven’t.

Vague quantifiers fit the same picture. *Several*, *many* and *a few* are small individuals in crowds (box size ×0.77, ×0.66 and ×0.65). *All* goes with members of matching, uniformed groups, clearly in DINOv3 and partly in SAM. The visual seeds of *the* and *a* differ as well (definites tend to pick scene elements such as *the street*, indefinites individuals such as *a man*), but this contrast is confounded with the source dataset and I leave it aside.

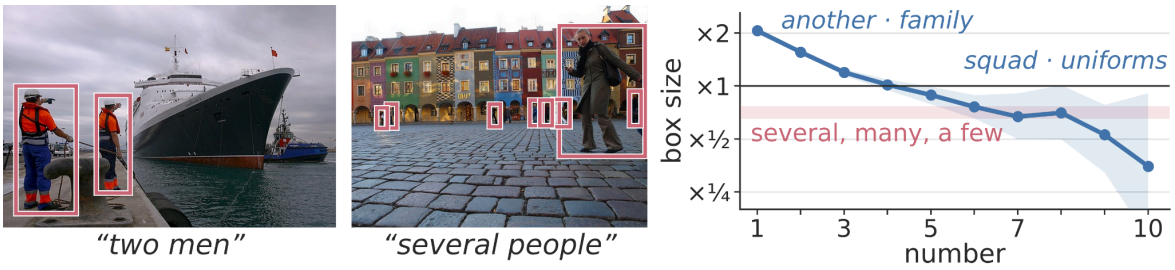



Figure 4: Left: one box per individual (photos: Flickr30k Entities). Right: box size relative to referents of the same class, by numeral; the band marks vague quantifiers, the labels give nearest words for small and large numerals (DINOv3).

**What should we test?** The standard linguistic tests for LMs are not equipped to catch any of the nuances discussed above. For function words, BLiMP pairs test whether an item is licensed in a structure. COMPS and VP-Swap test what a model knows about the referents of concrete nouns. The observations above have to do with when a negative description is appropriate and what kind of plurality a numeral or quantifier typically applies to.

A test for such content would have to meet some conditions. First, it targets a construction with a documented visual correlate and states in advance what a model should prefer: for instance, negation of an expected part against negation of an unexpected one (*a man with no shirt* / *a man with no scarf*), or large against small numerals with predicates of homogeneous groups. Second, the two members of a pair should be matched for frequency in the training data; in my VP-Swap analysis an apparent word-specific effect disappeared under such matching. Third, an untrained model should perform at chance; on the BabyLM entity-tracking task untrained masked LMs score about 42%, well above chance, so I had to set the task aside. Fourth, it should maybe separate the scene contribution from annotation artifacts: frame cut-offs and one box per individual are facts about how photos are taken and labeled – even though this might be interesting material as well.

I can't offer this kind of test yet, but I hope this work can start the discussion.

**Limitations.** One masked-LM architecture; a non-standard 10M-word corpus; English only; correlates measured on phrases in three datasets, not on words in general.

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## *What*-exclamatives, indescribability, and extremeness

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**Overview** This work aims to account for the semantics and pragmatics of English *what*-exclamatives. The analysis has two components.

**First**, I propose that *what*-exclamatives contain a **covert *kind of*** and thus share the syntax of corresponding *wh*-questions, which extract a constituent providing property information for characterizing an NP (see (3)) or modifying a degree (see (1)/(2)).

(1) What (cute) puppies you have! (What kind of (cute) puppies do you have?)
$\rightsquigarrow$ [What ~~kind of~~]$_i$ [[[$t_i$ (cute)] puppies]$_j$ you have $t_j$]!

(2) What a naughty puppy! (What kind of a naughty puppy is it?)
$\rightsquigarrow$ [What ~~kind of~~]$_i$ [[a [$t_i$ naughty] puppy]$_j$ ~~it is $t_j$~~]!

(3) What a puppy! (What kind of a puppy is it?)
$\rightsquigarrow$ [What ~~kind of~~]$_i$ [a [$t_i$ puppy]$_j$ ~~it is $t_j$~~]! ($\neq$ what a ~~cute~~ puppy!)

**Second**, I propose that *wh*-exclamatives can be considered (speaker-oriented) attitude reports based on the meaning of questions. *How*-exclamatives (see (4a)) express the speaker's surprise at an extremely high degree on a relevant scale associated with a gradable adjective (e.g., *large* in (4)), and similarly, *what*-exclamatives express the speaker's inability to use a positive property to describe an entity, thereby implying an extreme or unusual degree that leaves the speaker at a loss for words (see (5)).

(4) How (very) large the doll is!
a. $\rightsquigarrow$ I'm surprised / stunned at how (very) large the doll is. $\models$ the doll is large
b. cf. I wonder how (*very) large the doll is. $\not\models$ the doll is large

(5) What a puppy! (It is so ... that) I'm too stunned to characterize what kind of a puppy it is.

**1. Empirical observations** As noted in the literature (see e.g., Zanuttini and Portner 2003, Rett 2011, Chernilovskaya and Nouwen 2012, Nouwen and Chernilovskaya 2015), English *what*-exclamatives raise several puzzles. First, unlike *how*-exclamatives, which systematically correspond to degree questions (see e.g., (4)/(4a) vs. (4b)), *what*-exclamatives do not always seem to have a corresponding grammatical *wh*-question:

(6) a. What (beautiful) songs Lucy wrote! *What*-exclamative ✓
b. What (beautiful) songs did Lucy write? *Wh*-question ✓

(7) a. What a (beautiful) song Lucy wrote! *What*-exclamative ✓
b. *What a (beautiful) song did Lucy write? *Wh*-question #

(8) a. *What Lucy wrote! *What*-exclamative #
b. What did Lucy write? *Wh*-question ✓

Second, *what* is the only English *wh*-word permitted in exclamatives (Elliott 1974):

(9) a. I'm surprised at who came to the party. Embedded *who*-clause ✓
b. *Who came to the party! *Who*-exclamative in English #

(10) a. I cannot believe which book he chose. Embedded *which*-clause ✓
b. *Which book he chose! *Which*-exclamative in English #

Third, *what*-exclamatives allow only bare plurals / mass nouns or *a*+NP:

(11) a. *What the (beautiful) song(s) Lucy wrote! *the NP(s)* is not allowed
b. *What some (beautiful) songs Lucy wrote! *some NPs* is not allowed

(12) a. *What (beautiful) song Lucy wrote! *What*-exclamative # (cf. (7a))
b. What (beautiful) song did Lucy write? *Wh*-question ✓ (cf. (7b))

In particular, numerals are disallowed in exclamatives:

(13) a. *What three (beautiful) songs Lucy wrote! *What*-exclamative #
b. What three (beautiful) songs did Lucy write? *Wh*-question ✓

In addition to these distributional puzzles, the interpretation of *what*-exclamatives raises two prominent issues. First (see e.g., Zanuttini and Portner 2003, Rett 2011), a *what*-exclamative need not contain a gradable adjective, yet it triggers scale-based norm-sensitive inferences typically associated with gradable adjectives and focus-sensitive scalar particles such as *even* and *only* (see e.g., Greenberg 2022, Zhang 2026).

It is thus puzzling that the very information the speaker aims to emphasize is a high degree along a certain scale, but s/he chooses not to provide scale information.

(14) What a puppy! $\rightsquigarrow$ **Norm-sensitive inference**: Along a contextually salient scale, the degree measurement that the puppy reaches is far above expectations.

(15) a. I want to eat [what peppers John ate]. (see Rett 2011: (15b))
Free relatives: (15a) $\not\rightsquigarrow$ the peppers are spicy # norm-sensitivity
b. What peppers John ate! (see Rett 2011: (16))
*What*-exclamatives: (15b) $\rightsquigarrow$ the peppers are super spicy ✓ norm-sensitivity

Second, as noted by Rett (2011) and Chernilovskaya and Nouwen (2012), the norm-sensitivity brought by a *what*-exclamative must concern a scalar property of the characterized entity itself, rather than mere noteworthiness.

The *what*-exclamative in (16) is infelicitous in its context, because what is noteworthy here is the repeated coincidence across events, not any particular scalar property of the plural entity '3♢⊕ 6♡'.

(16) **Context**: Imagine that by some strange coincidence someone repeatedly picks out the same two cards (say, the 3♢ and the 6♡) from a repeatedly reshuffled pack of cards. Mary has seen this happen and now witnesses this person pick 3♢ and 6♡ yet again. (Chernilovskaya and Nouwen 2012: (4))
What cards he picked! **Infelicitous** (Chernilovskaya and Nouwen 2012: (5))

**2. Existing accounts** The scalarity (and norm-sensitivity) of *what*-exclamatives is a central concern of representative approaches in the literature.

Zanuttini and Portner (2003), following Karttunen (1977), draw a parallel between *what*-exclamatives and *wh*-questions: both denote sets of true propositions. A *what*-exclamative additionally involves domain widening, thus including propositions that contain items with extreme values along a scale (see (17)).

(17) ⟦What things he eats!⟧ (Habanero is extremely spicy)
$\Leftrightarrow$ {He eats poblano, He eats serrano, He eats jalapeño, He eats habanero}

Rett (2011) proposes a degree-based analysis: a *what*-clause can denote a degree property, and an exclamative operator turns a proposition (here, $\exists d[...]$) into a speech act of exclamation. Thus, (18)/(19) express the existence of a degree beyond expectations.

(18) $[\![\text{What}_j\ [[t_{j\,d}\ \text{delicious cakes}]_i\ \text{John baked}\ t_i]!]\!]$ **(with adjective *delicious*)**
$\Leftrightarrow \lambda d.\exists x[\text{John baked}\ x \wedge \text{cakes}(x) \wedge x \text{ is delicious to the degree of } d]$
(With an $\exists$,) EXCLAMATION-FORCE($p$) expresses that there is a degree $d$ such that it's beyond the speaker's expectations that John baked $d$-delicious cakes.

(19) $[\![\text{What cakes John baked!}]\!]$ **(accommodating a measure function)**
$\Leftrightarrow \lambda d.\exists x[\text{John baked}\ x \wedge \text{cake}(x) \wedge \mu(x) \geq d]$ $\mu$ is context-dependent

Chernilovskaya and Nouwen (2012) replace Rett (2011)'s context-dependent measure function with NOTEWORTHINESS, which constantly maps entities to the same scale, on which noteworthy things stand out considerably with respect to a comparison class.

(20) $[\![\text{What cakes John baked!}]\!]$
$\Leftrightarrow \exists x[\text{John baked}\ x \wedge \text{cake}(x) \wedge \text{NOTEWORTHINESS}(x) \geq \text{POS}]$

However, none of these approaches explains the distributional puzzles of *what*-exclamatives. If John baked three extremely delicious cakes, for example, why is (21) unacceptable?

(21) *What three cakes John baked! **Over-generation** by existing accounts

**3. Proposal** The current proposal is motivated by two ideas. First, in English, *a*+NP and bare plurals / mass noun have generic uses, i.e., they can denote a **kind** (see e.g., Carlson 1977a,b, Chierchia 1998). Thus, *a*+NP can be ambiguous between an individual and a kind reading (see (22)), and an overt expression of *kind of* disambiguates (see (23)).

(22) Kelly is seeking a unicorn. Carlson (1977a): (49) ✓ individual; ✓ kind
a. Kelly is seeking a unicorn, and Millie is seeking it, too. ✓ individual-reading;
b. Kelly is seeking a unicorn, and Millie is seeking one, too. ✓ kind-reading

(23) A: That luxurious car parking outside is mine.
B: I have the same (kind of) car (with a different color). (No possession dispute)

Second, cross-linguistically, there is ample evidence exhibiting the parallelism between kinds and degrees (see Anderson and Morzycki 2015). E.g., they share the same anaphor:

(24) a. Clyde is such a tall man. *such*: used as a proform related to degrees
b. Clyde is such an idiot. *such*: used as a proform related to kinds

In English, there is also syntactic parallelism between (i) the position of the proform *such* and (ii) the position of the question form *how* (+Adj). Both need to be dislocated to the left, between the indefinite part and a number (if there is one). In (26)–(28), *such*/*how* address degrees of cuteness or bigness, while in (25) *such* addresses a kind.

(25) a. It is such$_i$ a $t_i$ puppy.
b. *It is a such puppy.

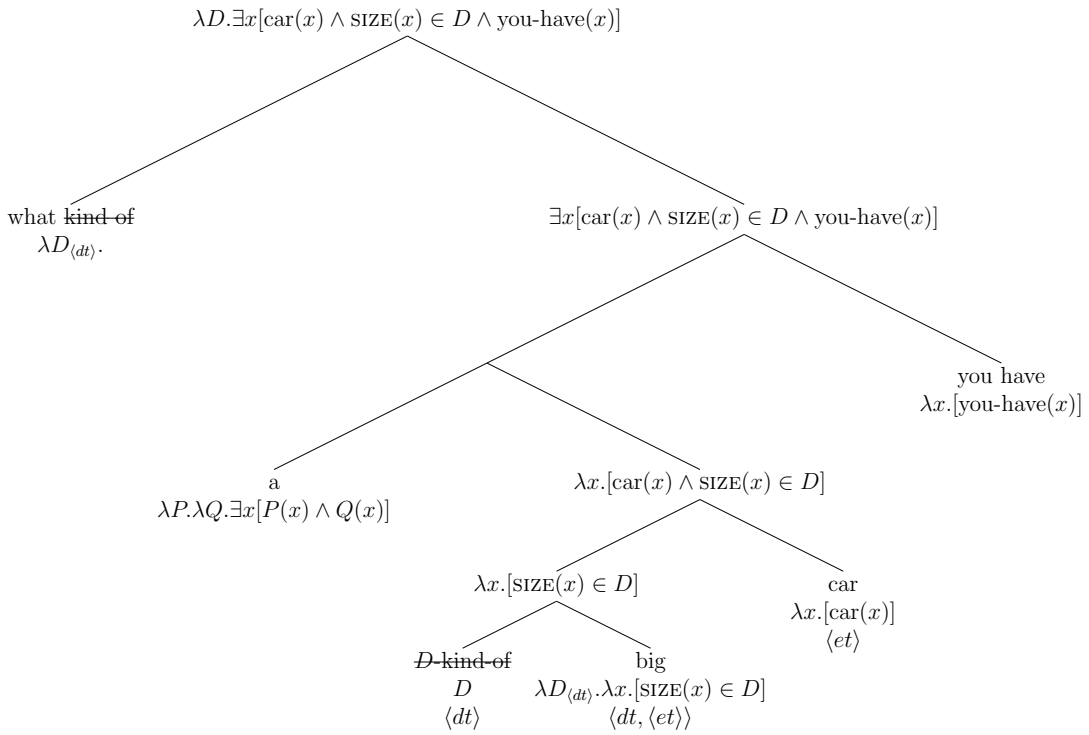
(26) a. It is such$_i$ a [$t_i$ cute] puppy.
b. *It is a such cute puppy.

(27) a. (three) [such$_i$ [$t_i$ cute] puppies].
b. *such three (cute) puppies.

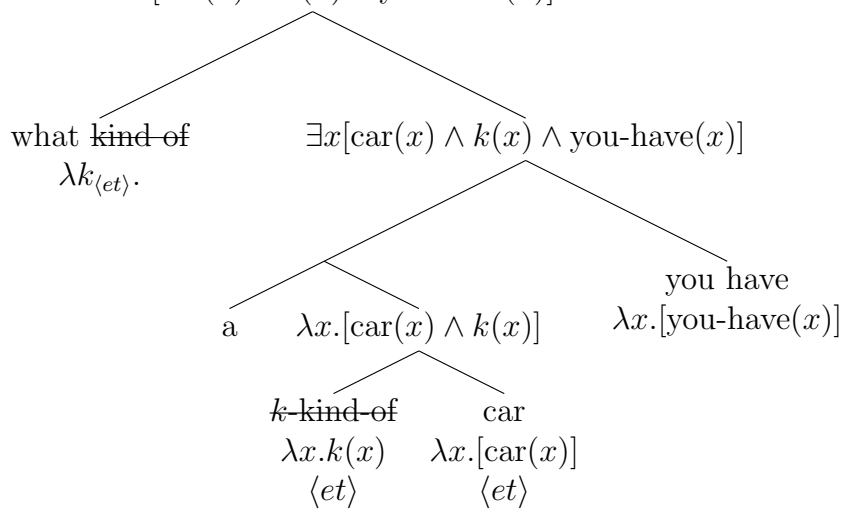
(28) a. I bought a [very big] toy.
b. [How big]$_i$ a $t_i$ toy did I buy?

I propose that **kinds** can be considered **properties** of **entities** (see (30)) or **degrees** (see (29)), and a *what*-exclamative corresponds to a *what-kind-of*-question about kinds/properties (of type $\langle \alpha t \rangle$).

(29) What ~~kind of~~ a big car you have!
Corresponding question: what kind of a big car do you have?
(a question about the property of bigness degrees)




(30) What (kind of) a car you have!
Corresponding question: what kind of a car do you have?
(a question about the kind/property of cars)




The analyses in (30)/(29) follow the categorial approach to questions (e.g., $[\![\text{who came}]\!] = \lambda x.[\text{came}(x) \wedge \text{human}(x)]$ (i.e., a question about the individual(s) who came), see e.g., Hausser and Zaefferer 1978, Krifka 2011). Thus a *what*-exclamative denotes a set of properties (of entities or degrees).

To address the puzzle that the very information the speaker aims to emphasize (e.g., a high degree along a scale) involves omission, I further propose that exclamation and surprise are deeply connected with speechlessness: the speaker simply finds words insufficient to describe the high degree that has impressed him/her.

Specifically, I propose that an exclamation operator, EXCL, presumably realized by exclamative intonation, turns the set of properties generated via question formation in (29) and (30) into an attitude report: the speaker believes that none of the properties under consideration is sufficiently informative.

(31) $[\![\text{EXCL}]\!]^{c,w} \stackrel{\text{def}}{=} \lambda P_{\langle \alpha t,t\rangle}.\forall w' \in \text{EPI}_{\text{speaker}_c}(w)[\forall k \in P[k \text{ is not sufficiently informative}]]$

For a set of degree properties, this means that the speaker believes that a sufficiently informative answer would lie beyond the endpoint of a relevant scale.

For a set of entity properties, this means that the speaker believes that the positive use of various gradable adjectives (e.g., *tall*), including extreme adjectives (e.g., *gigantic*) would fail to describe the entity adequately. This indescribability or unclassifiability captures the extremeness or noteworthiness associated with *what*-exclamatives.

(32) a. Positive use of *tall*: $\lambda x.\text{HEIGHT}(x) \geq$ a positive threshold
b. Positive use of *gigantic*: $\lambda x.x$'s height exceeds the maximum degree on the salient portion of the height scale, see Morzycki 2012)

Overall, the parallel between *what-kind-of*-question and *what*-exclamatives addresses the distributional puzzles, while the EXCL operator explains scalarity / norm-sensitivity.

**4. Discussion** The current analysis inherits the advantages of existing approaches.

Like Zanuttini and Portner (2003), it captures the parallelism between a *what*-exclamative and its corresponding *wh*-question – a *what-kind-of* question.

Like Rett (2011), it is based on degree semantics. Moreover, the current analysis explains why the very information the speaker aims to emphasize, i.e., an exceptionally high degree along a scale, involves omission: surprise is conveyed via speechlessness. In this sense, the current analysis also follows Chernilovskaya and Nouwen (2012), but with a more detailed analysis of the notion of NOTEWORTHINESS.

Moreover, the current proposal reveals a connection between answerhood and surprise. The definition of EXCL operator suggests that surprise can be analyzed as speechlessness, or a loss of words: the speaker cannot find a sufficiently informative answer for describing a degree or classifying an entity. This connection receives further cross-linguistic support. Chinese example (33) and Korean example (34) are both based on the construction 'not knowing how much', which emphasizes an exceptionally high degree and gives rise to a norm-sensitive inference. This speechless surprise is lexically realized in these languages.

(33) māmā huílái-le. tā bù-zhīdào yǒu duō kāixīn (Chinese: CCL corpus)
mom return-SFP 3SG NEG-know have much happy
'His mom is back. He is so happy.' **Chinese: *bù-zhīdào (yǒu) duō***
(Literal meaning: I/you have no idea how happy he is.)
$\rightsquigarrow$ His happiness > speaker's expectations

(34) ku tuleysi-ka elmana yeyppun-ci mol-la-yo.
that dress.NOM how pretty.COMP not-know.POL
'I/You have no idea how beautiful that dress is!' **Kor.: *elmana . . . -ci molu-***

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# Two types of rhetorical wh-expressives in Japanese

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## 1 Introduction

Japanese has two types of wh-sentences: *nani-ga* X-*da* 'what is X' and X-*ga nan-da* 'X is what', as illustrated in (1) and (2). The former conveys that the relevant act fails to properly exemplify X, whereas the latter suggests that X is meaningless.

(1) Nani-ga mejaariigaa-da.
what-NOM major.leaguer-COP
'lit. What is a major leaguer?' (≈ What kind of major leaguer are you supposed to be?)

(2) Mejaariigaa-ga nan-da.
major.leaguer-NOM what-COP
'lit. A major leaguer is what?' (≈ What's so great about being a major leaguer?)

What is the difference between *nani-ga* X-*da* 'what is X' and X-*ga nan-da* 'X is what'? How can we analyze their meanings? Are these constructions different from ordinary questions or rhetorical questions? In this paper, I investigate the meaning and use of *nani-ga* X-*da* 'what is X' and X-*ga nan-da* 'X is what' and argue that they are neither ordinary questions nor rhetorical questions. These constructions differ from ordinary questions in that they do not have the illocutionary force of a question. Furthermore, they differ from ordinary rhetorical questions in that they are expressive rather than assertive.

I then argue that although *nani-ga* X-*da* 'what is X' and X-*ga nan-da* 'X is what' have different meanings, both constructions conventionally imply that the speaker rejects all alternative propositions associated with the wh-sentence and expresses a negative, counter-expectational attitude toward the utterance situation. This paper proposes a new type of non-canonical wh-sentence: the rhetorical wh-expressive.

## 2 Empirical facts

Before analyzing these constructions, let us first observe some empirical facts. First, regarding the semantic property of X in *nani-ga* X-*da* and X-*ga nan-da*, X typically denotes an item that occupies a high position on a relevant scale. In (3), *eesu* 'ace' and *daigakusha* 'eminent scholar' represent high-status positions. In such cases, the speaker holds positive expectations of the person in question that correspond to those positions, but the speaker is expressing dissatisfaction that these expectations have been betrayed.

(3) Nani-ga {eesu / daigakusha}-da.
what-NOM ace / great.scholar-COP
'lit. What is an ace/a great scholar?' (≈ What kind of ace/great scholar is that?)

However, in situations where expectations of a 'negative' outcome are overturned, elements with low scalar values can appear:

(4) (Context: The speaker heard that his opponent was a beginner, but the ball is fast, and he hits it like crazy.)
Nani-ga shoshinsha-da.
what-NOM beginner-COP
'lit. What is a beginner?' (≈ What kind of beginner are you supposed to be?)

This sentence sounds natural in a situation where the speaker expects the person in question to make mistakes or perform poorly because they are a beginner, but those expectations are not met.

In X-*ga nan-da*, too, X represents a high of scale and if X is construed as low on the scale, the sentence sounds odd:

(5) a. {Mejaariigaa / ?? kusayakyuu senshu}-ga nan-da.
major.leaguer / amateur.baseball player-NOM what-COP
'lit. {A major leaguer/an amateur baseball player} is what?' (≈ What's so great about being a major leaguer/amateur baseball player?)

b. {Ichiryuudaigaku / ?? sanruu daigaku}-ga nan-da.
top-tier.university / third-rate university-NOM what-COP
'lit. {A top-tier university/a third-rate university} is what? (≈ What's so great about a {top-tier university/third-rate university}?)

The second descriptive property of *nani-ga* X-*da* and X-*ga nan-da* is that they behave as expressives. They do not have the illocutionary force of a question, unlike ordinary questions.

Furthermore, *nani-ga* X-*da* and X-*ga nan-da* are different from the ordinary rhetorical questions in (6) and (7)(depending on the context, the Japanese sentences in (7) may also receive a non-rhetorical interrogative interpretation):

(6) a. What has John ever done for Sam? (Interpretation: John has done nothing for Sam.)
b. Who lifted a finger to help Mary? (No one helped Mary.)

(7) a. Taro-wa Hanako-no.tameni koremade nani-o shi-ta-nda?
Taro-TOP Hanako-for so.far what-ACC do-PST-*noda*
'What has Taro done for Hanako so far? (Interpretation: He has done noting for Hanako.)

b. Dare-ga konna shikogo-o suru-nda?
who-NOM such job-ACC do-*noda*
'Who would do a job like this?' (Interpretation: No one will do a job like this.)

Rhetorical questions have the feel of an assertion (Sadock 1971; Han 2002) and the answers are already in the common ground (Caponigro & Sprouse 2007; Biezma & Rawlins 2017). Furthermore, in rhetorical questions, answers are not required, though possible, as shown in the following example:[1]

(8) A: Who cares about you?
B: Nobody. / Yeah, you're right. (Caponigro & Sprouse 2007: 123)

In contrast, *nani-ga* X-*da* and X-*ga nan-da* do not have these properties. First, they convey the speaker's negative feelings, which are not something already shared between the speaker and the hearer. Furthermore, since they are purely expressive, it is odd to respond to *nani-ga* X-*da* and X-*ga nan-da* with *sono toori-da* 'that's right'.

(9) A: {Nani-ga mejaariigaa-da. / Mejaariigaa-ga nan-da}.
what-NOM major.leaguer-COP mejor.leaguer-NOM what-COP
'lit. What is a major leaguer?' / 'lit. A major leaguer is what?'

[1] As for the definition of rhetorical question, in this paper I follow the definition made by Caponigro and Sprouse 2007: A RQ is an interrogative clause whose answer is known to the speaker and the addressee, and they both also know that the other knows the answer as well. An answer is not required, but possible. Either the speaker or the addressee can answer. (Caponigro & Sprouse 2007: 129)

B: ?? Sono toori-da.
that way-COP
'That's right.'

Even if a reply like B's were possible, it would merely echo A's anger and negative emotions rather than genuinely "respond".

## 3 Analysis of *nani-ga* X-*da*

Based on the above empirical facts, let us now analyze the meaning of *nani-ga* X-*da* and X-*ga nan-da*. First, let us consider *nani-ga* X-*da*. Anno (2019) argues that the *nani-ga* X-*da* construction expresses doubt about the target, denying its value or attributes. I argue below that this can be explained by assuming that the construction expresses the speaker's negative, counter-expectational attitude toward the utterance situation involving the target. To illustrate this point, consider the following example.

(10) (Context: This player is a major leaguer, but he makes errors and strikes out on easy pitches.)
Nani-ga mejaariigaa-da.
what-NOM major.leaguer-COP
'lit. What is a major leaguer?' (= What kind of major leaguer are you supposed to be?)

I assume that *nani* in (10) denotes a set of contextually salient propositions (e.g., "he made an error", "he struck out on an easy pitch."):

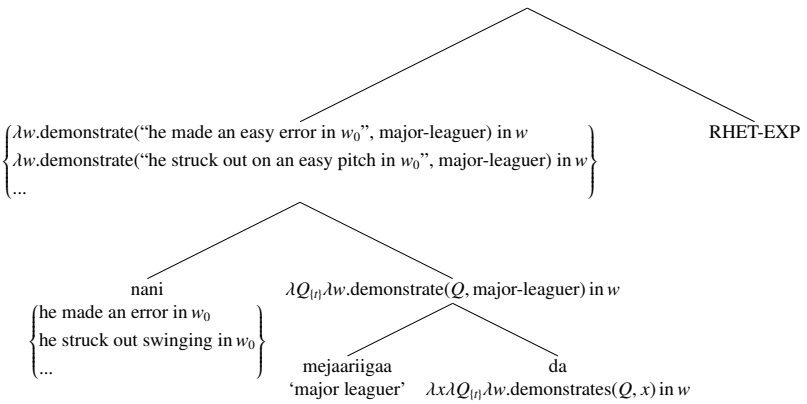
(11) $[\![\text{nani}_{PROP}]\!] = \{p|\ p \text{ is a contextually salient proposition in } w_0\}$

As for *da*, it denotes that "$Q$ demonstrates $x$ in $w$" ($\{\sigma\}$ is the type for the set of $\sigma$-type objects (Uegaki 2018)):

(12) $[\![\text{da}_{DEMON}]\!] = \lambda x \lambda Q_{\{t\}} \lambda w.\text{demonstrates}(Q, x) \text{ in } w$

As for the meaning of *mejaa riigaa* 'major leaguer', I assume that it denotes a kind of type $e$ (Chierchia 1998). Crucially, **nani** and **da**(**mejaa riigaa**) combine in a pointwise fashion (Kratzer & Shimoyama 2002), as shown in (13):

(13)




Finally, the expressive operator RHET-EXP combines with the set of propositions. (The superscript $a$ stands for an at-issue type, and the superscript $s$ stands for a shunting type, which is a special type of conventional implicature (CI) interpreted via resource-sensitive application; McCready 2010.)

(14) $[\![\text{RHET-EXP}]\!]: \langle\{\langle s^a, t^a\rangle\}, t^s\rangle = \lambda\alpha\forall p[p \in \alpha \rightarrow \text{reject}(sp, p) \wedge \text{unexpected}(s*) \wedge \text{bad}(s*)]$

RHET-EXP conventionally implies that the speaker rejects all the propositions in $\alpha$ and holds a negative, counter-expectational attitude toward the utterance situation $s$. Note that the at-issue argument $\alpha$ is shunted (McCready 2010; cf. Potts 2005), i.e., it does not remain in the at-issue dimension. If RHET-EXP combines with the set of alternative propositions in (13), we obtain the following CI:

(15) $\forall p[p \in \{\lambda w.\text{demonstrate}(\text{“he made an easy error in } w_0\text{”, major-leaguer) in } w,$
$\lambda w.\text{demonstrate}(\text{“he struck out on an easy pitch in } w_0\text{”, major-leaguer) in } w, ...\} \rightarrow \text{reject}(sp, p)$
$\wedge \text{unexpected}(s*) \wedge \text{bad}(s*)]$

So, how can we explain the example in (4)? The example in (4) sounds natural in a situation where the contextually salient propositions are positive ones, such as “He throws fast balls” or “He hits a lot”, which nevertheless fail to show that he is a beginner. Moreover, it is unexpected for the beginner to perform well, and, for the speaker (the opponent), this constitutes an unfavorable situation.

## 3.1 The quotation use of *nani-ga* X-*da*

In addition to the examples like (1) and (3), X in *nani-ga* X can be quoted material.

(16) a. Nani-ga “kyoo-wa isogashii”-da.
what-NOM today-TOP busy-COP
‘What do you mean, ‘I’m busy today’?’

b. Nani-ga “imasugu shi-masu”-da.
what-NOM right.now do-HON-COP
‘That do you mean, ‘I will do right now?’

For example, in (16a), it sounds natural in a situation where the person says, “I’m busy today”, yet spends the entire day lying around; whereas in (16b), it sounds natural in a situation where the person says, “I’ll do it right now”, yet takes absolutely no action.

These examples can be analyzed as cases where the actual behavior does not demonstrate what was said. To account for such quotation examples, this study follows Potts (2005) in introducing a new basic type $u$, the utterance type, and in assuming that quotation expressions refer not to the ordinary semantic value of an expression but to their linguistic form of type $u$. I then assume that *da* can take a quotation expression as its argument:

(17) $[\![\text{da}_{DEMON.QUOT}]\!] = \lambda S_u \lambda Q_{\{t\}} \lambda w.\text{demonstrates}(Q, S) \text{ in } w$

## 4 Analysis of X-*ga nan-da*

Let us now analyze the meaning of X-*ga nan-da* based on (18):

(18) (Context: The speaker wanted to play in the major leagues, but he wasn’t selected in the draft.)

Mejaariigaa-ga nan-da.
major.leaguer-NOM what-COP
‘lit. A major leaguer is what?’ (≈ What’s so great about being a major leaguer?)

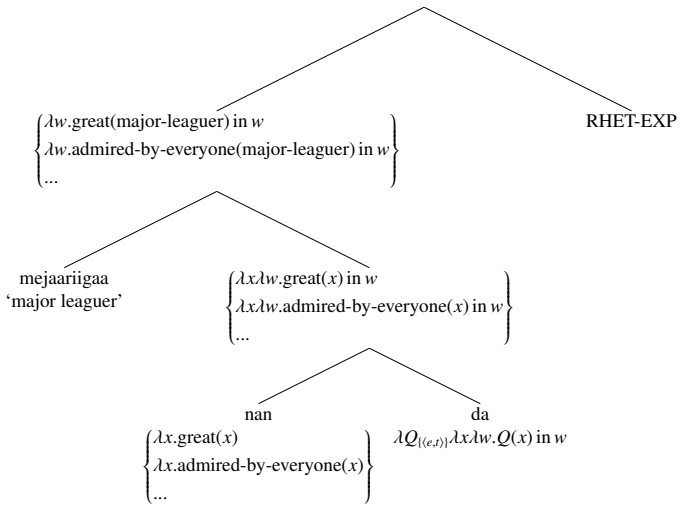
In this construction, *nani* ‘what’ appears in the predicate position. I assume that it denotes a set of socially determined evaluative properties associated with the target (e.g., “great”, “admired by everyone”) and that *da* has a predicative meaning:

(19) a. $[\![\text{nani}_{PRED}]\!] = \{P | P \text{ is a socially determined evaluative property associated with the target } x\}$

b. $[\![\text{da}]\!] = \lambda Q\{\langle e,t,\rangle\}\lambda x\lambda w.Q(x)$ in $w$

*Nan(i)* combines with the other elements in a pointwise fashion, as shown in the following Figure.

(20)




Finally, RHET-EXP applies to the resulting set of propositions (e.g., "A major leaguer is great", "A major leaguer is admired by everyone") and conventionally implies that the speaker rejects all of them and holds a negative, counter-expectational attitude toward the situation at issue (e.g., the speaker could not become a major leaguer).

(21) $\forall p[p \in \{\lambda w.\text{great(major-leaguer) in } w, \lambda w.\text{admired-by-everyone(major-leaguer) in } w, ...\} \rightarrow$
reject$(sp, p) \wedge$ unexpected$(s*) \wedge$ bad$(s*)]$

The above analysis explains the oddness of examples such as (5a) with *kusayakyuu senshu* 'amateur baseball player'. To make (5a) with *kusayakyuu senshu* 'amateur baseball player' sound natural, we would need to assume a situation in which the speaker wanted to become an amateur baseball player but failed to do so, and regards this failure as unexpected and undesirable. However, positing such a situation is itself odd. Moreover, the socially associated properties of an amateur baseball player are typically negative (e.g., having poor baseball skills), and it is difficult to construct positive properties for such a target and then reject them.

## 5 Related phenomena

In addition to *nani-ga* X-*da*, there is also the expression *doko-ga* X-*da* (cf. Anno 2019):

(22) Doko-ga mejaariigaa-da.
where-NOM major.leaguer-COP
'Where does he look like a major leaguer?'

Here, we consider *doko* to be a point rather than a location, and assume that, in principle, the same analysis as for *nani-ga* X-*da* is possible.

## 6 Conclusion

*Nani-ga* X-*da* 'what is X' and X-*ga nan-da* 'X is what' differ in meaning, but both constructions conventionally imply that the speaker rejects all alternative propositions associated with the wh-sentence and expresses a negative, counter-expectational attitude toward the utterance situation. This paper shows that there is a previously unrecognized type of rhetorical wh-expression—namely, a rhetorical wh-expressive, one that is neither an ordinary question nor a standard rhetorical question.

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# The Use Conditions of Melioratives and Tense/Mood-Marking

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**In a nutshell.** I propose an account of German declarative melioratives that derives their use conditions compositionally from a DEGREE-BASED semantics of the adjective *gut* ('good') and TENSE / MOOD (present indicative vs. past subjunctive vs. past perfect subjunctive).

**Meertens & Lauer's account.** Meertens & Lauer (2018) characterize MELIORATIVES as "forms with an imperative-like function that are formed with a version of the adverb *better*". Melioratives are typically used to give advice. This paper focuses on declarative melioratives in German as exemplified in (1).

(1) Du machst besser mehr Sport.
du make.PRS.IND better more sports
'You better exercise more.'

Meertens & Lauer (2018) propose an account of declarative melioratives in which "[t]he behavior of melioratives arises from the interaction of the contribution of the host clause [= declarative sentence mood] and the contribution of *better*." They treat the German adverb *besser* ('better') as a modal particle with a Kratzerian semantics (viz. Kratzer's (1981) 'better possibility') that takes the set of propositions representing the addressee's self-motivated effective preferences as ordering source. In addition, they assume that *besser* introduces a "diversity condition"—that is, it presupposes that the modal base contains both $p$- and $\neg p$-worlds. While I follow Meertens and Lauer in the general outline of their pragmatic account, I argue that treating the adverb besser as a lexicalized modal particle yields incorrect predictions.

**Motivation for a derivational account.** There are at least THREE REASONS to seek a derivational account of declarative melioratives. First, a particle analysis of *besser* leaves opaque the relationship between meliorative *besser* and ordinary adverbial or predicative use of *besser*.

(2) a. Christoph sieht mit Brille besser als ohne.
Christoph see.PRS.IND better with glasses than without.
'Christoph sees better with glasses than without.'

b. Es ist besser, du machst mehr Sport.
it be.PRS.IND better you do.PRS.IND more sports

'It's better if you exercise more.'

In (2-a), *besser* is a low adverbial modifier of *sieht* ('sees'); the sentence in (2-b) with the predicatively used adjective *besser* has an interpretation similar to the sentence in (1). A unified account should make this relationship transparent. Second, meliorative interpretations are not limited to the comparative form *besser*. The superlative *am besten* can be used with a similar interpretation:

(3) Du machst am besten mehr Sport.
you do.PRS.IND best more sports
'You'd best do more sports.'

This pattern is expected if the meliorative construction involves degree morphology. It is less straightforward if *besser* is treated only as a lexicalized modal particle. Third, declarative melioratives occur in a broader tense-and-mood paradigm:

(4) a. Du machst besser mehr Sport.
you do.PRS.IND better more sports
'You'd better exercise more.'

b. Du würdest besser mehr Sport machen.
you will.PST.SBJV better more sports do.INF
'You'd better exercise more.'

c. Du hättest besser mehr Sport gemacht.
you have.PST.SBJV better more sports done
'You should have exercised more.'

The use conditions of (4-a)-(4-c) are parallel to those of indicative and subjunctive conditionals. Indicative conditionals are associated with openness or diversity, subjunctive conditionals with a less vivid future, and past subjunctive conditionals with counterfactuality. The predicative constructions in (5-a)-(5-c) also share these conditions of use:

(5) a. Es ist besser, wenn du mehr Sport machst.
it is better if you more sports do.PRS.IND
'It's better if you exercise more.'

b. Es wäre besser, wenn du mehr Sport machen würdest.
it be.PST.SBJV better if you more sports do.INF will.PST.SBJV
'It would be better if you exercised more.'

c. Es wäre besser gewesen, wenn du mehr Sport gemacht
it be.PST.SBJV better been if you more sports done

hättest.
have.PST.SBJV
'It would have been better if you had exercised more.'

The parallelism between the interpretations and use conditions of the constructions in (5) and (4) motivates an account that derives meliorative use conditions from tense and mood rather than assigning them to the lexical meaning of *besser*.

**Theoretical contribution.** Against this background, I propose a compositional account of declarative melioratives that derives their use conditions from a particular scope-interaction of the gradable adjective *gut* ('good') in its comparative / superlative form on an adverbial use and TENSE (present vs. past) and MOOD (indicative vs. subjunctive). For the degree semantics of *gut* ('good') I follow Kennedy & McNally (2005); Lassiter (2017); Sode (2018); for the semantics of tense and mood in German and the assumptions about the morphology/semantics interface, I follow Grønn & von Stechow (2009); Grønn (2021). In (7)-(10) I give a sketch of some of the semantic building blocks used in the interpretation of (4-b)–focusing on mood for the purpose of exposition. The logical form of (4-b) is given in (6). X is the semantic interpretation corresponding to PST.SBJV in German.

(6) [[[ X **good** ][ **er** $d_c$ ]][ **you more sports do** ]] ≈ (4-b)

(7) $[\![[\ \textbf{good}\ [\ \textbf{er}\ d_c\ ]]]\!]^c = \lambda w.\ \lambda p.\ (\exists d)[\text{good}_c(w)(p) = d\ \&\ d \succ d_c]$
defined only if there is a salient decision problem $Q_c$ such that $p$ resolves $Q_c$.
$d_c$ is the degree of goodness of the salient action alternative to $p$ resolving $Q_c$.

(8) $[\![\text{X}]\!]^{f,g}(w)(w') = \text{BEST}_{f,g}(w)(w')$, where $f$ is empty and $g$ is what is common knowledge

(9) $[\![[\ \text{X}\ \textbf{good}\ ]]\!]^{f,g} = \lambda w.\ \lambda d.\ \lambda p.\ [\![\textbf{good}]\!](w)(d)([\![\text{X}]\!]^{f*,g}(w))$, where $f$ is an empty conversational background, $f* = \lambda w.\ f(w) \cup \{p\}$ and $g$ is what is common knowledge

(10) $[\![[[[\ \text{X}\ \textbf{good}\ ][\ \textbf{er}\ d_c\ ]][\ \textbf{you more sports do}\ ]]]\!]^{c,f,g} =$
$\lambda w.\ (\exists d)[\text{good}_c(w)(\text{BEST}_{f*,g}(w)) = d\ \&\ d \succ d_c]$, where $f$ is an empty conversational background, $f* = \lambda w.\ f(w) \cup \{\lambda w'.$ you do more sports in $w'\}$ and $g$ is what is common knowledge

In particular, I show that a decompositional account can derive the use conditions that Meertens & Lauer (2018) assume for declarative melioratives with *besser* in the indicative mood under standard assumptions, without attributing these conditions to the lexical meaning of a modal particle *besser*.

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# Events are times

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**In a nutshell.** We reopen the debate on the necessity of events in semantic ontology and contribute to the view that events are reducible to times. We argue that there are no non-temporal readings of *time/-s* as commonly assumed in the context of adverbial quantification (*every time*). The apparent event reading disappears as soon as *times* is left unrestricted. We propose that this is because the restriction in '*times at which p*' gives rise to kind-readings. We analyze so-called events as instances of kinds of times. This effects the observed admission of temporal overlap when counting times in certain environments.

**Keywords.** adverbial quantification, temporal ontology, event individuation, kinds of times.

**§1 Background.** Rothstein (1995) argues that sentences with '*n times*'-phrases have not purely temporal 'event interpretations' alongside temporal ones. Early related claims of *time* in *every time* quantifying over events or situations can be found in Berman (1987); Heim (1990); de Swart (1991); von Fintel (1994) a.o. Much subsequent literature follows these assumptions (Landman, 2008; Ferreira, 2005; Doetjes, 2007). This has contributed to increasingly complex semantic accounts of event quantification and action sentences (e.g. Landman, 2008; Pianesi and Varzi, 2000; Champollion, 2016) and is one of the main arguments (Rothstein, 1995, p.2) for semantically basic Neo-Davidsonian (1980) 'events' in general. The evidence given for 'event interpretations' of *times* stems from examples like (1) (cf. Landman, 2008's (8) & (9)) where events, rather than times, seem to be counted, since two flashings happen simultaneously:

(1) a. CONTEXT: A tech boss is looking at a board of light bulbs. 2 lights flash one after the other. Then, 2 lights flash simultaneously. (4 lights have flashed within 3 seconds.) The tech boss explains that the lights count millions of worldwide uses of his AI tool.
b. *Every time a light has turned on since we entered the room, I got 10,000 euros. So I have 40,000 euros more in my bank account now.* **event interpretation**

This allowance of temporal overlap is similar to the behavior of nouns like *party* which are often said to denote events. Individuation of different parties cannot only happen temporally, but also via other 'event properties' (Grimm, 2019; Sutton, 2025), thematic roles and objects (Gehrke and McNally, 2014). The noun is usually taken to be polysemous (Sutton, 2025, building on Sutton, 2024; Sutton and Filip, 2020) to restrict the options for this anchoring. The parallel behavior of (1) suggests, at first glance, that the meaning of *every time* is based on similar individuation; and that polysemy is needed to account for both readings here as well. We argue against this.

**§2 Debunking the 'temporal coincidence' argument.** Rothstein (1995) and Landman (2008)'s reasoning forces one to also accept non-temporal readings of 'minute':

(2) *Every minute in which someone working for me is waiting for our business partners to show up to a meeting late is a minute in which I lose 100 euros. So, by letting Dr. Smith and Mrs. Brown wait for 10 minutes, you have just cost me 2000 euros.* **event int.**

Either there is coercion at work in both (1) and (2), or they tell us more about individuation of temporal units in general than about two homonymous (Rothstein, 1995, p.5) readings of *time* specifically. Furthermore, the passing of the 'simultaneous times test' illustrated in (1) and (2) relies on a to-date overlooked factor: *times* must be restricted ('*times at which p*') to give rise

to 'event readings'. This is demonstrated by the contrast between (1) and (3).

(3) (1-a); *Lights went off {??4/✓3} times.* **intended event / temp. int.**

Similarly, the 2000 € from (2) are divided by 10 (the minutes at which both employees waited), not 20 (the sum of waiting times) in (4). '*Every minute*' quantifies over 'time slices' only.

(4) (2); *Every minute has just cost me {??100/✓200} euros!!* **intended event / temp. int.**

Acceptability of 'event interpretations' is much reduced in (3) and (4). This suggests that *times/minutes* alone has no non-temporal interpretations, but '*times/minutes at which p*' does.

**§3 Proposal.** Rothstein (1995) notes that the event interpretation of *time* is a count noun, while temporal *time* is a mass noun (p.5). On her view, this supports the idea that the two are homonymous. We interpret this mass/count distinction differently: The count noun *times* is the result of a classifying operation on the mass noun – thus, count *time/-s* relates to mass *time* like count *beer/-s* relates to mass *beer*. Having undergone this classification alone is not enough to support 'event' readings – see examples (3) and (4). Quantifying over (count) times unambiguously leads to temporal readings, see (8-a). 'Event readings' are derived by a second process which is independently attested in other domains: Plural count *times* is shifted to the name of the kind 'times' via Carlson (1977)'s $\cap$ operator and receives a 'subkinds' reading by individuation (Schoenfeld, 2022). These are then shifted back to instances of these subkinds in the actual world (via $\cup$, Chierchia, 1998, p.363f). On this general idea, the 'event' reading of *three times* is analogous to the '(some) instances of three subkinds' reading of *three animals* in (5).

(5) This zoo has only three animals (– lions, elephants, and turtles).

Kinds of times can be individuated along different criteria, one of which draws on tuples of light bulbs and temporal slices. Insights from the individuation of events (Grimm, 2019; Sutton, 2025) are preserved – only that the individuated entity is derived from the temporal meaning. Example (6) provides intuitive support that we talk about 'events' individuated by 'event properties' as kinds of times. Furthermore, one individual being an instance of two kinds is not unusual, looking beyond strict biological taxonomies, see (7).

(6) A: I had some good times with her! – B: What kinds of good times? – A: Well... Some parties at her place, some at mine, some times where a light went off and we burst out in laughter.

(7) Some kinds of German beer are these: Helles, Weizen, Dunkel, and unfiltered. Last Saturday, I had Hefeweizen – an unfiltered Weizen beer. Since I already knew Dunkel and Helles, I now know all of these kinds of German beer now.

One temporal unit can also count as instances of two or more kinds. This helps explain the possibility of temporal overlap in (1-b) and (2) without resorting to polysemy: The third second in (1-a) is an instance of the kind of time where light bulb *a* flashes and *also* of the kind of time where light bulb *b* flashes – see Figures 1 and 2 and example (8). The 'event' reading (8-b) of the first sentence in (1-b) licenses the continuation in the second sentence.

(8) a. $\lambda P[\forall x[time(x) \wedge light\ on\ at(x)] \longrightarrow P(x)](\lambda y[get 10.000\text{EUR} at(speaker, y)])$
= 1 iff $\forall x \in \{t_1, t_2, t_3\}[get 10.000\text{EUR} at(speaker, x)]$
'Every (distinct) time(-portion) which is such that a light turned on is also such that I got 10,000 euros in my bank account.' **(temporal) portion /** temporal int.

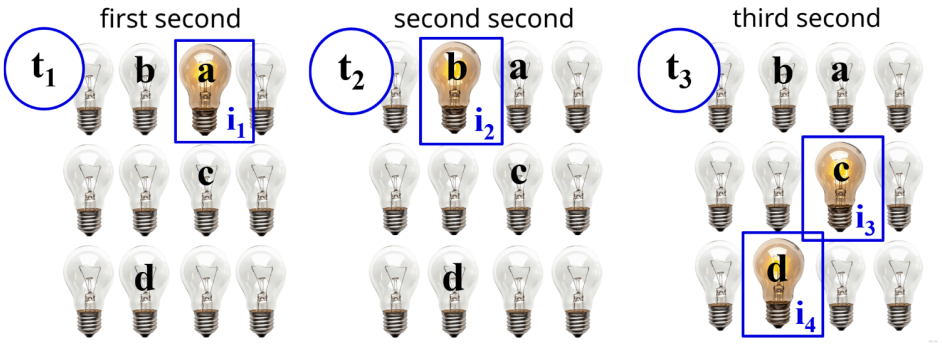



Figure 1: Instances of kinds of times

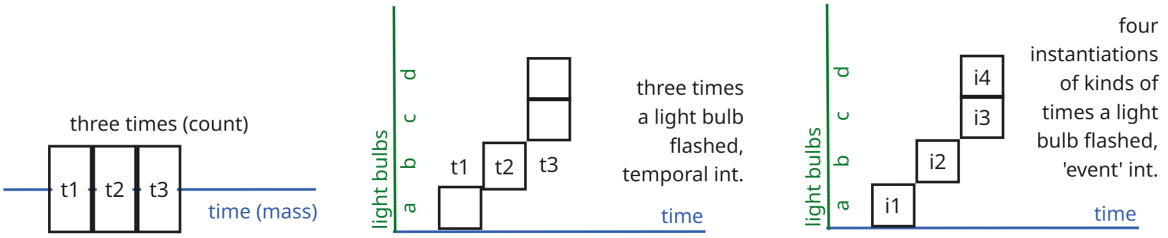



Figure 2: Different ways of counting times

b. $\lambda P[\forall x \exists k[[^{\cup}k(x) \wedge (k \sqsubseteq {}^{\cap}times)] \wedge light\ on\ at(x)] \longrightarrow P(x)]$
$(\lambda y[get 10.000\text{EUR} at(speaker, y)])$
= 1 iff $\forall x \in \{i_1, i_2, i_3, i_4\}[get 10.000\text{EUR} at(speaker, x)]$
'Every instance of a (distinct) (sub-)kind of times which is such that a light turned on is also such that I got 10,000 euros in my bank account.' **instances of kinds** / 'event int.'

This account also helps to explain why 'event' readings are associated with restrictions as in '*times at which p*', (3) and (4): Restricting plural count nouns, plus world knowledge, *generally* facilitates kind readings – see (9), given that beers can only win prices as (instances of) kinds.

(9) I had three beers which have won a price. ?? 3 portions / ✓ instances of 3 kinds

Similarly, the indefinite *a light* makes the kinds of times which are individuated also by light bulbs salient. We propose that the 'instance of kind' reading is always available, but strongly dispreferred in regular count contexts. Hence, the 'event' reading is dispreferred in (3) and (4). Suitable restrictions on 'which kind of time' (together with context) facilitate sub-kind formation. In other words, what we count on 'event readings' are 'kinds of times at which *p*'. These are non-overlapping even given temporal overlap: They do not overlap (abstractly speaking) with respect to the light bulb. Such restrictors appear in all attempts to show that *times* has 'event' readings – like Landman (2008)'s (8) and (9) or Rothstein (1995)'s '*every time I had dinner with him*.'

**§4 Significance.** Different presumed 'event properties' are non-equal on our account: The temporal dimension is the lexical fabric while all other properties are attributed to temporal portions

of this fabric or help dividing sub-kinds thereof. 'Events' are merely our meta-linguistic way of referring to instances of kinds of times. Of course, many arguments for (Neo-)Davidsonian (1980) event semantics beyond 'event' readings of *times* have been given. Instances of individuated time-kinds will serve the same purpose as 'events' in these cases. This is so because the resulting 'event-like' entity can have spatial, role-related, activity-related, and many other desired properties. Of course, it can also be picked up in subsequent discourse and referred to by *it*. It is merely not viewed as an atomic ontological building block anymore.

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# Intuitionistic-Bayesian Semantics of Generics Based on Belief Contraction (Extended Abstract)

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## 1. Motivation

Generics are used ubiquitously in various natural languages. Cohen's theory (1999) is one of the most promising theories of generics. Cohen proposes a probabilistic account of generics. Let $Alt(K)$ be a contextually determined set of alternatives to a kind $K$. On the basis of Cohen (1999), we distinguish between two different classes of generics:

1. *Absolute Generics*: '$K$s are $F$' is true iff the probability (relative frequency) that an arbitrary $K$ satisfies $F$ is greater than 0.5.

2. *Relative Generics*: '$K$s are $F$' is true iff the probability (relative frequency) that an arbitrary $K$ satisfies $F$ is greater than the probability (relative frequency) that an arbitrary member of $Alt(K)$ satisfies $F$.

(1) is an example of an absolute generic, whereas (2) is an example of a relative generic:

(1) Dogs bark.
(2) Mosquitoes carry the West Nile Virus.

(1) is a true absolute generic because the probability that an arbitrary dog barks is greater than 0.5. (2) is a true relative generic because an arbitrary *mosquito* is far more likely to carry the virus than an arbitrary *insect*. Leslie (2007, 2008) points out three shortcomings of Cohen's theory. Asher and Pelletier (2013) point out five more shortcomings of Cohen's theory. Suzuki (2020) proposed a new version of logic for generics—First-Order Logic for Generics (FLG)—that can overcome all of eight shortcomings. To accomplish this goal, Suzuki (2020) provided FLG with an intuitionistic-Bayesian semantics. Why intuitionistic-Bayesian semantics? It is well known that *the Stalnaker Thesis* (1970) can invite several versions of triviality results originating with Lewis (1976, 1986), which say that no binary conditional operator can satisfy this thesis except in some trivial cases. We do not know any probabilistic semantics of logic whose language contains an *indicative conditional connective* and that does not adopt the Stalnaker Thesis as its semantic clause, though there might be such a probabilistic semantics of logic. This problem has such a *structural* character that *any* probabilistic semantics of logic for generics based on the Stalnaker Thesis in which the logical forms of generics are given by a *universal quantifier* and some kind of *indicative conditional connective* can confront it, though we do not disagree with semantics of logic for generics in which the logical forms of generics are given neither by a universal quantifier nor by an indicative conditional connective. However, according to Morgan and Mares (1995), any superintuitionistic-Bayesian semantics of logics weaker than classical logic is immune to the triviality results. There are an infinite number of superintuitionistic logics. However, in general, it is difficult to attach any significance to the axioms peculiar to them respectively. So it is difficult to attach any importance in conceptual roles to each superintuitionistic-Bayesian semantics. Weatherson (2003) and Suzuki (2020) argue that intuitionistic-Bayesian semantics has some advantages over classical-Bayesian semantics. The most essential advantage is that, in providing FLG with its semantics, classical-Bayesian semantics can invite the triviality results, whereas intuitionistic-Bayesian semantics cannot invite them. So we adopt intuitionistic-Bayesian semantics as the semantics of FLG. The probabilistic representation of *belief contraction* in AGM plays essential roles in various fields when we try to analyze concepts and furnish solutions to problems. For example, in epistemology, Gärdenfors (1988) gives a probabilistic analysis of causality in terms of belief contraction. In philosophy of science, Suzuki (2005) gave a solution to the old evidence problem posed by Glymour (1980) to Bayesian confirmation theory in terms of belief contraction. Suzuki (2021) tried to modify the intuitionistic-Bayesian semantics of FLG by belief contraction. Asher and Morreau (1995) and others consider the validity of inferences involving generics in terms of *defeasible (default, nonmonotonic) reasoning* as follows:

(3) Dogs bark.
Benji is a dog.
Therefore, Benji barks.

We can retract this conclusion when we learn that Benji is a basenji. Basenjis do not tend to bark, and only when they are happy, it makes a sound similar to yodeling, but otherwise it hardly makes a noise and does not even howl.

(4) Mosquitoes carry the West Nile Virus.
Buzzy is a mosquito.
Therefore, Buzzy carries the West Nile Virus.

We can also retract the conclusion of (4). Suzuki (2020) did not discuss the relation between defeasibility and genericity. Though Suzuki (2021) introduced the notion of belief contraction to analyze genericity, we were not able to discuss adequately the relation between defeasibility and genericity on the basis of belief contraction. The aim of this paper is to revise the semantics of FLG in terms of the relation between defeasibility and genericity on the basis of belief contraction.

## 2. Language of FLG

We would like to summarize with modifications only the part of Suzuki (2020) necessary for the argument of this paper. We define the language $\mathscr{L}_{\mathsf{FLG}}$ of FLG as follows:

**Definition 1 (Language of FLG)** *Let $\mathscr{V}$ denote a set of individual variables, $\mathscr{C}$ a set of individual constants, and $\mathscr{P}$ a set of predicate symbols. The language $\mathscr{L}_{\mathsf{FLG}}$ of* FLG *is given by the following BNF grammar:*

$$t ::= x \mid a,$$
$$\varphi ::= F_i(t) \mid \tilde{F}_m(t) \mid t = t' \mid \bot \mid \varphi \wedge \psi \mid \varphi \vee \psi \mid \varphi \supset \psi \mid \varphi \to \psi \mid \varphi \Rightarrow \psi \mid \varphi \Rrightarrow \psi \mid \forall x\varphi \mid \exists x\varphi,$$

*where $x \in \mathscr{V}$, $a \in \mathscr{C}$, $F_{i\in\{1,2,\ldots,m\}}, \tilde{F}_m \in \mathscr{P}$, and where there are* neither nestings of $\Rightarrow$ nor those of $\Rrightarrow$. *The negation $\neg\varphi$ of $\varphi$ is defined as follows: $\neg\varphi := \varphi \supset \bot$. $\tilde{F}_m$ is an $(F_1, F_2, \ldots, F_m)$-membered* superordinate predicate symbol of $F_{i\in\{1,2,\ldots,m\}}$. *We suppose that, for any $F_{i\in\{1,2,\ldots,m\}} \in \mathscr{P}$, there is an $(F_1, F_2, \ldots, F_m)$-membered superordinate predicate symbol $\tilde{F}_m \in \mathscr{P}$ of $F_{i\in\{1,2,\ldots,m\}}$. $\top$ and $\equiv$ (material equivalence) are introduced by the standard definitions. We interpret $\supset$ as a material implication, $\to$ as an* indicative conditional connective, $\Rightarrow$ *as an* absolute generic conditional connective, *and $\Rrightarrow$ as a* relative generic conditional connective. *The set of all well-formed formulae of $\mathscr{L}_{\mathsf{FLG}}$ is denoted by $\Phi_{\mathscr{L}_{\mathsf{FLG}}}$.*

**Example 1 (Superordinate Predicate Symbol)** *Superordinate predicate symbols are necessary for relative generics. In the situation of (2) [Mosquitoes carry the West Nile Virus.], in Cohen's theory $Alt(mosquito) = \{butterfly, mosquito, flea, \ldots, grasshopper\}$, whereas in* FLG *'insect' is a (butterfly,mosquito, flea,. . . ,grasshopper)-membered superordinate predicate symbol. This example may be inaccurate from a taxonomic point of view. We just suppose in* FLG *that appropriate superordinate predicate symbols exist.*

Let $D(x)$ denote '$x$ is a dog' and $B(x)$ '$x$ barks'. Then the FLG-logical form of (1) is as follows:

(5) $\forall x(D(x) \Rightarrow B(x))$.

Let $I_1(x)$ denote '$x$ is a mosquito', $C(x)$ '$x$ carries the West Nile Virus', and $\tilde{I}_m$ $(I_1, I_2, \ldots, I_m)$-membered superordinate predicate symbol of $I_{i\in\{1,2,\ldots,m\}}$. Then the FLG-logical form of (2) is as follows:

(6) $\forall x(I_1(x) \Rrightarrow C(x))$.

## 3. Semantics of FLG: Superordinate Intuitionistic Conditional Probability Function

We introduce an *intuitionistic conditional probability function* $\mathbf{P}_I : \Phi_{\mathscr{L}_{\mathsf{FLG}}} \times \wp(\Phi_{\mathscr{L}_{\mathsf{FLG}}}) \longrightarrow [0,1]$ that satisfies Conditions 1–11 below (Leblanc and Morgan (1983), Morgan and Mares (1995)) for any $\varphi, \psi, \chi \in \Phi_{\mathscr{L}_{\mathsf{FLG}}}$ and for any $\Gamma \in \wp(\Phi_{\mathscr{L}_{\mathsf{FLG}}})$:

*Condition 1* $0 \leq \mathbf{P}_I(\varphi, \Gamma) \leq 1$,
*Condition 2* If $\varphi \in \Gamma$, then $\mathbf{P}_I(\varphi, \Gamma) = 1$,
*Condition 3* $\mathbf{P}_I(\varphi, \{\psi\} \cup \Gamma) \times \mathbf{P}_I(\psi, \Gamma) = \mathbf{P}_I(\psi, \{\varphi\} \cup \Gamma) \times \mathbf{P}_I(\varphi, \Gamma)$,
*Condition 4* $\mathbf{P}_I(\varphi \to \psi, \Gamma) = \mathbf{P}_I(\psi, \{\varphi\} \cup \Gamma)$ (*the Stalnaker Thesis*),
*Condition 5* $\mathbf{P}_I(\varphi \wedge \psi, \Gamma) = \mathbf{P}_I(\varphi, \{\psi\} \cup \Gamma) \times \mathbf{P}_I(\psi, \Gamma)$,
*Condition 6* $\mathbf{P}_I(\varphi, \{\psi, \chi\} \cup \Gamma) = \mathbf{P}_I(\varphi, \{\psi \wedge \chi\} \cup \Gamma)$,
*Condition 7* $\mathbf{P}_I(\varphi, \{\psi \vee \chi\} \cup \Gamma) = \mathbf{P}_I(\varphi, \{\psi\} \cup \Gamma) \times \mathbf{P}_I(\varphi, \{\chi, \psi \to \varphi\} \cup \Gamma)$,
*Condition 8* $\mathbf{P}_I(\varphi, \{\bot\} \cup \Gamma) = 1$,
*Condition 9* $\mathbf{P}_I(\forall x\varphi, \Gamma) = \lim_{n\to\infty} \mathbf{P}_I(\varphi'_1 \wedge \varphi'_2 \wedge \cdots \wedge \varphi'_n, \Gamma)$, where $\varphi'_i$ are substitution instances of $\forall x\varphi$.
*Condition 10* $\mathbf{P}_I(\varphi, \{\exists x\psi\} \cup \Gamma) = \lim_{n\to\infty} \mathbf{P}_I(\varphi, \{\psi'_1 \vee \psi'_2 \vee \cdots \vee \psi'_n\} \cup \Gamma)$,
where $\psi'_i$ are substitution instances of $\exists x\psi$.
*Condition 11* For any $t, t'$, $\mathbf{P}_I(t = t', \Gamma) = 1$ iff $\mathbf{P}_I(\varphi, \Gamma) = \mathbf{P}_I(\varphi', \Gamma)$,
where $\varphi'$ is obtained from $\varphi$ by replacing $t$ in zero or more (but not necessarily all) places by $t'$.

Then we introduce a *superordinate* intuitionistic conditional probability function $\mathbf{P}^S_I : \Phi_{\mathscr{L}_{\mathsf{FLG}}} \times \wp(\Phi_{\mathscr{L}_{\mathsf{FLG}}}) \longrightarrow [0,1]$ that satisfies not only Conditions 1–11 but also Condition 12 below, which asserts that $F_1, F_2, \ldots, F_m$ (e.g., 'butterfly', 'mosquito', 'flea', ..., 'grasshopper' in (2)) are exhaustive and mutually exclusive predicate symbols:

*Condition 12 ($(F_1, F_2, \ldots, F_m)$-Membered Superordinate Predicate Symbol $\tilde{F}_m$)*
For any $i, j \in \{1, 2, \ldots, m\}$, $\mathbf{P}^S_I(\forall x((F_1(x) \vee F_2(x) \vee \cdots \vee F_m(x)) \equiv \tilde{F}_m(x)) \wedge \neg\exists x(F_i(x) \wedge F_j(x)), \Gamma) = 1$.

## 4. Semantics of FLG: Diachronic Superordinate Intuitionistic Conditional Probability Function

Gärdenfors (1988) classifies belief changes into the following three types: *expansion*, *contraction*, and *revision*. The first type is when the epistemic attitude '$\varphi$ is indetermined' is changed into either '$\varphi$ is accepted' or '$\varphi$ is rejected'. The second is when one of the attitudes '$\varphi$ is accepted' or '$\varphi$ is rejected' is changed into '$\varphi$ is indetermined'. The third is when either '$\varphi$ is accepted' is changed into '$\varphi$ is rejected' or '$\varphi$ is rejected' is changed into '$\varphi$ is accepted'. Conditionalization (conditioning) is a method of *expansion* of a probability function. On the basis of Gärdenfors (1988, pp. 118–121), the contraction process can be represented as a function from $\mathscr{P} \times \Phi_{\mathscr{L}_{\mathsf{FLG}}}$ to $\mathscr{P}$, where $\mathscr{P}$ is the set of all probability functions. The value of such a contraction function when applied to $\mathbf{P} \in \mathscr{P}$ and $\varphi \in \Phi_{\mathscr{L}_{\mathsf{FLG}}}$ is called a contraction of $\mathbf{P}$ with respect to $\varphi$, in symbols $\mathbf{P}^-_\varphi$, which satisfies the following six postulates ($P^-1$)–($P^-6$). The first postulate is: ($P^-1$) For any $\mathbf{P} \in \mathscr{P}$ and any $\varphi \in \Phi_{\mathscr{L}_{\mathsf{FLG}}}$, $\mathbf{P}^-_\varphi$ is a probability function. The second postulate is a requirement of *success* of contraction: ($P^-2$) $\mathbf{P}^-_\varphi(\varphi, \{\top\}) < 1$ iff $\varphi$ is not 'valid in FLG'. The third postulate requires that $\mathbf{P}^-_\varphi$ be dependent not on the linguistic formulation of $\varphi$ but on its content: ($P^-3$) If $\varphi \equiv \psi$ is 'valid in FLG', then $\mathbf{P}^-_\varphi = \mathbf{P}^-_\psi$. In order to cover such a trivial case that $\varphi$ is not accepted yet in $\mathbf{P}$, the fourth postulate is necessary: ($P^-4$) If $\mathbf{P}(\varphi, \{\top\}) < 1$, then $\mathbf{P}^-_\varphi = \mathbf{P}$. The fifth postulate provides such a *recovery* condition that if $\varphi$ is first retracted from $\mathbf{P}$ and then added again by conditionalization, one should come back to the original state of belief: ($P^-5$) If $\mathbf{P}(\varphi, \{\top\}) = 1$, then $\mathbf{P}^-_\varphi(\psi, \{\varphi\}) = \mathbf{P}(\psi, \{\top\})$ for any $\psi \in \Phi_{\mathscr{L}_{\mathsf{FLG}}}$. The probability proportions among well-formed formulae that imply $\varphi \in \Phi_{\mathscr{L}_{\mathsf{FLG}}}$ are the same before and after conditionalization. The sixth postulate requires that contraction have a similar property: ($P^-6$) If $\mathbf{P}^-_{\varphi\wedge\psi}(\neg\varphi, \{\top\}) > 0$, then $\mathbf{P}^-_\varphi(\chi, \{\neg\varphi\}) = \mathbf{P}^-_{\varphi\wedge\psi}(\chi, \{\neg\varphi\})$ for any $\chi \in \Phi_{\mathscr{L}_{\mathsf{FLG}}}$. Independently of $-$, we construct a contraction function $\blacktriangledown : \mathscr{P} \times \Phi_{\mathscr{L}_{\mathsf{FLG}}} \to \mathscr{P}$ by means of a belief revision function, an ordinal family for a conditional probability function, and probability mixture.[1] Then we define the semantic entailment in FLG (Definition 2 below) not by $-$ but by $\blacktriangledown$, and

[1] Because of space limitations, we cannot provide the details of its construction. For the details, see Suzuki (2021, pp. 7–9) and Gärdenfors (1988, pp. 231–233).

then prove Proposition 1 below that the pair of $\blacktriangledown$ and the semantic entailment in FLG satisfies $(P^{-}1)$–$(P^{-}6)$. So because the definition of the semantic entailment in FLG does not necessitate –, neither $(P^{-}2)$ nor $(P^{-}3)$ involves circularity. Asher and Pelletier (2013) point out that, although the proposed interpretation of probability in Cohen's (1999) theory presupposes the existence of admissible histories, it does not express this presupposition explicitly. So Suzuki (2020) expressed it formally as follows: When $\mathscr{U}$ denotes a set of *moments (instants)*, via $\blacktriangledown$, we introduce a *diachronic* superordinate intuitionistic conditional probability function $\mathbf{P}_I^{S(u)}$ : $\Phi_{\mathscr{L}_{\mathsf{FLG}}} \times \wp(\Phi_{\mathscr{L}_{\mathsf{FLG}}}) \times \mathscr{U} \longrightarrow [0,1]$ that satisfies such Conditions 13 and 14 below. These conditions, which are the main conditions for FLG, add to Cohen's distinction of absolute/relative generics the requirement that the tendency of $F$s tendency to be $G$ (e.g., the tendency of dogs to bark in (1) and the tendency of mosquitoes to carry the West Nile Virus in (2)) is not temporary but *diachronically stable*:

> *Condition 13 (Diachronic Stability in Absolute Genericity)*
> Suppose that $\mathscr{U}$ denotes the set of all moments necessary to evaluate $F(t) \to G(t)$ for any $t \in \mathscr{V} \cup \mathscr{C}$.Then $\mathbf{P}_I^{S(u_1)}(F(t) \Rightarrow G(t), \{\top\}) = 1$ for a particular $u_1 \in \mathscr{U}$ iff $((\mathbf{P}_I)^{\blacktriangledown}_{F(t)})^{S(u)}(F(t) \to G(t), \{\top\}) > ((\mathbf{P}_I)^{\blacktriangledown}_{F(t)})^{S(u)}(F(t) \to \neg G(t), \{\top\})$ for any $u \in \mathscr{U}$.

Condition 13 makes the following two points possible:

1. Because retracting $t$'s being $F$ results in retracting $t$'s particularities presupposing $t$'s being $F$ by means of the *contraction* $((\mathbf{P}_I)^{\blacktriangledown}_{F(t)})^{S(u_1)}$ of $\mathbf{P}_I^{S(u_1)}$ with respect to $F(t)$, the general and lawlike probabilistic relation expressed by an absolute generic conditional connective $\Rightarrow$ between $t$'s being $F$ and $t$'s being $G$ that the subject of $\mathbf{P}_I^{S(u_1)}$ believes in is represented.

2. By quantification over $u$, this probabilistic relation that the subject of $\mathbf{P}_I^{S(u_1)}$ believes in is diachronically stable.

We also give Diachronic Stability in Relative Genericity via $\blacktriangledown$ as follows:

> *Condition 14 (Diachronic Stability in Relative Genericity)*
> Suppose that $\mathscr{U}$ denotes the set of all moments necessary to evaluate $F(t) \to G(t)$ for any $t \in \mathscr{V} \cup \mathscr{C}$.
> Then $\mathbf{P}_I^{S(u_1)}(F(t) \Rrightarrow G(t), \{\top\}) = 1$ for a particular $u_1 \in \mathscr{U}$
> iff $((\mathbf{P}_I)^{\blacktriangledown}_{F(t)})^{S(u)}(F(t) \to G(t), \{\top\}) > ((\mathbf{P}_I)^{\blacktriangledown}_{\tilde{F}(t)})^{S(u)}(\tilde{F}(t) \to G(t), \{\top\})$
> for any $u \in \mathscr{U}$.

Condition 14 makes the following two points possible:

1. Because retracting $t$'s being $F$ (resp. $\tilde{F}$) results in retracting $t$'s particularities presupposing $t$'s being $F$ (resp. $\tilde{F}$) by means of the *contraction* $((\mathbf{P}_I)^{\blacktriangledown}_{F(t) \text{ (resp. } \tilde{F}(t))})^{S(u_1)}$ of $\mathbf{P}_I^{S(u_1)}$ with respect to $F(t)$ (resp. $\tilde{F}(t)$), the general and lawlike probabilistic relation expressed by a relative generic conditional connective $\Rrightarrow$ between $t$'s being $F(t)$ (resp. $\tilde{F}$) and $t$'s being $G$ that the subject of $\mathbf{P}_I^{S(u_1)}$ believes in is represented.

2. By quantification over $u$, this probabilistic relation that the subject of $\mathbf{P}_I^{S(u_1)}$ believes in is diachronically stable.

Here we define the *semantic entailment* $\Vdash_{\mathsf{FLG}}^{\mathbf{P}_I^{S(u_1)}}$ *relative to* $\mathbf{P}_I^{S(u_1)}$ as follows:

**Definition 2** ($\Vdash_{\mathsf{FLG}}^{\mathbf{P}_I^{S(u_1)}}$) *Let* $\Gamma$ *and* $\Delta$ *denote a finite set of well-formed formulae in* $\mathscr{L}_{\mathsf{FLG}}$ *and let* $\varphi$ *denote a well-formed formula in* $\mathscr{L}_{\mathsf{FLG}}$. $\Gamma \Vdash_{\mathsf{FLG}}^{\mathbf{P}_I^{S(u_1)}} \varphi$, *which reads,* '$\Gamma$ *entails* $\varphi$ *in* FLG *relative to* $\mathbf{P}_I^{S(u_1)}$', *iff* $\mathbf{P}_I^{S(u_1)}(\varphi, \Gamma \cup \Delta) = 1$ *for a particular* $\mathbf{P}_I^{S(u_1)}$ *and any* $\Delta$. *When* $\Gamma = \{\top\}$, $\Gamma \Vdash_{\mathsf{FLG}}^{\mathbf{P}_I^{S(u_1)}} \varphi$ *is written as* $\Vdash_{\mathsf{FLG}}^{\mathbf{P}_I^{S(u_1)}} \varphi$, *which reads, '*$\varphi$ *is assertable in* FLG *relative to* $\mathbf{P}_I^{S(u_1)}$'. $\Gamma \Vdash_{\mathsf{FLG}} \varphi$, *which reads,* '$\Gamma$ *validly entails* $\varphi$ *in* FLG' *iff* $\mathbf{P}_I^{S(u_1)}(\varphi, \Gamma \cup \Delta) = 1$ *for any* $\mathbf{P}_I^{S(u_1)}$ *and any* $\Delta$. *When* $\Gamma = \{\top\}$, $\Gamma \Vdash_{\mathsf{FLG}} \varphi$ *is written as* $\Vdash_{\mathsf{FLG}} \varphi$, *which reads, '*$\varphi$ *is valid in* FLG'.

We can prove the following proposition:

**Proposition 1 (Satisfaction)** $(\blacktriangledown, \Vdash_{\mathsf{FLG}}^{\mathbf{P}_I^{S(u_1)}})$ *satisfies (P*$^-$*1)–(P*$^-$*6).*

**Proof** *For the details of the proof, see Suzuki (2021, pp. 7–9) and Gärdenfors (1988, pp. 231–233).* ■

We give the relative assertability condition of (5) and that of (6):

**Proposition 2 (Relative Assertability Conditions)**

$\Vdash_{\mathsf{FLG}}^{\mathbf{P}_I^{S(u_1)}} \forall x(D(x) \Rightarrow B(x))$ *for a particular* $\mathbf{P}_I^{S(u_1)}$
*iff for any* $u \in \mathscr{U}$,
$(((\mathbf{P}_I)^{\blacktriangledown}_{D(t_1)})^{S(u)}(B(t_1), \{D(t_1)\}) > ((\mathbf{P}_I)^{\blacktriangledown}_{D(t_1)})^{S(u)}(\neg B(t_1), \{D(t_1)\}))$ *and*
$(((\mathbf{P}_I)^{\blacktriangledown}_{D(t_2)})^{S(u)}(B(t_2), \{D(t_2)\}) > ((\mathbf{P}_I)^{\blacktriangledown}_{D(t_2)})^{S(u)}(\neg B(t_2), \{D(t_2)\}))$ *and*... *and*
$(((\mathbf{P}_I)^{\blacktriangledown}_{D(t_n)})^{S(u)}(B(t_n), \{D(t_n)\}) > ((\mathbf{P}_I)^{\blacktriangledown}_{D(t_n)})^{S(u)}(\neg B(t_n), \{D(t_n)\}))$ *and*....

$\Vdash_{\mathsf{FLG}}^{\mathbf{P}_I^{S(u_1)}} \forall x(I_1(x) \Rrightarrow C(x))$ *for a particular* $\mathbf{P}_I^{S(u_1)}$

*iff for any* $u \in \mathscr{U}$,
$(((\mathbf{P}_I)^{\blacktriangledown}_{I_1(t_1)})^{S(u)}(C(t_1), \{I_1(t_1)\}) > ((\mathbf{P}_I)^{\blacktriangledown}_{\tilde{I}_m(t_1)})^{S(u)}(C(t_1), \{\tilde{I}_m(t_1)\}))$ *and*
$(((\mathbf{P}_I)^{\blacktriangledown}_{I_1(t_2)})^{S(u)}(C(t_2), \{I_1(t_2)\}) > ((\mathbf{P}_I)^{\blacktriangledown}_{\tilde{I}_m(t_2)})^{S(u)}(C(t_2), \{\tilde{I}_m(t_2)\}))$ *and*... *and*
$(((\mathbf{P}_I)^{\blacktriangledown}_{I_1(t_n)})^{S(u)}(C(t_n), \{I_1(t_n)\}) > ((\mathbf{P}_I)^{\blacktriangledown}_{\tilde{I}_m(t_n)})^{S(u)}(C(t_n), \{\tilde{I}_m(t_n)\}))$ *and*....

## 5. Defeasible Reasoning and Belief Contraction

We return to (3). Suppose that Benji ($t_1$) is a basenji. Since basenjis are dogs that do not tend to bark, $D(t_1) \wedge \neg B(t_1)$ holds. Contrary to Proposition 2, if we focused not on $((\mathbf{P}_I)^{\blacktriangledown}_{D(t_1)})^{S(u)}$ but on $\mathbf{P}_I^{S(u)}$ in the relative assertability condition,

$$\mathbf{P}_I^{S(u)}(B(t_1), \{D(t_1)\}) > \mathbf{P}_I^{S(u)}(\neg B(t_1), \{D(t_1)\})$$

would contradict $D(t_1) \wedge \neg B(t_1)$. But by means of Proposition 2 the corresponding part of the relative assertability condition of (5) is given in fact by

$$((\mathbf{P}_I)^{\blacktriangledown}_{D(t_1)})^{S(u)}(B(t_1), \{D(t_1)\}) > ((\mathbf{P}_I)^{\blacktriangledown}_{D(t_1)})^{S(u)}(\neg B(t_1), \{D(t_1)\}),$$

which does not contradict $D(t_1) \wedge \neg B(t_1)$. In this way, because retracting $t_1$'s being $D$ results in retracting $t_1$'s being a basenji presupposing $t_1$'s being $D$ by means of the contraction $((\mathbf{P}_I)^{\blacktriangledown}_{D(t_1)})^{S(u)}$ of $\mathbf{P}_I^{S(u)}$ with respect to $D(t_1)$, the relative assertability condition of (5) does not contradict $D(t_1) \wedge \neg B(t_1)$ implied by the fact that $t_1$ is a basenji. So we can retract the conclusion of (3). We can also consider (4) in the same way as (3). Such defeasible reasoning as (3) and (4) directly follows from Proposition 2:

**Corollary 1 (Defeasible Reasoning)**

$\{\forall x(D(x) \Rightarrow B(x)), D(t_1) \wedge \neg B(t_1)\} \nVdash_{\mathsf{FLG}} \bot$,

$\{\forall x(I_1(x) \Rrightarrow C(x)), I_1(t_1) \wedge \neg C(t_1)\} \nVdash_{\mathsf{FLG}} \bot$.

## 6. Concluding Remarks

Asher and Morreau (1995) and others consider the validity of inferences involving generics in terms of defeasible reasoning. Suzuki (2020) did not discuss the relation between defeasibility and genericity. Although Suzuki (2021) introduced the notion of belief contraction to analyze genericity, we were not able to discuss adequately the relation between defeasibility and genericity on the basis of belief contraction. In this paper, we have revised the semantics of FLG in terms of the relation between defeasibility and genericity on the basis of belief contraction.

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# A Boolean Many-Valued Treatment of Vague Quantified Statements

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Vagueness is an important source of uncertainty in natural language, which has given rise to the famous Sorites Paradox. In the current literature, Fuzzy Theory (FT) (as developed by Zadeh (1965), Machina (1976), etc.) and Supervaluation Theory (ST) (as developed by Fine (1975), Keefe (2000), etc.) have been two main approaches to vagueness, each with its own strengths and weaknesses. In recent years, Akiba has developed a Boolean many-valued (BMV) theory on vagueness (as in Akiba (2017), (2022), (2024)), which has in some sense combined features of FT and ST. I first briefly introduce the main features of FT, ST and the BMV theory.

The main feature of FT is that it extends the classical binary truth values consisting of 1 (representing "true") and 0 (representing "false") to an infinite set of truth values, represented by the real numbers on the interval $[0, 1]$. The many-valued approach for truth values enables FT to represent different levels of truthfulness of vague statements. Moreover, logical connectives can be represented as truth functions, thus satisfying the principle of compositionality.

As pointed out by some ST scholars, a serious weakness of FT is that it fails to correctly handle certain vague statements involving the borderline cases of the same single concept such as "tall" (hereinafter called "internal penumbral connections") or two different concepts such as "tall" and "short" (hereinafter called "external penumbral connections").

The main feature of ST is that it assumes a precisification process. This process starts from a base point (represented by @) which contains some given facts and uncertainties about the relationship between the relevant individuals and the relevant vague predicates. The precisification process then turns all these uncertainties into precisified statements about the aforesaid relationship with the classical bivalent truth values. To obtain reasonable results, the precisified statements thus obtained must be consistent with the given facts as well as the logical, conceptual, and linguistic framework of our language. The outputs of such a process are called "admissible precisifications" (APs).

Based on APs, ST defines the notions of "supertrue", "superfalse" and "no truth value", which are the 3 truth values of vague statements under ST. By using these notions, one can then properly handle the aforesaid penumbral connections. On the other hand, under ST logical connectives are no longer truth functions, which may be seen as a weakness from the perspective of compositionality.

Akiba's BMV theory has features similar to each of FT and ST. But it is also distinct from these two theories in certain important respects. Like FT, BMV theory assumes a many-valued approach for the truth values of vague statements. But unlike FT which assumes a linearly ordered set of truth values, i.e. [0, 1], BMV theory assumes that the truth value set forms a Boolean algebra.

Like ST, BMV theory also assumes a precisification process as well as the notion of APs. But unlike ST which uses the notions of "supertrue" and "superfalse", BMV theory views APs as possible worlds. All these APs form a "precisification space", represented by $W$. To simplify matters, in this paper I will assume that the precisification process is accomplished in just one step and is thus called "one-step precisification". I will also leave out @ from $W$. By doing so, the elements of $W$ are then just like elements of an ordinary set without any internal structure.

According to the theory of Boolean algebras, the power set of a given set with more than 2 members forms a Boolean algebra with non-linear structure. If we now define the truth value of a vague statement as the set of APs in which the precisified statement is true, then the truth values of vague statements are subsets of $W$ and are thus members of a many-valued Boolean algebra whose domain is the power set of $W$, which have more than 2 members provided that there is more than 1 AP, and so the truth values of statements under the BMV theory essentially have a non-linear structure.

BMV theory has inherited some merits of FT and ST and overcome some of their demerits. Like FT and unlike ST, the many-valued approach enables the theory to represent different levels of truthfulness of vague statements in a straightforward way. Moreover, logical connectives can be represented as truth functions. If we assume "one-step precisification" and leave out @ from $W$ as mentioned above, then we have the following truth functions: $\|\neg p\| = -\|p\|$, $\|p \wedge q\| = \|p\| \cap \|q\|$, $\|p \vee q\| = \|p\| \cup \|q\|$ and $\|p \rightarrow q\| = -\|p\| \cup \|q\|$.

On the other hand, like ST and unlike FT, BMV theory is able to handle internal / external penumbral connections correctly. This is due to the fact that the theory adopts a non-linear Boolean structure rather than a linear structure as adopted by FT for truth values.

In this paper, I will extend the BMV theory so that it is applicable to subsentential components. To this end, I first treat unary predicates as entities of type $e(st)$, which differs from the treatment of GQT, under which unary predicates are treated as entities of type $et$. Here $s$ represents the type of possible worlds, which are just APs in this paper. Thus, a predicate is now a function which maps an individual to the set of APs in which the predicate is precisified as true of the individual. Predicates with higher arities can be treated in a similar fashion.

Under GQT, type $\langle 1 \rangle$ quantifiers and type $\langle 1, 1 \rangle$ quantifiers (i.e. determiners) have types $(et)t$ and $(et)((et)t)$, respectively. They will now be treated as functions of types $(e(st))(st)$ and $(e(st))((e(st))(st))$, respectively. Moreover, the denotations of these quantifiers of the new types resemble the classical denotations of quantifiers under GQT. For example, the denotations of the Montagovian individual $I_{Alex}$ and the determiner *every* are given below (where $a$ is an individual representing the proper name *Alex*):

$$\|I_{Alex}\| = \lambda X[\{w : a \in \{z : w \in X(z)\}\}] \qquad (1)$$

$$\|every\| = \lambda X \lambda Y[\{w : \{z : w \in X(z)\} \subseteq \{z : w \in Y(z)\}\}] \qquad (2)$$

In (1) and (2) above, the logical relations $\in$ and $\subseteq$ are constant across APs. This is the case for the crisp quantifiers (CQs) studied under GQT. But apart from CQs, we now also have vague quantifiers (VQs) such as *almost every*, *almost no*, *about n*, etc., which will be treated as quantifiers associated with logical relations that may vary across APs. To be more precise, each of these logical relations involves a special function depending

on $w$ of type $s(nt)$, where $n$ represents the type of numbers (which can be integers or real numbers, etc.).

For example, the function associated with *almost every* is $f_{almost\,every}$, which maps different APs to different intervals in the form $[c, 1]$, where $c$ is a real number larger than 0.5 but not larger than 1. For example, in one AP $w_1$, we may have $f_{almost\,every}(w_1) = [0.9, 1]$; and in another AP $w_2$, we may have $f_{almost\,every}(w_2) = [0.8, 1]$. Since the denotation below will involve the product of a non-negative integer and an interval, I now provide a formal definition for such kind of products: if $n$ is a non-negative integer and $[a, b]$ is an interval, then $n \times [a, b] = [na, nb]$. The denotation of *almost every* is given below:

$$\begin{aligned} \|almost\,every\| &= \lambda X \lambda Y[\{w : |\{z : w \in X(z)\} \cap \{z : w \in Y(z)\}| \\ &\quad \in |\{z : w \in X(z)\}| \times f_{almost\,every}(w)\}] \end{aligned} \quad (3)$$

The denotation for *almost no* differs from the above only in that $f_{almost\,every}$ is replaced by $f_{almost\,no}$, which maps different APs to different intervals in the form $[0, c]$, where $c$ is a real number smaller than 0.5 but not smaller than 0.

Moreover, the current framework can further be extended to cater for vague quantified statements containing binary predicates by using the case extension operators introduced in Keenan (1987) given below (where $Q$ and $R$ are variables of type $\langle 1 \rangle$ quantifiers and binary predicates, respectively):

$$Q_{nom} = \lambda R \lambda y[Q(\lambda x[R(x, y)])] \quad (4)$$

$$Q_{acc} = \lambda R \lambda x[Q(\lambda y[R(x, y)])] \quad (5)$$

For illustration, consider a model consisting of 12 individuals $a$ (representing *Alex*), $b, g_1, \ldots, g_{10}$, the precisification space $W = \{w_1, \ldots, w_5\}$, a (unary) crisp predicate *girl* and a binary crisp predicate *meet* shown below:

$$\|girl\| = g_1, \ldots, g_{10} \mapsto W \quad (6)$$

$$\|meet\| = (a, g_1), \ldots, (a, g_7), (b, g_1), \ldots, (b, g_9) \mapsto W \quad (7)$$

as well as a function $f_{almost\,every}$ with the following definition:

$$f_{almost\,every} = w_1 \mapsto \{1\}; w_2 \mapsto [0.9, 1]; w_3 \mapsto [0.8, 1]; w_4 \mapsto [0.7, 1]; w_5 \mapsto [0.6, 1] \quad (8)$$

By using the definitions and denotations given above, we can compute the truth value of the statement representing "Alex met almost every girl" with respect to the given model as follows:

$$\|I_{Alex}(almost\,every(girl)_{acc}(meet))\| = \{w_4, w_5\} \quad (9)$$

This result means that the above vague quantified statement is precisified as true in the two APs $w_4$ and $w_5$ given above.

In the traditional studies on vagueness, the examples of penumbral connections and Sorites Paradox mostly involve vague predicates. A merit of the current framework is that it can also handle penumbral connections and Sorites Paradox involving vague quantifiers

properly. For example, it can be shown that the following statement representing "Almost every girl sang and almost no girl sang" involving external penumbral connection (because $almost\,every(girl)(sing)$ and $almost\,no(girl)(sing)$ stand in a contrary relation subject to the condition that *girl* does not denote an empty set) must have truth value $\emptyset$ with respect to any model in which *girl* does not denote an empty set:

$$almost\,every(girl)(sing) \wedge almost\,no(girl)(sing) \qquad (10)$$

I next turn to the topic of monotonicity, an important property of quantifiers to which Peters & Westerståhl (2006) devoted a whole chapter. Since monotonicity is related to the inference patterns of quantified statements, I first introduce the "bottomline preservation notion" of semantic entailments in Akiba (2024) (with some adaptations). We say that a set of premises $\Gamma$ (semantically) entails a statement $p$, in symbols $\Gamma \models p$, if and only if

$$\bigcap_{\gamma \in \Gamma} \|\gamma\| \subseteq \|p\| \qquad (11)$$

Equipped with the above notion and the definitions of monotonicity (which can be found in the GQT literature such as Peters & Westerståhl (2006)), we can then determine and prove the monotonicity of quantifiers, including VQs. For example, it can be shown that *almost every* is left non-monotonic and right increasing, *almost no* is left non-monotonic and right decreasing, while *about n* is left and right non-monotonic.

Monotonicity inferences have a close relation with syllogisms. The monotonicity of VQs can give rise to new types of syllogisms. Peterson (2000) has studied a number of "intermediate quantifiers" including *almost every* and proposed a series of new syllogisms involving these quantifiers. For example, the following APP-1 syllogism proposed by Peterson (2000) is in fact a monotonicity inference based on the right increasing property of *almost every*:

$$\{every(Y)(Y'), almost\,every(X)(Y)\} \models almost\,every(X)(Y') \qquad (12)$$

According to Keenan & Faltz (1985), quantifiers form Boolean algebras under which quantifiers of the same type can enter into the $\leq$ relation. Such a relation can be defined in a pointwise fashion as follows: let $Q$ and $Q'$ be quantifiers with $n$ arguments. Then we have $Q \leq Q'$ if and only if for any $X_1, \ldots, X_n$ of the suitable arities, we have the following:

$$Q(X_1, \ldots, X_n) \models Q'(X_1, \ldots, X_n) \qquad (13)$$

Sometimes such relations are subject to the condition that a certain argument does not denote an empty predicate (which is called "existential import"). For example, it can be shown that we have the following relation:

$$almost\,every \leq most \qquad \begin{array}{l}\text{(subject to the existential import}\\ \text{of the left arguments of both quantifiers)}\end{array} \qquad (14)$$

Quantifiers usually play the role of functions in a quantified statement. But a quantifier can also in some sense serve as the argument of a logical connective. We can thus talk about the monotonicity of these logical connectives. In fact, it is not difficult to show the following monotonicity of the main logical connectives: $\neg$ is decreasing in its sole

argument, $\wedge$ and $\vee$ are both left and right increasing, $\rightarrow$ is left decreasing and right increasing. Combining the monotonicity of $\rightarrow$ with (14), we obtain the following two valid inference patterns (in what follows, $\|exist\| = E$, the set consisting of the individuals in a particular model, and $some(X)(exist)$ is the existential import which is treated as an additional premise):

$$\{some(X)(exist), most(X)(Y) \rightarrow q\} \models almost\,every(X)(Y) \rightarrow q \qquad (15)$$

$$\{some(X)(exist), p \rightarrow almost\,every(X)(Y)\} \models p \rightarrow most(X)(Y) \qquad (16)$$

Here is an exemplification of (15): "There exists some participant. If most participants are absent, the activity will be cancelled. Therefore, if almost every participant is absent, the activity will be cancelled."

What's more, in an iterated quantifier, a quantifier with narrower scope can be seen as appearing at an argument position of another quantifier with wider scope. For example, in the expression $every(D(X)_{acc}(R))(Y)$, where $D$ and $R$ are variables of a determiner and a binary predicate respectively, $D$ appears in the left argument position of *every*. Combining the left decreasing property of *every* with (14), we obtain the following valid inference pattern:

$$\{some(X)(exist), every(most(X)_{acc}(R))(Y)\} \models every(almost\,every(X)_{acc}(R))(Y) \qquad (17)$$

Here is an exemplification of the above: "There exists some problem. Everybody who can solve most problems will get a prize. Therefore, everybody who can solve almost every problem will get a prize."

In conclusion, I have developed a framework to handle vague quantified statements by combining the ideas of Akiba's BMV theory with GQT. While my treatment of APs as possible worlds makes my framework look similar to intensional GQT, and my treatment of VQs as involving functions depending on $w$ resembles the standard GQT treatment of context-dependent quantifiers, my framework has its distinctive theoretical yield.

First, in standard intensional GQT, $W$ represents the set of possible worlds structured by an accessibility relation. The truth value of a statement is a classical bivalent truth value localized to a specific world. In contrast, my framework treats $W$ as a set of APs forming a Boolean algebra. The semantic value of a quantified statement is not a localized bivalent truth value, but an element of this global algebra. The use of elements of a BMV structure as truth values makes my framework distinctive from the mainstream theories on formal semantics, including intensional GQT.

Second, even if one views APs as a kind of context, APs are different from the mere notion of context in that they are related in a non-linear Boolean algebra. It is precisely this non-linear BMV structure that enables my framework (being an extension of Akiba's BMV theory) to handle the Sorites Paradox and penumbral connections at the same time. It is doubtful whether a theory that uses the mere notion of context is able to handle the Sorites Paradox or penumbral connections.

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# Estimating the positive threshold of gradable adjectives with implicit comparison

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**Overview** With the paradigm of Spector et al. (2025), we conducted a crowdsourced behavioral experiment, investigating how native Chinese speakers interpret the **positive** use of gradable adjectives in **implicit comparison** constructions and estimate the positive threshold. Our results provided support for the Bayesian model over the simple model.

**1. Introduction** In the positive use of gradable adjectives, the literal meaning (see (1a)) is that a measurement under discussion (e.g., Lucy's height in (1), represented as $h_a$) reaches (i.e., is as high as) a contextually relevant positive threshold ($s$ in (1)).

In a **simple** model (see (1b)), the probability of the literal meaning (i) increases with $h_a$ and (ii) decreases with $s$. Thus the utterance of sentence (1) should (i) raise the estimated value of $h_a$ and (ii) lower that of $s$, respectively.

In a **Bayesian** model (see (1c), see e.g., Lassiter and Goodman 2017), a speaker aims to be informative so that sentence (1) would not be uttered if $s$ is not high enough itself. Thus the utterance of (1) should first push upward the estimated value of $s$ (contrary to the prediction of the simple model in (1b)), which in turn raises the estimated value of $h_a$.

(1) Anna is tall. The positive use of gradable adjective *tall*
   a. Literal meaning: $h_a \geq s$
   b. Prediction of a simple model: $E(h_a|h_a \geq s) \geq E(h_a)$ and $E(s|h_a \geq s) \leq E(s)$
   c. Predict. of a Bayesian model: $E(h_a|h_a \geq s) \geq E(h_a)$ and $E(s|h_a \geq s) \geq E(s)$

Spector et al. (2025) point out that both the simple model and the Bayesian model make the same prediction for (2), and their experimental findings confirmed this prediction.

(2) Anna, Beth, and Cara are tall.
   Both models: $E(h_a|h_a \geq s, h_b \geq s, h_c \geq s) \leq E(h_a|h_a \geq s, h_b \geq s) \leq E(h_a|h_a \geq s)$
   a. Simple model: each sentence $h_i \geq s$ pushes $s$ downward.
   b. Bayesian model: the informativity can be compensated by the increase in the number of individuals, leading to a weaker upward push on $s$.

For (3), it seems that the simple model's prediction (see (3a)) was not supported by Spector et al. (2025)'s experimental results, thus favoring the Bayesian model.

(3) Beth is not tall, and Anna is tall.
   a. Simple model: $E(h_a|h_b < s, h_a \geq s) \geq E(h_a|h_a \geq s)$ (Spector et al. 2025)
   ($h_b < s$ pushes $s$ upward, which further pushes $h_a$ upward)
   b. Bayesian: maximal informativity is achieved with a very low or very high $s$.

However, there is a potential way to save the simple model: Each instance of a gradable adjective in its positive use may be associated with an independent threshold (see the empirical support in (4)). Under this view, the literal meaning of (3) is as in (5), and the simple model does not generate the prediction in (3a). In other words, Spector et al. (2025)'s results cannot break the tie between the simple model and the Bayesian model.

(4) a. He is tall and not tall. (e.g., Alxatib and Pelletier 2009)
   b. Everyone in my family is tall. (Context: my son is 2.) (see Kennedy 2007b)

(5) Alternative analysis for the literal meaning of (3): $h_b < s_2, h_a \geq s_1$

The current project builds on existing observations about **implicit comparison**.

In English, the distinction between implicit and explicit comparison is reflected morphologically, semantically, and pragmatically (Kennedy 2007a, Sawada 2009).

Morphologically, implicit comparison uses the positive form of an adjective (e.g., *tall* in (6a)), whereas explicit comparison uses the comparative form (e.g., *taller* in (6b)).

Semantically, only explicit comparison can be felicitous in a 'crisp judgment' context (e.g., the difference is tiny) and take an optional numerical differential (e.g., *1 cm taller*).

Pragmatically, Sawada (2009) observes that implicit comparison in (6a) leads to two inferences absent from (6b): (i) Beth is definitely not tall; (ii) Anna is not definitely tall.

(6) a. Compared to Beth, Anna is tall. **Implicit comparison**: $h_a \geq s > h_b$
   (i) Literal meaning: Anna's height reaches a contextually relevant positive threshold $s$ that Beth's height doesn't reach, i.e., $h_a \geq s > h_b$.
   (ii) According to Sawada (2009), pragmatically, if *Anna is tall* is true, then due to the economy principle, the utterance of *Anna is tall* is preferred to (6a). Thus the utterance of (6a) suggests that *Anna is tall* is likely to be false, i.e., Anna is not definitely tall, which means $s_0 > h_a \geq s > h_b$ ($s_0$ stands for the positive threshold in interpreting *Anna is tall*).

   b. Anna is taller than Beth. **Explicit comparison**: $h_a > h_b$
   (No comparison with a contextual threshold is involved.)

In Chinese, the positive and comparative forms of gradable adjectives are morphologically identical, so morphology does not distinguish implicit from explicit comparison.

(7) a. Anna zhǎng dé gāo
   Anna grow LINKER tall
   'Anna is tall.' **Positive use of *gāo*** ('tall')

   b. Anna zhǎng dé bǐ Beth gāo (yī límǐ)
   Anna grow LINKER than Beth tall one cm
   'Anna is (1 cm) taller than Beth.' **Comparative use of *gāo*** ('taller')

Then based on the semantic criteria above, Zhang and Zhang-Yukun (2026) identify two distinct implicit comparison constructions in Chinese: with vs. without *gèng* ((8b) vs. (8a)). Neither (8a) nor (8b) is compatible with a 'crisp judgment' context or an optional numerical differential.

(8) a. gēn Beth xiāng-bǐ Anna hěn gāo
   with Beth compare Anna (very) tall
   'Compared with Beth, Anna is tall.' $h_a \geq s > h_b$

   b. Anna bǐ Beth gèng gāo
   Anna COMP Beth tall
   'Compared with Beth, Anna's height reaches a new level.' $h_a \geq s > h_b$
   (i.e., there is a contextually relevant positive threshold (i.e., a new level) that Anna's height reaches, but Beths's doesn't.)

Crucially, although the English translation of (8b) seems close to the meaning of (9), (8b) (along with its English translation) is incompatible with a numerical differential or a 'crisp judgment' context, unlike the explicit comparison sentence (9).

(9) Anna is even (1 cm) taller than Beth. **Explicit comparison with *even***

a. (9) is compatible with a numerical differential.

b. (9) is true if B is 1.9 m tall, and A is 1.91 m tall. ✓ 'crisp judgment' context.

Both (8a) and (8b) share the same literal meaning: $h_a \geq s > h_b$. Thus, under a simple model, the two utterances should yield the same pragmatic inferences and, consequently, the same estimated value of $h_a$. In contrast, the Baysian model predicts that the presence of *gèng*, which is often stressed and prosodically prominent, makes the utterance of (8b) more costly than (8a). Choosing (8b) therefore requires higher informativity to offset its higher cost, resulting in a higher estimated value of $h_a$ for (8b) than for (8a).

(10) a. The simple model: no significant difference between $E(h_a|(8a))$ and $E(h_a|(8b))$

b. The Bayesian model: to offset the cost of *gèng*, $E(h_a|(8b)) > E(h_a|(8a))$

**2. Methodology** We conducted our behavioral experiment on an online crowdsourcing platform, Credamo. Each participant was randomly assigned to one experimental condition in (11), reading one test sentence and two filler trials (three-digit addition and subtraction) and answering each trial by typing a number. Responses to the filler trials were used to filter out participants who completed the whole survey task with irrelevant answers.

(11) **Context and instruction**: There are three boxes, each containing 1000 tokens numbered from 1 to 1000. Three people—Fāngfāng, Lìlì, and Qíqí—each randomly draw one token from a different box. Based on the information provided below, please guess Fāngfāng's number. Try to make your guess as close as possible.

a. **Condition 1 – 'one number'**

Fāngfāng dédào yī gè dà-de shùzì
Fāngfāng obtain one CL large number
'Fāngfāng got a large number.'

b. **Condition 2 – 'two numbers'**

Lìlì hé Fāngfāng fēnbié dédào yī gè dà-de shùzì
Lìlì and Fāngfāng each obtain one CL large number
'Lìlì and Fāngfāng each got a large number.'

c. **Condition 3 – 'three numbers'**

Lìlì, Fāngfāng, hé Qíqí fēnbié dédào yī gè dà-de shùzì
Lìlì Fāngfāng and Qíqí each obtain one CL large number
'Lìlì, Fāngfāng, and Qíqí each got a large number.'

d. **Condition 4 – 'neg-pos'**

Lìlì dédao de shùzì bú dà Fāngfāng dédào de shùzì dà
Lìlì obtain REL number NEG large Fāngfāng obtain REL number large
'Lìlì's number was not large. Fāngfāng's number was large.'

e. **Condition 5 – 'implicit comparison'**

gēn Lìlì dédào de shùzì xiāng-bǐ Fāngfāng dédào de shùzì dà
with Lìlì obtain REL number compare Fāngfāng obtain REL number large
'Compared with Lìlì's number, Fāngfāng's number was large.'

f. **Condition 6 – '*gèng*-construction'**

Fāngfāng dédào de shùzì bǐ Lìlì dédào de shùzì gèng dà
Fāngfāng obtain REL number COMP Lìlì obtain REL number large

'Compared with Lìlì's number, Fāngfāng's number reached a new level.'

**3. Results** We have three findings.

1. The comparison among Conditions 1–3 replicated Spector et al. (2025)'s results and confirmed the predictions of both the simple and Bayesian models (see (2)) (see Fig. 1).

2. The significant difference between Conditions 5 and 6 confirmed the prediction of the Bayesian model (see Fig. 2).

3. The lack of a significant difference between Conditions 1 and 4 replicated Spector et al. (2025)'s finding for (3).

(12) **Summary of results**:

| **Condition** | **#Participant** | **Mean** | **SD** |
|---|---|---|---|
| Condition 1 'one number' | 915/950 | 829.03 | 169.46 |
| Condition 2 'two numbers' | 915/950 | 793.27 | 171.13 |
| Condition 3 'three numbers' | 910/950 | 773.13 | 179.06 |
| Condition 4 'neg-pos' | 909/950 | 817.70 | 145.00 |
| Condition 5 'implicit comp.' | 912/950 | 759.44 | 177.67 |
| Condition 6 'gèng' | 915/950 | 782.59 | 187.35 |

(13) ***p*-values of pairwise two-tailed *t*-tests**:

| | **Cond 1** | **Cond 2** | **Cond 3** | **Cond 4** | **Cond 5** | **Cond 6** |
|---|---|---|---|---|---|---|
| **Cond 1** | / | | | | | |
| **Cond 2** | *** | / | | | | |
| **Cond 3** | *** | .014 | / | | | |
| **Cond 4** | .125 | *** | *** | / | | |
| **Cond 5** | *** | *** | .101 | *** | / | |
| **Cond 6** | *** | .203 | .270 | *** | .007 | / |

**4. Discussion** The comparisons between Conditions 1/2/4 vs. 6 (see (12) and (13)) also support the analysis of Zhang and Zhang-Yukun (2026): $E(h_a|$*gèng*-sentence) is not necessarily upward pushed. In other words, Chinese implicit comparison with *gèng* (see (8b)) is not interpreted like an explicit comparison with the use of *even* (see (9) and Krifka 2000, Sawada 2009, Greenberg 2018, Zhang 2022, 2026).

**5. Conclusion** With the use of two implicit comparison constructions that differ in cost, we provided experimental evidence in support of the Bayesian model over the simple probabilistic model for human language comprehension.

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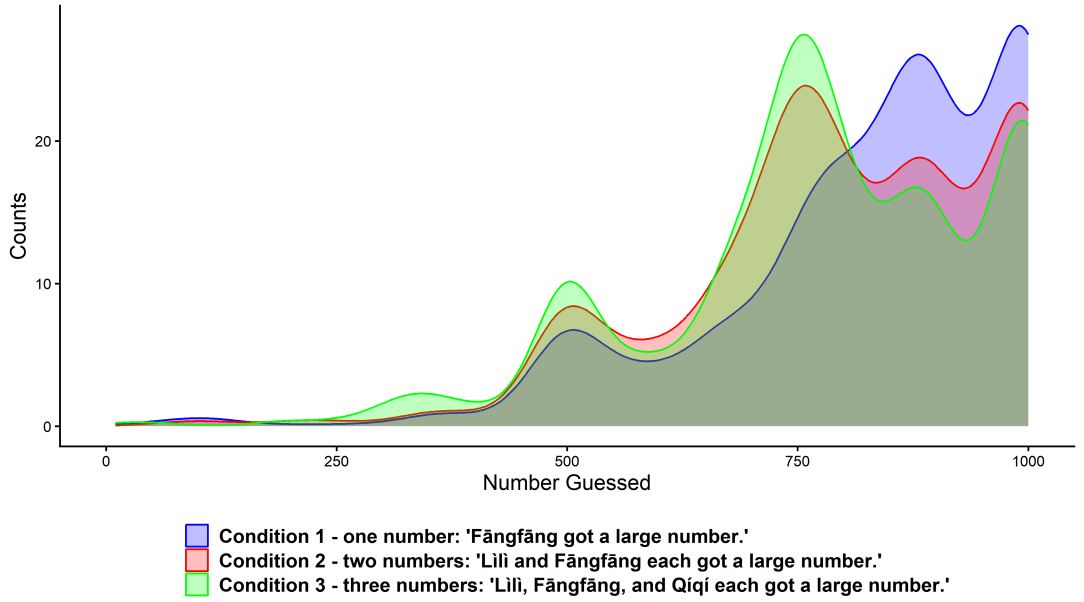



Figure 1: The mean response in Condition 1 ($M = 829.03$) is significantly higher ($p < .001$) than that in Condition 2 ($M = 793.27$), which is in turn significantly higher ($p = .014$) than that in Condition 3 ($M = 773.13$).

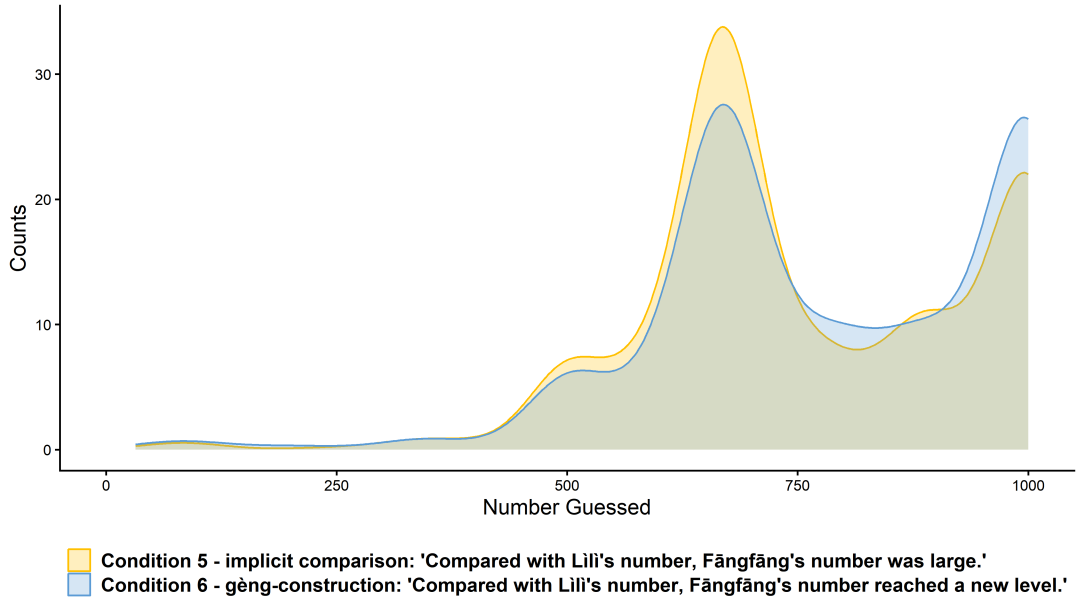



Figure 2: The mean response in Condition 5 ($M = 759.44$) is significantly lower ($p = .007$) than that in Condition 6 ($M = 782.58$).

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# A degree-semantic analysis of possessive measure phrases

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**Introduction**: Measure phrases (henceforth MPs) in a comparative construction typically involve a numeral and a measure unit in terms of their internal components, as illustrated with English in (1).

(1) a. Adam is **two centimeters** taller than Bill.
b. This door is **two inches** longer than that door.

In contrast to the paradigm in (1), a different typological pattern is presented by Mandarin Chinese (henceforth Mandarin): MPs in a comparative construction can be a numeral-classifier-noun sequence such as *liang-ge-zhitou* 'two fingers', as witnessed by (2). The sentence (2) is judged true if and only if the number of fingers that *Luxun* has exceeds the number of fingers that *Laoshe* has, and the difference is two.

(2) Luxun bi Laoshe duo **liang-ge-zhitou**.
Luxun than Laoshe much two-CL-finger
'Luxun has two more fingers than Laoshe.'

Crucially, the MP *liang-ge-zhitou* 'two fingers' in the form of a numeral-classifier-noun sequence specifies not only **the difference value** (i.e., two) but also **the dimension of comparison** (i.e., the cardinality of fingers). Moreover, as indicated by the translation and truth condition of (2), **a possession relation** holds between the measure phrase (i.e., *zhitou* 'finger') and the comparative target (i.e., *Luxun*)/ the comparative standard (i.e., *Laoshe*).

In addition to the case of inalienable possession (e.g., body parts) in (2), MPs involving alienable possession are also attested in Mandarin, as evidenced by (3):

(3) Luxun bi Laoshe duo **yi-ben-shu**.
Luxun than Laoshe much one-CL-book
'Luxun has one more book than Laoshe.'

(3) is judged true if and only if the number of books that *Luxun* has exceeds the number of books that *Laoshe* has, and the difference is one. Again, the MP *yi-ben-shu* 'one book' specifies not only **the difference value** (i.e., one) but also **the dimension of comparison** (i.e., the cardinality of books); furthermore, **a possession relation** holds between the measure phrase (i.e., *shu* 'book') and the comparative target (i.e., *Luxun*)/ the comparative standard (i.e., *Laoshe*).

Examples like (2) and (3) raise many important questions: **(a)** How do MPs (in the particular form of a numeral-classifier-noun sequence) like *liang-ge-zhitou* 'two fingers' and *yi-ben-shu* 'one book' semantically compose with linguistic elements such as the quantity adjective *duo* 'much' and comparative morpheme (if any) in the comparative? **(b)** How do we account for the possession relation between measure phrases and the comparative target/ comparative standard? This study proposes that these two puzzles can be naturally explained if the framework of degrees-as-kinds recently advocated by Scontras (2014, 2017) is adopted. Conceiving degrees as kinds (i.e., nominalized properties) crucially leaves room for encoding the observed possession relation in the semantic representation of degrees.

**Analysis**: The proposed analysis involves four ingredients: **(a)** the mappings between kinds and properties, **(b)** the semantic representation of degrees, **(c)** the semantics of quantity adjectives and comparatives, and **(d)** the semantics of measure phrases.

First, we assume with Chierchia (1998) that Mandarin bare nouns denote kind terms; furthermore, the semantic correspondence between properties and kinds is captured via the application of the up operator $\cup$ and the down operator $\cap$.

Second, following Scontras (2014, 2017), the notion of degrees is conceived as information bundles, as shown in (4). Setting $\mu_f$ to the kilogram measure and its value $n$ to 3, we get the *three kilos of something* degree: This degree is the individual correlate of the property of weighing three kilos, as shown in (5).

(4) DEGREE := $\cap\lambda x.\exists k[\mu_f(x) = n \wedge \cup k(x)]$
Where $\mu_f$ is a contextually-specified measure, $n$ is some number in the range of the measure $\mu_f$

(5) a. **Degree denotation (type *d*)**: $\cap\lambda x.\exists k[\mu_{kg}(x) = 3 \wedge \cup k(x)]$
b. **Property denotation (type <*e*, *t*>)**: $\cup\cap\lambda x.\exists k[\mu_{kg}(x) = 3 \wedge \cup k(x)]$
(Equivalently: $\lambda x.\exists k[\mu_{kg}(x) = 3 \wedge \cup k(x)]$)

Third, couched in Scontras (2014, 2017)'s framework of degrees as kinds, the semantics of quantity adjective *duo* 'much' (cf. English *much* in Wellwood 2014, 2015, 2019) and the covert comparative morpheme CMPR (see e.g., Liu 2012, 2018; Lin 2022) are illustrated in (6) and (7), respectively, borrowed from Chen (2025).

(6) $[\![\text{duo}_\mu]\!]^A = \lambda d.\lambda x$: $d$ is suitable for $A(\mu)$. $\cup d(x)$ $\quad\quad$ $<d, <e, t>>$

(7) $[\![\text{CMPR}]\!] = \lambda g.\lambda d.\lambda y.\lambda x.\ \exists d'\exists d''[g(d')(y) \wedge g(d'')(x) \wedge \text{Diff}(d', d'', d)]$
Where Diff($d'$, $d''$, $d$) is defined iff $d'$, $d''$ and $d$ are the same type of degrees;
When defined, Diff($d'$, $d''$, $d$) = 1 iff $m(d'') - m(d') = m(d)$

For purposes of this study, the function $m$ is defined in terms of cardinality degrees, serving as a means extracting the numerical value obtained by the measure associated with a cardinality degree, as shown in (8), borrowed from Chen (2025).

(8) $[\![\text{m}]\!] = \lambda d.\iota n.\forall x[\cup d(x) \rightarrow \mu_{\text{card}}(x) = \text{n}]$

Furthermore, some notion of degree similarity is required to guarantee that the comparison is based on *the same kind of degrees*. Following Chen (2025), a notion of degree similarity is provided in (9).

(9) For any two degrees $d$ and $d'$, $d \approx d'$ iff $\cup d$ and $\cup d'$ differ only with respect to numerical values in the semantic representation.

Fourth, aligning with the insights of Scontras (2014, 2017), and assuming with Partee (1997, 1997) that the meaning of possession involves a contextual relation $R$ (see also Barker 1995, 2011; Partee & Borschev 1998, 2000), we propose that possessive MPs like *liang-ge-zhitou* can be semantically shifted to involve a contextually-determined possession relation $R_c$ and deliver the individual correlate of the property of 'having two fingers' (i.e., a set of individuals having two fingers).

(10) a. **Property denotation**
$[\![liang\text{-}ge\text{-}zhitou]\!] = \lambda y.\ \exists x[^{\cup}FINGER(x) \wedge \mu_{card}(x) = 2 \wedge R_c(y, x)]$
b. **Degree denotation**
$[\![liang\text{-}ge\text{-}zhitou]\!] = {}^{\cap}\lambda y.\ \exists x[^{\cup}FINGER(x) \wedge \mu_{card}(x) = 2 \wedge R_c(y, x)]$

Finally, putting the pieces together, the truth-condition of (2) is presented in (11), where *LIANG-GE-ZHITOU* is abbreviated for the degree denotation of possessive MP in (10b).

(11) $[\![(2)]\!] = 1$ iff
$\exists d'\exists d''[duo(d')(Laoshe) \wedge duo(d'')(Luxun) \wedge \text{Diff}(d', d'', LIANG\text{-}GE\text{-}ZHITOU)]$
Where Diff($d'$, $d''$, $d$) is defined iff $d'$, $d''$ and $d$ are the same type of degrees;
When defined, Diff($d'$, $d''$, $d$) = 1 iff $m(d'') - m(d') = m(d)$

According to (11), the sentence (2) is true iff the difference between the number of fingers that *Laoshe* has (i.e., the nominalized property *d'*) and the number of fingers that *Luxun* has (i.e., the nominalized property *d''*) is two (i.e., the numerical value of the degree *LIANG-GE-ZHITOU*).

**Implications**: If the proposed analysis is on the right track, our investigation into Mandarin possessive measure phrases contributes significant cross-linguistic support to the view that **degrees are ontologically complex entities rather than simple numerical values**. This conclusion resonates with a growing body of recent literature (Scontras 2014, 2017; Anderson and Morzycki 2015; Mendia 2017, 2020; Snyder 2017, 2021). Last but not the least, a possession relation can be part of the semantic representation of degrees, given that degrees by nature are individual correlates of properties.

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**Two types of nominal similatives: the case of Mandarin Chinese**

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**Introduction:** Previous studies on nominal similative plurality (e.g., Smith 2020a, b) report that nominal similatives deliver a conjunction-like meaning (i.e., the exclusive reading in the terminology of Smith 2020a, b) in upward-entailing contexts while a disjunction-like meaning (i.e., the inclusive reading in the terminology of Smith 2020a, b) in downward-entailing contexts. (1) illustrates the case of Persian m-reduplication (adapted from Smith 2020b: (1) and (10)) and (2) the case of Japanese *-toka* (adapted from Smith (2020b: (71) and (75a)).

(1) a Mohsen ketâb metâb xund. Upward-entailing contexts
Mohsen book RED read.PAST
'Mohsen read a book **and** other such things.'
b. Mohsen ketâb **metâb** -na xund -am. Downward-entailing contexts
Mohsen book RED -NEG read.PAST -1.SG
'Mohsen didn't read books **or** anything like that.'

(2) a. Taro-wa mikan-**toka**-o tabe-ta. Upward-entailing contexts
Taro-TOP orange-toka-ACC eat-PAST
'Taro ate oranges **and** other such food.'
b. Taro-wa eigo-**toka**-o benkyoo si-nakat-ta. Downward-entailing contexts
Taro- TOP English-toka-ACC study do-NEG-PAST
'Taro didn't study English **or** anything like that.'

Based on the data of Persian and Japanese, Smith (2020a, b) propose that Persian *m*-reduplication and Japanese *-toka* semantically deliver the inclusive reading, while the exclusive reading is derived as an obligatory scalar implicature via pragmatic strengthening.

However, in contrast to the above paradigm, Mandarin Chinese (henceforth Mandarin) has two different expressions for nominal similatives: one shows the familiar monotonic flip illustrated above, but the other does not.

**Two types of nominal similatives in Mandarin:** Mandarin has three different expressions of nominal similatives: *deng*, *zhileide* and *shenme de*. However, these three expressions fall into two camps: one camp shows the familiar monotonic flip in the interpretation, while the other camp does not.

Just like Persian *m*-reduplication and Japanese *-toka*, Mandarin *deng* demonstrates the familiar monotonic flip observed in Smith (2020a, b): it conveys a conjunction-like meaning (the exclusive reading) in upward-entailing contexts (see (3)), but a disjunction-like meaning (the inclusive reading) in downward-entailing contexts (see (4)).

(3) Akiu zaocan chi-le pingguo **deng** shuiguo.
Akiu breakfast eat-ASP apple DENG fruit
'Akiu ate apples **and** other such fruit for breakfast.'

(4) Akiu zaocan mei(you) chi pingguo **deng** shuiguo.
Akiu breakfast not.have eat apple DENG fruit
'Akiu didn't eat apples **or** other such fruit for breakfast.'

Crucially, by contrast, Mandarin *zhileide* and *shenme de* do not show the monotonic flip in question and consistently deliver a disjunction-like meaning (i.e., the inclusive reading) across both upward-entailing and downward-entailing contexts. The case of *zhileide* is illustrated in (5) and (6), and the case of Mandarin *shenme de* in (7) and (8).

(5) Akiu zaocan chi-le pingguo **zhileide** shuiguo.
Akiu breakfast eat-ASP apple ZLD fruit
'Akiu ate apples **or** other such fruit for breakfast.'

(6) Akiu zaocan mei(you) chi pingguo **zhileide** shuiguo.
Akiu breakfast not.have eat apple ZLD fruit
'Akiu didn't eat apples **or** other such fruit for breakfast.'

(7) Akiu zaocan chi-le pingguo **shenme** **de**.
Akiu breakfast eat-ASP apple what MOD
'Akiu ate apples **or** something like that for breakfast.'

(8) Akiu zaocan mei(you) chi pingguo **shenme** **de**.
Akiu breakfast not.have eat apple what MOD
'Akiu didn't eat apples **or** something like that for breakfast.'

Given the contrast between (3)/(4) on the one hand, and (5)/(6) and (7)/(8) on the other hand, **the difference between the two types of nominal similatives is unlikely to lie in an *ad hoc* stipulation—namely, the *exh* operator is obligatorily present for Mandarin *deng*, but obligatorily absent in the case of Mandarin *shenme de* despite sharing the same semantic representation.** To avoid this stipulation, this study argues for a necessary semantic distinction: the two types of expressions involve different semantic representations, which consequently dictates the (un)availability of pragmatic strengthening. This study uses *deng* and *zhileide* to illustrate the proposal.

**Analysis:** The proposed analysis involves two semantic ingredients: a kind-based similarity relation $\sim_c$ and a kind-based semantics of nominal similatives. First, assuming the neo-Carlsonian approach to kinds advocated in Chierchia (1998) and following the insights of Smith (2020a, b), a similarity relation $\sim_c$ is defined between kinds based on their corresponding property denotation in (9). A *tolerance* relation is reflexive, symmetric, and non-transitive. Furthermore, with (9) in hand, the proper similarity set is obtained in (10).

(9) $k \sim_C k'$ iff k counts as similar to k' in context C  A *tolerance* relation (Smith 2020a)

(10) $[|\cup k^{\sim}|] = \{x| \exists k': k' \sim_C k \ \& \ \cup k'(x)\}$

Crucially, the two types of Mandarin expressions of nominal similatives are semantically distinct. Specifically, Mandarin *deng* produces new kinds from the similarity set of the input kind via sum-formation, as shown in (11), where C represents the domain restriction (e.g., *shuiguo* 'fruit' in (3)). In contrast, Mandarin *zhileide* existentially quantifies over the similarity set of the input kind, as illustrated in(12).

(11) $[|deng|] = \lambda k \lambda P \lambda x. \cup \oplus \{k' | \ k' \sim_C k\}(x) \wedge P(x)$

(12) $[|zhileide|] = \lambda k \lambda P \lambda x. \exists k'[k' \sim_C k \wedge \cup k'(x) \wedge P(x)]$

Putting the pieces together, (13) illustrates the asserted content of the sentence with *deng* in (3) and (14) that of the sentence with *shenme de* in (5).

(13) $[|(3)|] = 1$ iff $\exists x.\ ^{\cup}\oplus\{k' | k' \sim_C \text{APPLE}\}(x) \wedge \text{ate}(\text{Akiu}, x) \wedge \text{fruit}(x)$

(14) $[|(5)|] = 1$ iff $\exists x \exists k'[k' \sim_C \text{APPLE} \wedge {}^{\cup}k'(x) \wedge \text{ate}(\text{Akiu}, x) \wedge \text{fruit}(x)]$

Given the reflexive nature of *tolerance* relation, the truth-conditions in (13) and (14) by themselves do not guarantee the presence of the conjunction-like meaning. This fact aligns with the insights of Smith (2020a, b).

Crucially, however, an important consequence following the semantic difference between (11) and (12): Mandarin *deng* includes not only the atomic kinds (APPLE, ORANGE, PEAR), but also their sums (APPLE+ORANGE, APPLE+PEAR, ORANGE+PEAR) as alternatives, given that sum-formation is involved. By contrast, Mandarin *zhileide* has only the atomic kinds available as alternatives {APPLE, ORANGE, PEAR}, where atomic kinds by nature are inherently disjoint.

Such semantic difference crucially leaves room for the obligatory presence of pragmatic strengthening: sentences with Mandarin *deng* such as (3) are strengthened into a conjunction-like meaning when those sum alternatives (APPLE+ORANGE, APPLE+PEAR, ORANGE+PEAR) are *innocently excluded* (in the terminology of Fox 2007), as illustrated in (15).

(15) The strengthened meaning: APPLE∧ORANGE∧PEAR
APPLE∨ORANGE∨PEAR & **¬ APPLE+ORANGE & ¬ORANGE+PEAR & ¬APPLE+PEAR**
≡ APPLE∧ORANGE∧PEAR

By contrast, none of the alternatives in the case of Mandarin *zhileide* are innocently excludable: a contradiction arises when the asserted content combines with the negation of the alternatives, as shown in (16).

(16) Contradiction: APPLE∨ORANGE∨PEAR & **¬APPLE & ¬ORANGE & ¬PEAR**

**The contrast between (15) and (16) explains why Mandarin *deng*-sentences necessarily undergo strengthening in upward-entailing environments, unlike their *shenme de* counterparts.** Put differently, sentences with Mandarin *zhileide* do not necessarily convey a conjunction-like meaning under upward-entailing contexts; by contrast, strengthening effects are readily observed in Mandarin *deng* as well as cross-linguistic nominal similatives that involve sum-formation, such as Persian *m*-reduplication and Japanese *-toka* (analyzed under a mixture-based framework in Smith 2020a, b).

**Implications:** Should the proposed analysis prove correct, it provides deeper insight into the semantic pathways and typological variations of nominal similatives in natural language: (a) **nominal similatives can be semantically constructed from either kinds or mixtures** (cf. the kind-based analysis in (11)/(12) vs. Smith 2020a, b's mixture-based account); and (b) ***deng*-type expressions (including Persian *m*-reduplication and Japanese *-toka*) involve sum-formation in their semantic representations while *zhileide*-type expressions (including Mandarin *shenme de*) do not**, **a semantic variation that explains the asymmetric availability of pragmatic strengthening in upward-entailing environments** (see the contrast between (3)/(4) on the one hand, and (5)/(6) and (7)/(8) on the other hand).

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# What a *mass*! Counting Hasawi Arabic mass nouns without coercion

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**Intro:** Semantically, Arabic collectives are parallel to mass nouns, and singulative morphemes to classifiers in generalized classifier languages (Noble 2025 a.o.). (1) illustrates this in **Hasawi Arabic** (**HA**, an understudied dialect spoken in eastern Saudi Arabia) with the singulative suffix ***-at*** (word final *-ah*) (cf. Fassi Fehri (2018) on Classical Arabic). The collective base (usually non-liquid substances, animals and fruits, vegetables, etc. that typically appear in groups) is number neutral and cumulative (≈ mass nouns). It cannot be directly counted by units (for objects) or integrated portions (for substances), unless the singulative suffix *-at* is used (1)/(5).

(1) səmak ~ smək-**ah** ~ læjmuun ~ læjmuun-**ah** ~ xaʃab ~ xʃəb-**ah**
fish.COLL fish-SGTV lemon.COLL lemon-SGTV wood.COLL wood.SGTV
'fish (mass) ~ a fish ~ lemon (mass) ~ a lemon ~ wood (mass) ~ a piece of wood'

The ability of counting by subkinds, in fact, has been proposed in the literature as a property that distinguishes substance and object mass nouns. It has been noted that English substance mass nouns can be coerced to give rise to either a **portion** (2-a) or **subkind** reading (2-b), but object mass nouns cannot (2-c) (Pelletier 1975, Michaelis 2003, 2004, Rothstein 2015, Sutton & Filip 2016, 2018 a.o.). Similar observations have been made in German (Sutton & Filip 2016, 2018) and Dutch (Cowper & Hall 2012, De Belder 2013).

(2) a. Three waters, please! (= 3 glasses/bottles of water)
b. I ordered three waters for the party: still, sparkling, and fruit-flavored for the kids.
c. #I ordered two furnitures from Ikea: chairs and tables.

Sutton & Filip (2016, 2018) argue that object mass nouns fail to be counted as subkinds due to the extensional overlap of subkinds relative to a level of categorization. On the other hand, Grimm & Levin (2017) focus on artifact nouns (e.g. *furniture, mail*) and argue that their denotation include different associated events, and therefore do not participate in the sub-/superkind relation.

Extending the typology further, Erbach & Schoenfeld (2022) challenge counting by subkinds as a characterization of object mass nouns, and report data from Hungarian where the subkind reading of object mass nouns is not considered more marked (3). Erbach (2021) also notes that Japanese artifact noun *choori-ki* 'kitchenware' can count by objects if their number correspond to subkinds (4).

(3) Ez a bolt csak két ruházatot árul: nadrágot és pólót.
this DEF shop only two apparel.ACC sell trousers.ACC and shirt.ACC
'This shop only sells two (kinds of) apparel: trousers and shirts.'

(4) mi-ttsu no choori-ki
three-$CL_{obj}$ GEN kitchenware
✗chopping board, two knives ✓chopping board, knife, mixing bowl.

In this paper, we provide novel insight to this discussion and note that in HA, the vast majority of collective mass nouns productively allow direct counting (i.e. without intervening singulative morpheme) as subkinds (as long as there is no paradigmatic gap), regardless of whether they are artifact nouns or not (cf. Borer & Ouwayda 2021 on Lebanese Arabic, but no formal semantic analysis), challenging the previous observations and generally accepted characterization of 'mass nouns'. We argue that the HA pattern reflects a fundamentally different mechanism of mass-to-count mapping, namely one that is **encoded grammatically via different morphological means**. **The singulative *-at* is semantically underspecified** (allowing counting by units, portions or subkinds (12)) **and competes with a null $\text{PART}_{\text{type}}$ (10)** (specifies a partition by subkind (9-e)) **for the projection above the base noun. $\text{PART}_{\text{type}}$ conditions direct counting mor-**

**phology** (see below). If direct counting paradigm is attested for a mass noun, *-at* is reserved for the MSSC reading (9-c) (Grimm 2012: a.o.). This can be derived via pragmatics mechanisms. **The subkind reading of the singulative *-at* resurfaces when direct counting morphology is a paradigmatic gap for the base noun.** We provide a formal analysis in mereotopology.

**Collective-singulative pattern in HA** Number marking in HA: DU⇒ ***-een***, PL ⇒ stem-internal rule (‘**broken plural**’). In HA, almost all collectives allow **direct counting as subkinds**. With the singulative *-at*, we get ① **natural units for objects** (5) (animals, fruits, etc. that typically appear in groups) and ② **integrated portions for substances** (5), and ③ **subkinds** (6), see below).

(5) səmak / χaʃab ∼ səmak-een / χaʃab-een ∼ smək-**t**-een / χʃəb-**t**-een ∼
fish wood fish-DU wood-DU fish-SGTV-DU wood-SGTV-DU
ʔasmaak / ʔaχʃaab ∼ səmak-**aat** / χʃəb-**aat**
fish.BRKN.PL wood.BRKN.PL fish-SGTV.PL wood-SGTV.PL
‘fish(mass)/wood(mass) ∼ 2 **kinds of** fish/wood ∼ 2 **ind. fish/pieces of** wood ∼ **kinds of** fish/wood ∼ **ind. fish/pieces** of wood’

We identify a wide range of different distributional patterns of the singulative and the subkind reading collective mass nouns, and note that **the subkind reading of *-at* arises whenever the direct number declension forms are paradigmatic gaps** (6)-(8). For example, *batˤtˤ* ‘duck’ is missing only the the broken plural (7), while *sˤaχaɪ* ‘rock’ is only missing the direct dual. Other patterns are omitted here due to limited space.

(6) keek, keek-**ah**, {keek-**at**-**een**/*keek-een}, {keek-**aat**/*BRKN.PL}
cake.COLL cake-SGTV cake-SGTV-DU cake-SGTV.PL
‘cake(mass), a **piece/type** of cake, {2 **pieces/kinds** of cake}, {**pieces/kinds** of cake}’

(7) batˤtˤ, batˤtˤ-ah, {batˤtˤ-ət-een, batˤtˤ-een}, {batˤtˤ-**aat**/*BRKN.PL}
duck.COLL duck-SGTV duck-SGTV-DU duck-DU duck-SGTV.PL
‘duck(mass), an ind. duck, {2 ind. ducks, 2 kinds of ducks}, {**ind./kinds** of ducks}’

(8) sˤaχaɪ, sˤaχaɪ-ah, {sˤaχaɪ-ət-**een**, *sˤaχaɪ-een}, {sˤaχaɪ-aat, sˤχuuɪ}
rock.COLL rock-SGTV rock-SGTV-DU rock-SGTV.PL rock.BRKN.PL
‘rock(mass), a piece of rock, {2 **pieces/kinds of** rock}, {pieces of rock, kinds of rock}’

**Analysis:** We use mereotopology (Casati & Varzi 1999: a.o.), i.e., mereology enriched with spatial relations like overlap and connectedness. In this line of literature, the notion of Maximally Strongly Self Connected (MSSC) objects (9-c) (Grimm 2012, Wągiel & Shlikhutka 2023 a.o.) captures not only the notion of ‘atoms’ in mereology, but also integrated portions of substances. **We further propose a connection relation based on sub-kinds (MSCT (9-e)), which enforces disjointness of the extensions of different subkinds, and we argue this it what mediates counting by sub-kinds.**[1]

We assume that counting is mediated via a null M-head CARD (Scontras 2014 a.o.) and number marking regulated by the #-head. The structure is shown in (11). The singulative *-at* provides a partition with an underspecified maximal connection relation (12)-(13) of either MSSC units (objects: natural units; substances: integrated portions) or MSCT units (subkinds).

(9) **Different connectedness relations**

a. **SC (self connected)**: $SC(x)$ if all individual parts of $x$ are connected to each other.

[1] Disjoint reference is a necessary but not sufficient conditiona for counting by subkinds. The dimension $f$ must also be fixed when partitioning by subkinds. Consider a model with just $a$(tuna, female), $b$(shark, male), $c$(tuna, female). We have: *There are two kinds of fish here.* ✓*Tuna and shark.* ✓*Male and female.* **Tuna and male.* Let $f$=species. We have $SCT(a)$(fish), $SCT(c)$(fish), $SCT(a+c)$(fish), $SCT(b)$(fish), $MSCT(a+c)$(fish), $MSCT(b)(fish)$. We take this observation as a reason to not build disjointness of subkinds in the meaning of the base noun as in Sutton & Filip (2018).

b. **SSC (strongly self connected)**: $SSC(x) := SC(x) \wedge SC(INT(x))$,
where $INT(x)$ is the interior of $x$.

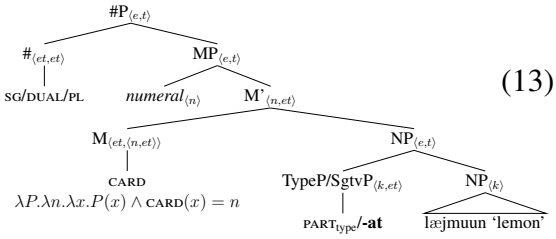
c. **MSSC (maximally SSC) relativized to a kind** $k$
$MSSC(x)(k) := SSC(x) \wedge^{\cup} k(x) \wedge \forall y[^{\cup}k(y) \wedge SSC(y) \wedge O(x,y) \rightarrow y \leq x]$

d. **SCT (Self-Connection by (sub)kinds) relativized to a kind** $k$
$SCT(x)(k) :=^{\cup} k(x) \wedge \exists k'[①\textsc{subkind}_f(k) \wedge ②\forall y[(y \leq x \wedge MSSC(y)) \rightarrow^{\cup} k'(y)]]$
①: $k'$ is a subkind of $k$ along a **contextually supplied dimension** $f$ (e.g. species, colour, etc., Carlson (1977) and Zamparelli (1998)); ②: all MSSC parts of $x$ are of kind $k'$.

e. **MSCT (maximally SCT) relativized to a kind** $k$
$MSCT(x)(k) := SCT(x)(k) \wedge \forall y[(SCT(y)(k) \wedge O(x,y)) \rightarrow y \leq x]$

(10) **Phonologically null partition head $\textsc{part}_{\text{type}}$**
$[\![\textsc{part}_{\text{type}}]\!] = \lambda k.\lambda x.x \in \pi_{\text{type}}(k)$ for a contextually salient partition function $\pi_{\text{type}}$.
where $\pi_{\text{type}\langle k,et\rangle}$ is such that $\forall k, \forall x \in \pi(k)$: $^{\cup}k(x) \wedge MSCT(x)(k)$.

(11) **Counting of mass nouns**




(12) **Singulative *-at***
$[\![\text{-at}]\!]_{\langle k,et\rangle} = \lambda k.\lambda x.x \in \pi_{\text{SGVT}}(k)$ for some contextually salient partition $\pi_{\text{SGVT}}$.

(13) **The partitioning function** $\pi_{\textbf{SGVT}\langle k,et\rangle}$ is such that for all $k$, for all $x \in \pi(k)$: $^{\cup}k(x) \wedge R(x)(k)$.
$R$ is an underspecified maximal connectedness relation: $MSSC$ (9-c) or $MSCT$ (9-e).

**Conclusion and outlook:** The division of labor between direct number declension and singulative number declension suggest that HA has a null subkind-based partition head that enables the counting of collective mass nouns, which competes with the singulative *-at* that (12) provides an underspecified partition.

**On the plural of English mass nouns:** In addition, the possibility of having a null partition head, and the productiveness of the subkind reading of mass nouns in HA, suggest an alternative analysis for the subkind reading of English nouns.

The term 'coercion' is often used then there is a meaning-form mismatch or inconsistencies of grammatical form and function, and involves implicit type-shifting. Michaelis (2003) proposes the Override Principle, in which the meaning of the syntactic environment of the construction always overrides the lexical meaning with which it is combined, hence forcing the type-shifting. For example, de Swart (1998) discusses the selectional properties of certain aspectual construction in French, and shows that when there is a mismatch, the meaning of the verbal predicate is shifted. The same mechanism has been applied to the interpretation of verb complements in constructions like *began the book* (Pustejovski 1995, Pustejovsky & Bouillon 1995).

Given this definition of coercion, we can reconsider the English data. It turns out that there is nothing in the inherent semantics of object mass nouns that prevents the subkind-based partition, contra Sutton & Filip (2016, 2018) and Grimm & Levin (2017). In English, plural substance mass nouns with the portion/subkind reading is productive and perfectly natural (e.g. *three beers*).[2] For both substance and object mass nouns, the overt *kind(s) of* composes with the meaning of the base noun to enable counting of subkinds. If the restriction against the sub-

[2] Baggio et al. (2010) notes that coercion (of cases like *began the book*) differs from standard N400 effects. We will leave the neurological evidence and processing of mass-to-count coercion to future research.

kind reading is something inherent to object mass nouns, this should be surprising given that overt morphemes has no problem with such type-shifting.[3] Likewise, in classifiers languages like Mandarin Chinese (14-a) and Japanese (14-b), subkind-level classifiers occupy the same position as individual-level and portion-level classifiers, and are equally productive.

(14) a. san zhong jiaju
three kind furniture
'three kinds of furniture'

b. san shurui no choori-ki
three kind GEN kitchenware
'three kinds of kitchenware'

These observations, along with the HA data, suggest that the crosslinguistic difference in how languages express the subkind reading (and the individual/portion reading) of mass nouns really is a matter of the syntactic construction. In HA, we have the division of labor between direct number declension and singulative declension. In Mandarin Chinese and Japanese, we have different subkind-level and individual/portion-level classifiers. In English, for substance mass nouns, we have either direct number declension or overt atomizers (*piece/kind of*), and for object mass nouns, only overt atomizers.

Therefore, contra previous literature that makes use of 'coercion', we instead suggest that English differs from HA in: (i) the lack of overt singulative morpheme, and (ii) the selectional property of the null partition head is such that it only wants substance-denoting nouns.

(15) **English null partition head**

a. $[\![\text{PART}]\!]_{\langle k,et\rangle} = \lambda k : k$ is substance-denoting.$\lambda x.x \in \pi_{\text{PART}}(k)$ for some contextually salient partition $\pi_{\text{PART}}$.

b. **The partitioning function** $\pi_{\textbf{PART}\langle k,et\rangle}$ is such that for all $k$, for all $x \in \pi(k)$: $^{\cup}k(x) \wedge R(x)(k)$.
$R$ is an underspecified maximal connectedness relation: $MSSC$ (9-c) or $MSCT$ (9-e).

In other words, the felicitous use of *three beers* (✓portions; ✓subkinds) and the ungrammatical **three furnitures* can be seen as the failure of the application of the null partition head, which conditions the plural morphology in the paradigm. In this sense, English is really not that different from HA or classifier languages in this respect.

**On quantity judgments:** Furthermore, our analysis suggests that both the subkind reading and the cardinality reading should be salient for HA mass nouns, since both are productive and grammatically encoded. Preliminary investigation of comparison contexts show that with nouns that display both the direct counting and singulative counting (16), native speakers of HA indeed easily allow the subkind reading (17) (more = more kinds) in subkind-oriented contexts (e.g. comparing the quality of dates shops).

(16) tamr, tamr-**ah**, tamr-**ət**-een, tamr-**aat**, tamr-een, tmuur
dates.COLL date-SGTV date-SGTV-DU date-SGTV.PL date-DU date.BRKN.PL
'date(mass), date, 2 dates, dates, 2 **kinds of** dates, **kinds of** dates'

(17) miin ʕənd-ah **tamr** ʔakθar?
who at-him date.COLL more
'Who has more date(s)?'

In the next step, we plan to further test for factors that may affect the judgments, including finer

[3] In fact, alternative analyses to this phenomenon other than coercion already exist in the literature. For example, Ziegeler (2007, 2010) argues that mass-to-count coercion is a case of metonymy: *a beer* stands for a kind/bottle of beer.

grained distinctions between mass nouns (e.g. aggregates vs. artifact nouns, etc.), context and world knowledge, and take into account of the crosslinguistic variation (collective/singulatives in Slavic and Celtic languages, Mandarin Chinese kind-level vs. individual-level classifiers), along the lines like Barner & Snedeker (2005) and Li, Barner & Huang (2008: a.o.).

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# Trinity

## The Three Levels of Harmony as Components of One Isomorphism, and How They Come Apart

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*. . . et tamen non tres dii, sed unus est Deus. (Athanasian Creed)*

**Abstract.** Harmony, the balance required of the rules for a logical connective, has been explicated at three levels: local (inversion), intermediate (normalization) and global (conservative extension). On unit-free multiplicative linear logic we show that the three levels are components of one isomorphism between proofs and their wirings, and we ask how the components come apart. This extended abstract revises the submitted one in response to the referees. Its main changes: the ledger condition is stated on leaf occurrences; execution is defined on proofs with cuts; the global level turns out to be soundness together with faithfulness of the wiring, not fullness; and the independence claims of the submitted version are withdrawn and replaced by a table separating what is shown from what is conjectured.

# 1 Three levels of harmony

On the view that the meaning of a connective is fixed by its rules [9, 20], the rules must be in **harmony**, on pain of admitting Prior's *tonk* [21]. Dummett distinguishes *intrinsic harmony*, the eliminability of local peaks, from *total harmony*, conservativeness of the extension the rules produce [6, p. 250], and adds *stability* [6, ch. 13]; the various explications are not equivalent [22]. In earlier work [25] we arranged them into three levels:

| level | requirement | source |
|---|---|---|
| local | an elimination right after the matching introduction can be removed (inversion principle) | [17], [20, p. 33] |
| intermediate | the removals terminate in a normal proof (normalization) | [20] |
| global | the new rules prove nothing new in the old vocabulary (conservativity) | [1], [6] |

The arrangement is ours. Dummett's own distinction is twofold, and for him normalization is the bridge from intrinsic to total harmony [6, p. 250] rather than a level in its own right. In the systems where harmony is usually discussed the levels are indeed separate. Prawitz's rules for unrestricted set abstraction satisfy the inversion principle while the derivation of Russell's paradox does not normalize [20, App. B], and the classical rules for negation are not conservative over positive logic, as Peirce's rule shows [6, pp. 291–292]. So we ask: *are the three levels three conditions, or one condition seen from three sides?*

Following Došen [5], who reads connectives as punctuation marks for structural deduction, we look where there is nothing but punctuation: unit-free multiplicative linear logic. Since both proof-theoretic semantics [8] and Girard's ludics [16] have been applied to natural language semantics, which explication of harmony is the right one is a question for meaning theories of natural language too. The proof-theoretic ingredients below are known; what is ours is their arrangement and what it reveals.

# 2 Systems, ledgers and wirings

The **core** $\mathcal{C}$ is unit-free MLL. Formulas are built from atoms $p$ and their duals $p^{\perp}$ by $\otimes$ and $\parr$, with negation defined by De Morgan. Sequents are one-sided, the axiom is atomic, $\vdash p^{\perp}, p$, and

the other rules are $\otimes$, $\parr$ and cut. Identities on compound formulas are $\eta$-expansions of atomic axioms. $\mathsf{Syn}(\mathcal{C})$ has formulas as objects; its morphisms $X \to Y$ are proofs of $\vdash X^{\perp}, Y$ modulo the equivalence $\sim$ generated by cut-reduction steps and by permutations of non-interfering rules, and composition is cut. Referee 2 asked what a "system" is. A **leaf** of a formula is an occurrence of an atom or a negated atom (and of a unit, if units are present).

**Definition 1.** A **system** extending $\mathcal{C}$ is a one-sided sequent calculus whose rules are schemata, each rule coming with a map from the leaf occurrences of its conclusion to those of its premises. Each new connective $c$ comes with its dual $\bar{c}$, a **cut link** pairing the leaves of $A$ with the dual leaves of $A^{\perp}$ bijectively, and a reduction step for a cut between $c$ and $\bar{c}$. A system satisfies the **ledger condition** (0) when axioms create one dual pair of leaves, cuts consume a pair of formulas whose leaves are paired by the cut link, and every other rule induces a bijection between the leaf occurrences of its premises and those of its conclusion.

So every leaf occurrence in a proof traces back to exactly one axiom. The submitted version stated this for formula occurrences, which is false, as Referee 2 noted: $\otimes$ creates the occurrence $A \otimes B$, but no leaf. The condition fails for contraction (it duplicates leaves), weakening, the introduction rule of tonk and the $\oplus$-introduction rule (they create leaves traced to no axiom), and & (it duplicates the context). Since $\oplus$ and & are paradigms of harmony, (0) is not a test of harmony. It delimits the scope of the method, namely multiplicative systems. The submitted version said that tonk breaks functoriality; in fact tonk falls outside the scope.

**Path wiring and execution.** Let $\pi$ be a proof, possibly with cuts, in a system satisfying (0). Consider the graph whose vertices are the leaf occurrences of its conclusion and of its cut formulas, and whose edges are axiom links and cut links.

**Proposition 2.** *Every conclusion leaf lies on a path ending at another conclusion leaf, and the pairing of the endpoints, the* **path wiring** *$G(\pi)$, is a perfect matching of dual conclusion leaves. The other components of the graph are closed cycles.*

*Proof.* Each vertex has exactly one axiom edge, each cut leaf exactly one cut edge, and conclusion leaves none, so degrees are at most 2 and conclusion leaves have degree 1. Paths alternate axiom and cut edges and begin and end with an axiom edge; both kinds of edge pair dual leaves, so the endpoints are dual. □

This answers Referee 2's first comment. The path wiring is what the token of the interaction abstract machine follows in the multiplicative case [18, 4, 15]. The submitted version wrongly cited [3] for the token machine. We define $G$ on proofs with cuts, not on $\mathsf{Syn}(\mathcal{C})$, so that whether $G$ respects $\sim$ becomes a property to be proved. Girard's execution formula [11] computes the same matching when there is no closed cycle and is undefined otherwise; we therefore no longer claim that "execution is total".

# 3 The isomorphism on the core

For a system $T$ consider the following conditions.

- (L) Every reduction step preserves the path wiring.
- (N) Reduction terminates in a cut-free proof; no cut gets stuck.
- (S) $G(\pi)$ satisfies the Danos–Regnier criterion (every switching graph is acyclic and connected) [2].
- (Fa) $G(\pi) = G(\pi')$ implies $\pi \sim \pi'$.

(Fu) Every correct matching of dual leaves of $\vdash X^{\perp}, Y$ is $G(\pi)$ for some proof $\pi$.

Let $\mathsf{PN}$ have formulas as objects and correct matchings on $|X^{\perp}| \uplus |Y|$ as morphisms $X \to Y$, composed by composing paths.

**Theorem 3** (known results, assembled)**.** *In $\mathcal{C}$ all of (0), (L), (N), (S), (Fa), (Fu) hold. Hence $G\colon \mathsf{Syn}(\mathcal{C}) \to \mathsf{PN}$ is well defined and is an isomorphism of categories.*

As Referee 2 asked, domain and codomain are now part of the statement, and the theorem is restricted to the core. (L) holds by inspection: an axiom–cut step shortens a path, a $\otimes/⅋$ step splits one cut link into two, and commutative steps do not touch links. So $G$ respects $\sim$, and it is a functor because cut composes paths. (N) holds because cut nodes decrease on proof nets [10]. (S) and (Fu) are sequentialization [10, 2]. For (Fa), normalize two proofs with the same wiring: by (L) they reach cut-free proofs with the same axiom links, that is, the same cut-free net, and two sequentializations of one net differ by rule permutations.

**The correspondence, redone.** Referee 2 asked for a clear account of how the levels match the components. Our submitted answer was wrong at the global row, and the correct answer is:

| level | component | a property of |
|---|---|---|
| local | (L) | one system |
| intermediate | (N) | one system |
| global ($T$ over $\mathcal{C}$) | $(\mathrm{S})_T$ and $(\mathrm{Fa})_T$ on core objects (Lemma 4) | a pair $\mathcal{C} \subseteq T$ |
| none | (Fu) | the rules against the criterion |
| scope | (0) | the rules |

*Local.* Intrinsic harmony asks that removing a peak return what the introduction was given. (L) asks that it return those very leaves, wired as they were. This is stronger than inversion at the level of types, which only checks that some $A$ comes back. One can write a connective $A \bowtie A$ whose reduction crosses its two components. It satisfies inversion at the level of types, and whether (L) holds depends on how the cut link is chosen. If the link is read off the identity, which here is the crossed $\eta$-expansion, the system is a notational variant of MLL and (L) holds. So inversion at the level of types does not determine the leaf correspondence, and (L) fixes it through $\eta$. This is where intensional harmony [23, 24] meets wirings. *Intermediate.* On nets termination is trivial, so the content of (N) is that no cut gets stuck. *Global.* We read the global level as conservativity at the level of proofs (§4). This is a choice, and it strengthens the provability-level notion of Belnap and Dummett. *(Fu)* says that the rules are not too weak for the geometry. No level of harmony asks for this; that (Fu) is the geometric half of stability is, for now, only an idea.

# 4 The global level is geometric

Let $T \supseteq \mathcal{C}$ satisfy (0) and let $F\colon \mathsf{Syn}(\mathcal{C}) \to \mathsf{Syn}(T)$ be the inclusion. Assume that $G_T$ is well defined on $\sim_T$-classes and that $G_T \circ F = G$; this is a real hypothesis. Call $T$ **conservative over $\mathcal{C}$ at the level of proofs** when $F$ is full.

**Lemma 4.** *$F$ is full iff for all core formulas $X, Y$: $(\mathrm{S})_T$ $G_T(\pi) \in \mathsf{PN}(X, Y)$ for every $\pi\colon FX \to FY$, and $(\mathrm{Fa})_T$ $G_T$ is injective on $\mathsf{Syn}(T)(FX, FY)$.*

*Proof.* ($\Leftarrow$) By $(\mathrm{S})_T$ and (Fu) for $\mathcal{C}$, $G_T(\pi) = G(f) = G_T(Ff)$ for a core $f$, so $\pi = Ff$ by $(\mathrm{Fa})_T$. ($\Rightarrow$) Every $\pi$ is some $Ff$, so $G_T(\pi) = G(f)$ is correct; and $G_T(Ff) = G_T(Fg)$ gives $f \sim g$ by (Fa) for $\mathcal{C}$. □

The argument is two-out-of-three, and we present it as a reformulation, not as a theorem with depth. What it shows is the split: a global property of an extension becomes two geometric properties of its wirings on the old formulas. Conservativity at the level of proofs implies the provability-level notion for non-empty sequents. Prove $\vdash A_1, \ldots, A_n$ in $T$; for $n \geq 2$ apply $\parr$ and invert it in $\mathcal{C}$, and for $n = 1$ use $\vdash A \otimes p^\perp, p$. The converse fails: adding a rule $\vdash \Gamma \Rightarrow \vdash \Gamma$ that no reduction removes changes no provability, but gives $p \to p$ infinitely many $\sim_T$-distinct proofs, all with the identity wiring.

Referee 2 asked for typical $T$. (i) **MLL with units**, with the ledger kept on atoms only: every proof of a unit-free $\vdash X^\perp, Y$ normalizes, by the subformula property, to a core proof, so $T$ is conservative at the level of proofs. (ii) **MLL with mix** proves $p \otimes q \to p \parr q$, whose wiring is acyclic but disconnected, so $(\mathrm{S})_T$ fails; the acyclicity criterion characterizes mix [7]. (iii) **MLL with contraction** proves $\vdash p^\perp, p \otimes p$; it violates (0) and falls outside the scope. (iv) The rule $\vdash \Gamma \Rightarrow \vdash \Gamma$ above breaks $(\mathrm{Fa})_T$ alone.

# 5 How the trinity comes apart

The submitted version claimed that the components break independently. None of its examples survives: tonk and contraction fall outside the scope, units break nothing on core formulas, and the "self-reproducing detour" cannot occur under (0). The table records what we now have. Its entries are evaluated on core formulas.

| system | (0) | L | N | S | Fa | Fu | status |
|---|---|---|---|---|---|---|---|
| core | ○ | ○ | ○ | ○ | ○ | ○ | known |
| mix | ○ | ○ | ○ | × | ? | ○ | S shown, Fa conjectured |
| inert rule $\vdash \Gamma \Rightarrow \vdash \Gamma$ | ○ | ○ | ○ | ○ | × | ○ | shown |
| cyclic MLL (a subsystem) | ○ | ○ | ○ | ○ | ? | × | Fu shown, Fa conjectured |
| self-dual connective | ○ | ? | × | ? | ? | ? | idea |
| units (atom ledger) | ○ | ○ | ○ | ○ | ○ | ○ | Fa fails on unit formulas |
| contraction, weakening, tonk, $\oplus$, & | × | | | | | | outside scope |
| only (L) failing | | | | | | | no example known |

Referee 1 singled out how the levels come apart with respect to structural rules, and the table gives two cases that mirror each other. Mix makes the rules too strong for the criterion and breaks (S). Cyclic MLL makes them too weak and breaks (Fu). Take Yetter's cyclic exchange [26], the rule $\vdash \Gamma, A$ and $\vdash B, \Delta$ to $\vdash \Gamma, A \otimes B, \Delta$, and $(A \otimes B)^\perp = B^\perp \parr A^\perp$. Then the swap $p \otimes q \to q \otimes p$ is unprovable, although its wiring is correct; it is crossing, and non-crossing nets are exactly the cyclic proofs [19, Thm. 6.39]. The comparison is made in PN after mirroring the leaves of $X^\perp$, and the failure depends on keeping the commutative criterion fixed.

Units show that where a failure appears depends on the ledger. If 1 and $\perp$ are counted as leaves, the unit rules create leaves traced to no axiom, and (0) fails. If they are not counted, (0) holds and faithfulness fails, but only on new formulas: $\vdash \perp \otimes \perp, 1 \parr 1$ has two proofs, the identity and the symmetry on $1 \parr 1$. Both have the empty wiring, and they are distinct in the free $*$-autonomous category [13, Ex. 1]. The phenomenon goes back to [14]. The submitted version wrongly credited this example to [12].

So the trinity does not shatter all at once. Outside the scope of (0) the correspondence is lost entirely. Inside it, mix costs soundness and cyclic exchange costs fullness, while units cost only the reach of the isomorphism. Open are a connective that breaks (L) alone, a connective (rather than an inert rule) that breaks $(\mathrm{Fa})_T$ alone, and whether every failure of (N) under (0) is a stuck cut. If the three levels are components of one isomorphism, these are the questions on which their independence turns.

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**On the incremental use of *again*: a view from Mandarin**

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**Synopsis**: In this paper we show that an analysis of Mandarin *yòu*, the counterpart of English *again*, along the lines of von Stechow 1996 and Beck 2005, may fall short on accounting for the interaction of *yòu* with predicates of change and those of incremental thematic objects (Krifka 1989). Our argument is mainly based on the observation that a *yòu*-sentence with these predicates may give rise to what Tovena and Donazzan (2008) call **incremental reading**; building on Kennedy and Levin 2008; Kennedy 2012, we suggest that scalarity and measure of change should be encoded in the semantic contribution of *yòu*.

**Backgrounds**: The Mandarin adverb *yòu* in (1) has been analyzed on par with English *again*; for instance, Xu (2016) simply extends von Stechow's (1996) analysis of *again* in (2) to Mandarin *yòu* to account for the repetitive and restitutive readings of (1): having *again* adjoining at *v*P and VP or FP at LF (see (3)) gives respectively the repetitive reading (i.e., ZS opened the door previously, before the asserted event) and the restitutive reading (i.e., the door was open previously).

(1) Zhāngsān yòu dǎ-kāi-lė mén. 'Zhangsan opened the door again.'
Zhangsan YOU hit-open-PERF door

(2) $[\![$ *again/yòu* $]\!](P_{\langle v,\, t\rangle})(e_v)$ is defined only if: there is e' s.t. i) P(e') and ii) e' temporarily precedes e and iii) there is no e" s.t. e" is part of e' and P(e"); if defined, $[\![$ *again/yòu* $]\!](P)(e)=1$ iff P(e).

(3) $[_{IP}$ ... <**you**> $[_{vP}$ Zhangsan *v* <**you**> $[_{VP}$ the door $[_{FP}$ F <**you**> $[_{XP}$ $PRO_1$ open]]]]]

**Challenges**: There are, however, uses of *yòu* that cannot be subsumed under the repetitive or restitutive reading: the *yòu* sentence in (4) is used to express that ZS ate two more apples, rather than the repetitive reading that ZS ate 3 apples previously (i.e., repetitive) or the restitutive that someone ate 3 apples.

(4) *ZS ate two apples first, and then ...* tā yòu chī-lė sān-gė píngguǒ.
3SG YOU eat-PERF 3-CL apple

This use of *yòu* is even more evident with predicates of change (POC); e.g., 'grow tall'; (5), w/wo the measure phrase *3cm*, in the designated context therein, expresses two consecutive events of growing, and after the preceding event there is an increase on the height of the tree (by 3cm) after the subsequent one.

(5) *Last month the height of this tree increased by 2cm; this month ...*
zhè-kē shù yòu zhǎng-gāo-lė (sān gōngfēn). 'This tree got taller again by 3cm.'
this-CL tree YOU grow-tall-PERF 3 cm

Following Tovena and Donazzan 2008, we term the use of *yòu* in (4)-(5) the 'incremental reading'. Such a use seemingly cannot be captured by a scopal analysis of *yòu* along the lines of Xu 2016.

It is worth noting that not all predicates of change lead to the incremental reading when they are modified by *yòu*: (6) by no means carries an incremental reading, according to which the degree of being dry/wet of the floor increases with two consecutive events of drying/wetting; instead, it only expresses that there are two events of drying/wetting with a separation of the change toward the other direction. See also Pedersen 2014 for the contrast of the same kind with English *again*.

(6) dìbǎn yòu gān/shī-lė. 'The floor dried/got wet again.'
floor YOU dry/wet-PERF

A proper semantics of *yòu* should accommodate such a difference among different predicates of change; this is what we intend to achieve in the following.

**Proposal**: We suggest that the issue outlined above may be addressed with a proper semantics of *yòu* that encodes scalarity and measure of change, along the lines of Kennedy and Levin 2008; Kennedy 2012. Kennedy's (2012) notions of difference functions and measure of change are given in (7); along with (7), the measure function $\mu_{\triangle}$ applies to an object x and an event e and returns the difference between the degree x possesses at the initial time interval (i.e., *init*(e)) and that at the final one (i.e., *fin*(e)).

(7) a. Difference functions: For any measure function $\mu$ from objects and time intervals to degrees on a scale $S$, and for any $d \in S$, $\mu^{\uparrow}_{d}$ is a function just like m except that: i) its range is $\{d' \in S | d \preceq d'\}$, and ii) for any x, t in the domain of m, if $m(x)(t) \preceq d$, then $\mu^{\uparrow}_{d}d(x)(t)=d$.

b. Measure of change: For any measure function $\mu$, $\mu_{\triangle}(x)(e)=\mu^{\uparrow}_{\mu(x)(\mathit{init}(e))}(x)(\mathit{fin}(e))$, where *init*/*fin*(e) is the time interval of the initial/final stage of e.

Along with these notions, we suggest that Mandarin *yòu* be assigned the denotation in (8); (8a) differs from the previous wisdom (e.g., (2)) in the component of measurement of change encoded in the presupposition: *yòu* requires that the difference from the preceding event e' cannot exceed the difference from e' together with the subsequent event e. With this presuppositional component, *yòu* is subject to Wellwood's (2015) **monotonic measurement**, which requires that the part-whole structure of the domain of a measure function be strictly preserved in the domain of degrees.

(8) a. $[\![ \textit{yòu}_1 ]\!]^{\mu,g}(P)(e)$ is defined only if there is e' s.t. i) P(e') and $\tau(e') \prec \tau(e)$, and ii) $\mu_{\triangle}(g(1))(e') < \mu_{\triangle}(g(1))(e \oplus e')$; if defined, $[\![ \textit{yòu}_1 ]\!]^{\mu,g}(P)(e)=1$ iff P(e)

b. For any e, e': i) $\mathit{init}(e \oplus e')=\mathit{init}(e')$ if $\tau(e') \prec \tau(e)$, and undefined otherwise; ii) $\mathit{fin}(e \oplus e')=\mathit{fin}(e)$ if $\tau(e') \prec \tau(e)$, and undefined otherwise.

In a *yòu*-sentence that implicates the increment of degrees, the nature of measurement introduced by *yòu* is in accordance with the one encoded in the event predicate it modifies. In cases where the linguistic environment fails to provide a proper measurement function, *yòu* then operates with measurement along the temporal scale by default.

Incremental reading in (5): Along with Kennedy and Levin 2008; Kennedy 2012, we assume that in the absence of an overt measure phrase, the covert positive morpheme POS serves to saturate the degree argument of a predicate of change (see (9b)) and introduces the standard of comparison. (5) then is parsed as (9a) at LF and assigned the truth conditions (9c), where the presupposition says that i) in the preceding e' there is some increase in height and such an increase is lower than that from the sum of e' and the subsequent event e. These truth conditions amount to saying that there are two consecutive growing-tall events, e and e', and each of them results in the increase in height. Since *yòu* modifies the predicate *grow-tall*, which encodes a monotonic measurement of change in height, the measure function of change $\mu_{\triangle}$ encoded in *yòu* then measures the event along the scale of height, subject to the monotonic constraint discussed above.

(9) a. [ this-tree [ 1 [ POS/3cm [ 2 [ yòu$_1$ [ t$_1$ grow-tall-d$_2$ ]]]]]

b. $[\![ \textit{grow-tall} ]\!]=\lambda d_d.\ \lambda x_e.\ \lambda e_v.\ \mu_{\triangle \mathrm{height}}(x)(e) \geq d$

c. Presupposition: There is e' s.t.: i) $\tau(e') \prec \tau(e)$ and $\exists d[\mu_{\triangle \mathrm{height}}(\text{this-tree})(e) \geq d]$, and ii) $\mu_{\triangle \mathrm{height}}(\text{this-tree})(e') < \mu_{\triangle \mathrm{height}}(\text{this-tree})(e' \oplus e)$
Assertion: $\mu_{\triangle \mathrm{height}}(\text{this-tree})(e) \geq 3\mathrm{cm}$

Incremental reading in (4): We assume that a count noun like *apple* has a degree argument (Creswell 1976; Krifka 1989) and encodes in its meaning a parametrized measure function of change NU$_{\triangle}$ that, according to 'natural units', measures things based on the intension of the

noun (Kennedy 2012). Accordingly, when the measure function of change $\mu_{\triangle}$ encoded in *yòu* applies to the count noun *apple* in its presupposition, it becomes $\text{NU}_{\triangle\text{apple}}$, which measures apples along the corresponding dimension. Therefore, (4) is parsed as (10b) and assigned the truth conditions in (10c): the presuppositional component says that ZS ate more apples in the sum of the preceding e' and the subsequent e than in e' only; this amounts to saying that there is an increase in the number of apples eaten in both e' and e.

(10) a. $[\![$ *apples* $]\!]=\lambda d_d.\ \lambda x_e.\ \lambda e_v.$ apple(x) and $\text{NU}_{\triangle\text{apple}}(x)(e)\geq d$
b. [ three [ 7 [ $d_7$-apples [ 2 [ yòu$_2$ [ ZS eat $t_2$ ]]]]]]
c. Presupposition: There is e' s.t.: i) $\tau(e')\prec\tau(e)$ and $\exists x\exists d$[apples(x) and $\text{NU}_{\triangle\text{apple}}(x)(e')\geq d$ and ZS eats x in e'], and ii) $\exists x$[apples(x) and $\text{NU}_{\triangle\text{apple}}(x)(e')< \text{NU}_{\triangle\text{apple}}(x)(e'\oplus e)$]
Assertion: Zhangsan ate three apples in e.

Event repetition: The implication of event repetition from a *yòu*-sentence that does not involve increment in degrees is derived through the assumption that the default option for measurement *yòu* introduces is along the temporal scale. With the LF (12a) and the truth conditions (12b), the second presuppositional component derived for (11) amounts to saying that the running time of e' is less than the sum of e and e'. Given that this follows from the first one (see (12a)), the role of the measurement of change *yòu* introduced is rendered trivial. The repetitive/restitutive ambiguity (e.g. (1)) then still results from the adjunction site of *yòu* at LF, which is consistent with the existent scopal accounts (e.g., von Stechow 1996; Beck 2005; a.o.).

(11) Zhāngsān yòu lái-lė. 'ZS came again.'
ZS YOU come-PERF

(12) a. [ZS [ 1 [ yòu$_1$ [ $t_1$ come]]]]
b. Presupposition: There is e' s.t. i) $\tau(e')\prec\tau(e)$ and ZS came in e'; and
ii) $\mu_{\triangle\text{time}}(\text{this-tree})(e')<\mu_{\triangle\text{time}}(\text{this-tree})(e'\oplus e)$
Assertion: ZS came in e.

With (8), our proposal predicts that the incremental reading of a *yòu*-sentence cannot arise once there is no proper monotonic measurement function other than the default option available to satisfy the presupposition. This prediction is borne out and evidenced in (6) (parsed as in (13a)). Along with Kennedy 2007; *et seq*, the truth conditions in (13b) are derived, where STD stands for 'standard of comparison'. Given that the measure function of dry/wet is not monotonic (i.e., x's degree of being dry/wet is not necessarily lower than y's, if x is a proper part of y; Wellwood 2015; a.o.), the presupposition ii) can only be satisfied with the default option, the temporal measure function, as already seen in (12b). This then renders the presupposition ii) trivial, which differs from that in (9b), yielding the increase in degree measured along the scale of POC, and hence gives rise to only the event repetitive reading.

(13) a. [ the-floor [ 1 [ POS [ 2 [ yòu$_1$ [ $t_1$ dry/wet-$d_2$ ]]]]]
b. Presuppositon: i) There is e' s.t.: i) $\tau(e')\prec\tau(e)$ and $\exists d[\mu_{\triangle\text{dry/wet}}(\text{the-door})(e)\geq d]$, and
ii) $\mu_{\triangle\mathbf{time}}\mathbf{(this\text{-}tree)(e')}<\mu_{\triangle\mathbf{time}}\mathbf{(this\text{-}tree)(e'\oplus e)}$
Assertion: $\exists d[\text{STD}(d)$ and $\mu_{\triangle\text{dry/wet}}(\text{the-door})(e)\geq d]$

**Comparison with the alternative**: Pedersen (2014) discussed the contrast of the kind we have seen in (5) and (6) (see (14)) and connected the availability of the incremental reading of *again* to the nature of the scale the de-adjectival predicate is interpreted against.

(14) a. The river widened again. ✓incremental reading
b. The roof dried again/The image blurred again. ✗incremental reading

Pedersen suggests that: i) the incremental reading is available for *widen* because *widen* is interpreted with an open scale and hence the standard of comparison is contextually determined; under this analysis, the endpoint of change in the degree of the preceding event can have the

same value as the starting point of the subsequent event; therefore, the truth conditions of an *again*-sentence may be verified with two consecutive widening without a separation of narrowing; ii) *dry* and *blur* are interpreted with a upper-end closed and lower-end closed scale respectively; consequently, the standard they are interpreted against are set to the upper end (i.e., the maximum) and the lower end (i.e., the minimum); the endpoint of change in an upper-end closed POC is then specified as the maximum; in contrast, the starting point of change in a lower-end closed POC is specified as the minimum; in neither case can be interpreted that the endpoint of the preceding event have the same value as the starting point of the subsequent event in an *again*-sentence; therefore, the truth conditions derived for the *again*-sentence with these de-adjectives can only be verified by two events of drying/blurring with a separation of a change toward the other direction.

An analysis along these lines is challenged by the fact that seemingly *yòu* does not give rise to the incremental reading with all open-scaled POCs with open-scaled adjectives, as shown in (15), with the POC *become expensive*. This then undermines the connection between the rise of the incremental reading and the nature of the scale.

(15) *The pice of gas rose to $6.5r gallon, which is already very expensive; today the price went even higher to $8 per gallon; therefore, ...*

#/??jīntiān qìyóu yòu guì-lė
today gasoline YOU expensive-PERF

**Conclusion**: Investigating the incremental use of Mandarin *yòu*, the counterpart of English *again*, we argue that measurement of change along the lines of Kennedy and Levin 2008; Kennedy 2012 should be encoded in the presuppositional component of *yòu*; crucially, the measurement of change *yòu* introduces should be subject to monotonic requirement. This accounts for the lack of the incremental reading in cases with POCs that do not involve a scale of measurement subject to monotonicity *á la* Wellwood 2015. We also propose that, when no monotonic measurement is available, change can be measured along the temporal scale by default. This analysis of *yòu* derives repetitive/restitutive ambiguity and is consistent with the previous analysis, which attributes the ambiguity to different adjunction sites (Xu 2016).

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**Incrementality and *even*-like particles in Korean**

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Korean additive particle *-to* (1a) (glossed as 'also') combines typically with a definite but with an indefinite like *amwu-* 'any' to form an NPI with negation, as in (1b) (Lee 1999: see also Lee and Horn 1994, a.o.). Note that the latter can alternatively be viewed as a result of scalarity; it is equivalent to (1b) with *amwu-* replaced by *HAN salam* 'one person' in quantity. Note further that, in contrast *amwu-* cannot br replaced by *HAN salam* in quality, which is also implied by *amwu-* (which may be understood in terms of epistemic indefinites such as *any*).

(1) a. John-i Mary-to manna-ess-ta.
John-NOM Mary-also meet-PAST-DEC
'John also met Mary.'
b. John-i amwu-to manna-ci.anh-ass-ta.
John-NOM any-also meet-NEG-PAST-DEC
'John didn't meet anyone.'

Another particle *-lato* (from *-la-to*), usually glossed as 'even', can appear under the scope of various so-called nonveridical operators (as defined in Giannakidou 1998: see also Lee 1999; c.f. Lim 2017, a.o., where *-lato* is analyzed as a combination of a special kind of additive particle roughly corresponding to *also* and an exhaustive particle corresponding to *only*, in parallel with Guerzoni 2003). In (2), the nonveridical operator *-tamyen* 'if' (glossed as a conditional marker), question, request, or modal, licenses the particle *-lato*.

(2) John-i Mary-lato manna-n-tamyen na-nun hayngpokha-lkesi-ta.
John-NOM Mary-even meet-PRES-COND I-TOP happy-FUT-DEC
'If John meets even Mary, I will be happy.'

As far as we can see, following König (1991) and Greenberg and Umbach (2024), if we define incrementality as the notion of 'adding up items to a larger whole', then both *-to* and *-lato* can express incrementality, as exemplified in (3a) and (3b), respectively.

(3) a. John-i sakwa yel kay-to mek-ul.swuiss-ta.
John-NOM apple 10 CL-also eat-be.able.to-DEC
'John can even eat 10 apples.'
b. John-i thekkeli han kay-lato ?(te) ha-myen iki-l.swu.iss-ta.
John-NOM pull.up one CL-even more do-COND win-be.able.to-DEC
'If John even does one more pull up, he can win (the game).'

In (3a) *-to* is used as an additive particle, which expresses the incrementality in the sense that, from some amounts of apples less than 10, John may eat some more, up to ten apples. However, as pointed out by many authors, including Lee (1999), as indicated by the gloss, *-to* also has the meaning similar to that of *even*. Specifically, as assumed under the rather standard semantics of *even* (Karttunen and Peters 1979, Rooth 1985, Giannakidou 1998, Guerzoni 2003, a.o.), (3a) carries the following two implications: (i) there is another number of apples that John can eat, such as 9, 8, 7… and (ii) 10 is the least likely amount for John to be able to eat. Given that, without *-to* these implications become absent, we may say that *-to* is the trigger of these implications, and therefore in (3a) *-to* has its 'original' meaning of additivity, as described by

(i), as well as the implication of scalarity, as described by (ii). Similarly, (3b) carries the implication that, given the numeral scale, one pull-up is the most likely for John to do, but given the commonsense knowledge that one pull-up is the smallest amount one can do, one pull-up is the least likely amount for John to win the game if he does that number of pull-ups. Note that if *te* 'more' is omitted, again due to the commonsense knowledge (usually one pull-up is so small amount that if a person did just one pull-up, it would not make them win the game), the sentence becomes less acceptable (of course, an appropriate and specific scenario may save it: for example, if there is no one, except John, who did even one pull-up, and John is the last player to try to do the pull-up, then John may win the game by doing just one pull-up, but in general this kind of scenario is not realized).

Note that the adverb *te*, which literally means 'more', as indicated above, can also be used to express incrementality. Examples like (3b) strongly suggest to us that (scalar) additive particles such as *-to* and *-lato* are closely related to the semantics of incrementality, at least in Korean. This is further confirmed by the example like (4), which is the same as (3a) except that *te* is used. Here *te* expresses incrementality, in the sense that (4) means that John can eat 10 apples, and some more amounts of apples can be added to 10 apples as the amount that John can eat more.

(4) John-i sakwa yel kay-to te mek-ul.swuiss-ta.
John-NOM apple 10 CL-also more eat-be.able.to-DEC
'John can even eat 10 apples, and maybe even more.'

Given this, in this study we would like to focus on the interaction between scalarity and additivity, on the one hand, and incrementality, on the other hand, which can be reformulated as (5a). While doing, so, we would also like to address related questions, among which we raise two, that is (5b) and (5c).

(5) a. What is the relation between the incrementality and the scalarity/additivity?
b. Why can the same particle be used both as an additive particle and as a scalar particle?
c. How are the (non-)monotonic/(non-)veridical operators related to the behavior of these particles?

To answer (5a), we propose that the incrementality comes from the additivity given by the lexical item as well as a scale available in the context: that is, we argue that the incrementality can be understood as something is added to the end of a certain scale given in the context (note that in this sense incrementality is distinct from scalarity: specifically, incrementality is something that is added based on scalarity, or a scale in the context). In (3a), for example, the additive particle *-to* itself provides additivity, and the (indefinite) numeral *yel* 'ten' combined with *-to* is understood as something added to the end of the numeric scale indicating the least likeliness (from zero apple to nine apples, so to speak), resulting in the incrementality. In (3b), we propose that the particle *-lato* contains an element introducing additivity, given the previous analyses of *-lato* as an *even*-like weak NPI under nonveridical operators (because of its lexical entry: see Lee 1999, a.o.) or as a kind of compound containing an additive particle *-to* (Lim 2017, a.o.), and the numeral *hana* can be understood as something added to the end of the numeric scale: due to its status as an NPI (c.f. Lim 2017), it can only appear under the environment where the scale is reversed.

This proposal can be extended to answer other two questions. For (5b), we argue that the additivity is the basic meaning of these two particles, but they can introduce scalarity only when one of the following three conditions described in (6) is met:

(6) a. When an appropriate scale is given by numerals or other items on Horn-scales, where scales are determined with respect to the relevant entailment relation
b. When there is an indefinite such as *amwu* 'any'
c. When there is any contextually salient scale

In case of (6b), we propose that an indefinite can be used to denote an end of a certain scale by domain widening suggested by Kadmon and Landman (1993) or covert exhaustification suggested by Chierchia (2012). By (6c) we mean the case where it is difficult to find any scale based on entailment relations, such as different types of medals in Olympic Games, as we can find in the example such as *John even won the [gold] medal in this Olympic Game*, or *John didn't even win the [bronze] medal in this Olympic Game*. For the lexical item such as *gold* or *blue* to lie on a certain scale, we further assume that there is a covert lexical item which is fully responsible for a scale (as proposed by Rooth 1992, among others).

Finally, for (5c), we assume lexical differences between *-to* and *-lato*: *-to* behaves as a PPI (or strong NPI) whereas -lato behaves as an (weak) NPI (no matter whether it is inherently an NPI as argued in Lee 1999 or it is not inherently an NPI but behaves like an NPI due to its internal composition as argued in Lim 2017).

Our proposal has several implications. First, we believe it can shed light on recent discussions on the nature of incrementality. As pointed out Greenberg and Umbach (2024), there have been two different approaches to incrementality, the degree-based approach vs. discourse-oriented approach. According to the former what is crucial in incrementality is a construction introducing degree interpretations, whereas according to the latter incrementality should be based on a certain pragmatically given notion of 'as a whole', so to speak. Our proposal suggests both are required for incrementality: the scale provided by the discourse context is required, which is responsible for the notion of the wholeness in incrementality, but for that scale to be used to incrementality, there must be a lexical item which provides additivity. This idea also strongly suggests that scalarity may be purely contextual: only additivity is lexically encoded, which may combine with a scale in the context to produce scalarity.

Next, our proposal can be thought to be in parallel with other recent proposals (such as Liu 2023, a.o.), which try to analyze additivity and scalarity in a unified way. Finally, our proposal predicts that particles like *-to* and *-lato* do not show any incrementality under the environment where a scale is difficult to be assumed, such as generics. This prediction seems to be borne out. For example, in (7), where *inkan* 'human' is used as a generic reference, *-to* seems to only introduce additivity. Note further that, as shown below, here *te* is infelicitous, which further shows that incrementality is difficult to be expressed with generics.

(7) Inkan-to (#*te*) tongmwul-i-ta.
Human-also more animal-COP-DEC
'A human is also an animal.'

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# *ALMOST* AT-ISSUE NEGATIVE INFERENCE LICENSES EXPLETIVE NEGATION AND MORE

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§1 **Brief.** Expletive Negation (XNEG) is ‘‘a curious phenomenon, a construction in which the negation can be dropped without changing the meaning.’’ (Krifka, 2010: 214) We provide an empirically novel set of data that concern XNEG licnsed under proximative operators like *almost* (ALM) that we analyse and theoretically expand so as to include a class of non-XNEG expressions that give rise to parallel inferences, which we generalise as giving rise to an ‘extraordinary’ scope, where OP is an appropriate operator, such as as XNEG:

(1) $\textsc{alm}\big(\textsc{op}(p)\big) \quad \rightsquigarrow \quad \textsc{op}(p) \wedge \textsc{alm}(p)$

§2 **Introduction & novel data.** While expletive negation has been observed in many languages (Horn, 1989; Yoon, 2011; Greco, 2019; Delfitto, Melloni, and Vender, 2019; Delfitto, 2020; Jin and Koenig, 2020; Olguin Martinez, 2024:*int. al.*), we provide novel data and identify a wider class of operators beyond negation with the same interpretation pattern. To start with, both Mandarin Chinese (2) and Bosnian (3) allow optional XNEG (Kaufmann and Xu, 2013), where the version with XNEG has the same truth-functional interpretation as the version without.

(2) Wo chadian (*mei*) shuai-zhe.
I almost NEG fall-hit
‘I almost fell’
⇝ I did not fall, but *I was close to falling*.

(3) Skoro (*ni-*) sam pala
almost NEG AUX fall
‘I almost fell.’
⇝ I did not fall, but *I was close to falling*.

§2.1 *Preliminary assumption.* that we need to make at this point regards the semantic contribution of proximative markers like *almost*. We start by assuming that the meaning of *almost* is the one proposed by Penka (2006) and given in (4), which states the intuitive dual output of almost, namely the falsity of its propositional argument and a true assertion of an alternative $r$ ($\in \mathcal{A}(p)$) that was ‘close to’ (signalled by $\approx$) the starting proposition ($p$).

(4) $[\![\text{almost}]\!] = \textsc{alm}_1 = \lambda w \cdot \lambda p_{\langle s,t\rangle} \cdot \neg p(w) \wedge \exists r \in \mathcal{A}(p)[r \approx p \wedge r(w)]$ (Penka, 2006)

The two conjuncts that encapsulate the contributing meaning of ALM, as Horn (2002: 63) dubss them, are the negative component, $\neg p(w)$, and the proximative component, $r(w)$. We will modify the details as we develop our empirically driven proposal.

§3 **Beyond XNEG: more data.** While our XNEG data licencensed under ALM consitute an analytical core, we submit a wider set of data, not featuring XNEG, that behave in a highly parallel fashion once embedded under ALM. There are two such ancillary yet critical set of data: one coming from the non-factive belief predicates in Mandarin, and the other one stemming from the related belief predicates in English, which we now overview in turn.

§3.1 *Mandarin: non-factive belief predicates.* In Mandarin, the attitude verb *yiwei* presupposes the falsity of its prejacent $p$ and asserts the belief in $p$. Therefore, when used in the first person, it can only describe a past false belief that the speaker is aware now of being false.

(5) Wo yiwei ta ye xihuan wo ne.
I think they too like me PART
'I thought they liked me too (and now I know they don't).'

We note that this *yiwei* interacts with *almost* the same way as negation does. In (6), the *almost* is blind to *yiwei* and targets the embedded $p$, and *yiwei* is interpreted independently, parallel to (2)-(3). The same pattern is observed with Bosnian as well (7).

(6) a. [CTX] After several good-seeming dates with someone, you got ghosted.
b. Wo chadian *yiwei* ta ye xihuan wo ne.
I almost think they too like me PART
'I almost thought they liked me too.' ⇝ I thought they liked me too, and *they were 'close to' liking me back*.

(7) a. [CTX] After waiting for 2 hours for a friend, they finally showed up.
b. Skoro sam *mislio* da ne-ćeš doći.
almost AUX.1.SG think that NEG-AUX come.INF
'I almost thought you wouldn't come.' ⇝ I thought you wouldn't come, and *you were 'close to' not coming*.

§3.2 *English: evidence from the backyard.* We further note that, while English does not have expletive negation (especially one licensed under *almost*), modern English does have operators which reproduce the above pattern: *modal operators that allow* $w_0 \notin p$, with $w_0$ being the actual world (8) These examples, all found on the web, have in common that *the past tense generates a 'cessation' inference* that the past modal no longer holds at speech time. Note that the reading reported is neither the surface scope nor a lower scope of ALM: Given (4), the surface scope would be equivalent to $\neg\text{MODAL}(p)$. The lower scope MODAL [Almost $p$] would mean $\text{MODAL}(\neg p)$. But all these examples describe an *actual* (past) modal relation with *p* that no longer holds.

(8) a. I almost *thought* this was an album cover. I have been convinced he's dropping soon and I thought this was it. (Source: www)
⇝ The speaker thought it was an album cover, and *it's 'close to' being one*.
b. A year ago Tyler *was* almost *going to* give up on football but then this awesome coach showed up. (Source: www)
⇝ Tyler was going to give up, and *he almost ('close to') gave up*.
c. I *was* almost *losing*, but bounced back very sufficiently! (Source: www)
⇝ The speaker was losing, and *they almost lost*.
d. Almost *wanted* to give up running …(but didn't in the end.) (Source: www)
⇝ The speaker wanted to give up, and *they almost did*.

§3.3 *Desiderata.* Keeping our focus on the starting XNEG expressions licensed under ALM in Chinese Mandarin and Bosnian, our primary desiderata are to derive explanatorily their semantic profiles. With the wider empirical class set against the background, we naturally aim to extend the treatment in an equally uniform way.

§4 **Analysis.** Our analysis comes with a static and a dynamic account, aiming to explain the following properties that our XNEG data under *almost* exhibit: (i) they promote the negative inference (§4.1), (ii) they have an exclamative effect (§4.4), and (iii) their nucleus is an undesirable proposition (§4.3). In short, the first component (§4.2) invokes the EXH-operator which 'levels' the non/at-issue status of the output of ALM under it, essentially ensuring the promotion of both

components of the embedded meanings, to the exclusion of non-XNEG expressions for which we suppose lack the cover EXH. Secondly, and this we demonstrate in the dynamic component (§4.4) of our analysis, the exclamative and surprise-related effects of these expressions can be captured perfectly under a Speech Act theory that is syntactically grounded.

Before sketching the system that derives these desiderata, let us give arguments for why and how the non/at-issue content in XNEG-expressions under ALM is unlike non-XNEG-expressions under ALM.

§4.1 *At-issue status tested.* Our inspection of the XNEG expressions licensed under ALM requires us to explicate the notion of non/at-issue content (Tonhauser, 2012; Koev, 2013; Koev, 2018; Koev, 2021; Sun, 2022:*int. al.*). Our concern especially regards the status of the two-component outputs of ALM. We demonstrate, and derive also, the fact that the proximate 'close to' part of the meaning of ALM has the at-issue status, to the exclusion of the negation part, as shown by the (dis)agreeing with the at-issue content test (10). We do not argue that the negation component is not part of the asserted meaning of *almost*, but just that it is not at-issue, in a way parallel to appositives (Koev, 2013), such as the following example.

(9) A: *Mary, who is a PhD student, got a job recently.*
B: *Yes, she indeed got a job./No, she didn't.*
B': *#Yes, she is indeed a PhD student./#No, she isn't a PhD student.*

(10) A: Mary almost got into trouble.
B: That's right. She was close to getting into trouble.
B': That's right. #She did not get into trouble.

Our analysis makes a stronger claim than the latter description purports: the silent presence of EXH predicts that any component of the output of ALM, however non/at-issue in its status, will be equalised by virtue of EXH-levelling of the prejacent and any other innocently includable alternative relevant to it. We take this to be a highly desirable consequence, for which we have not found evidence to the contrary.

Furthermore, we provide a *compositional implementation* for this phenomenon. We argue that given a PF of the form *Almost* (OP (*p*)), we identify two possible LFs: **(i)** the *vanilla* reading with a 'fully nested scope' (14-a), and **(ii)** *our* reading the one with a 'truly split scope' (14-b), which we derive from covert movement. 'Our reading' (LF in (14-b)) is derived by movement and repair strategies. We culminate our paper on an idea, which we consider amply grounded, that provides an explanation of the cross-linguistic typology.

In regard to pinning down ALM via the lexical entry for *almost* we gave in (4), as proposed by Penka (2006), we start by observing that this entry presents the meaning of *almost* as a seemingly symmetric conjunction of the negative and the proximal ('close to') component. The behavior of *almost* in our novel dataset in fact comes closest to what Amaral (2007) calls the 'inverted interpetation' of *almost*.

§4.2 *The Static component.* It has been noted that Mandarin and Bosnian expletive negation under *almost* is only attested when the embedded *p* is considered *undesirable*. In (11)-(12), the negation must be interpreted (cf. (2)-(3)). Moreover, the examples in (8) also embed an undesirable *p*. As for *yiwei* (6), while the embedded *p* is good, the overall sentence is undesirable (the speaker wanted them to like them back). This suggests that undesirability plays a key role in generating these interpretations.

(11) Wo chadian **mei** kao-shang daxue.
I almost NEG take.test-get university
'I almost **didn't** pass the university entrance exam.' ⇏ 'I almost passed.'

(12) Skoro **ni**-sam prošla na ispitu.
almost NEG-AUX.3SG.F pass.PRT.3SG.F on exam.LOC
'I almost **didn't** pass the exam.' ⇏ 'I almost passed.'

We analyse XNEG expressions under *almost* as involving a covert EXH operator. In particular, we adopt the version of EXH as proposed by Bar-Lev and Fox, 2020 which, aside from standardly asserting the prejacent and *innocently excluding* (IE) those alternatives that yield inconsistency, also *innocently includes* (II) some other alternatives. We minimally upgrade and adapt their $\text{EXH}^{\text{IE+II}}$ as EXH′ given below, where we suppose that aside from $R$, being the set of contextually relevant alternatives, we require $S$, the set of structurally relevant alternatives.

(13) $[\![\text{EXH}'_{\text{IE+II}}]\!](C)(p)(w) \Leftrightarrow \forall q \in \text{IE}(p, C) \cap R[\neg q(w)] \wedge \ \forall r \in \text{II}(p, C) \cap S[r(w)]$

Our extraordinary scope (14-b) is thus derived solely by assuming that the alternative generated by *almost* is relevant and/or innocently includable. We take this to be a natural assumption and further hardwire this generated alternative as a structurally relevant one ($\in S$) which, in turn, has to be obligatorily included in the computation (Bar-Lev and Fox, 2020:16n33), as the minimal upgrade of $[\![\text{EXH}]\!]$ in (13) asserts.

(14) a. $\text{ALM}\big(op(p)\big)$
b. $\text{OP}(p) \wedge \text{ALM}(p)$

The resulting set is therefore the partition set which innocently includes the generated alternative output, followed by the innocent exclusion of the negated prejacent as contributed by *almost*. This also explains why and how the non-at-issue *almost*-alternative is promoted to at-issue status–courtesy of EXH.

As we demonstrate, the first two conjuncts in (13) correspond to the first conjunct of (14-b), while the last conjunct asserting the innocently includable alternative identical to the second conjunct in (14-b). This, therefore, derives the desired effect of the observable readings (14-b), without departing from standard assumptions. (We omit our calculations here due to limits on space.)

§4.3 *Undesirability.* Kaufmann and Xu (2013:§2.1) mention the notion of desirability as a distributional factor of XNEG in Chinese, although this property is incompletely derived. We contend that that the undesirability is a parametrically dictated setting with respect to the true licensing factor of speaker ATTITUDE, in the sense that Yoon (2011) proposes. Korean and Japanese, for stance, license XNEG under attitudes without being restricted to the negatively perceived one by the speaker (such as HOPE). We therefore do not delve further and consider undesirability to be a language-particular parametric class made available by the true licensing factor of ATTITUDE, on which we have nothing to say at this point in time. There appears to be nothing universal about the negative attitude being held about $p$, and which would allow for XNEG to be licenses, instead there is something that remains to be uncovered about why holding an attitude in the first place would provide the conditions in languages like Chinese or Bosnian to license XNEG and derive the inferences we have just shown to exists because of this.

§4.4 *The Dynamic component.* The second component of our analysis is dynamic which is required to explain the exclamative effect of those expressions which feature XNEG. Our analysis thus far

considers XNEG expressions under ALM as involving a silent contextual enrichment operation militated by EXH, while the the ALM-expression without XNEG do not. This allowes us to derive the at-issue symmetry of both the negative compoment and the proximal component. What remains to be derived are the properties of XNEG expressions under ALM that we have not explicitly stated, the primary one being the exclamative effect of such terms (which is lacking in ALM-expression void of XNEG). Our use-conditional segment of meaning carried by the XNEG under ALM is characterised by a contrastive exclamative surprise (compared to the use-conditional alternative expressions lacking the XNEG-marking, which we dub regular, REG).

(15) A dynamic interpretation of REG:

$$\lambda \mathfrak{c}\left\{i' \mid \exists i \in \mathfrak{c}\left[i \multimap\!\bullet\, i'\left[\lambda i[S_1 \vdash_i \lambda i[\neg p_i^{S_1}]]\right]\right]\right\}$$

(16) A dynamic interpretation of XNEG:

$$\lambda \mathfrak{c}\left\{i' \mid \exists i \in \mathfrak{c}\left[i \multimap\!\bullet\, i'\left[\lambda i[S_1 \vdash_i \lambda i[\neg p_i^{S_1} \wedge r_i^{S_1}]^{\text{SURP}}]\right]\right]\right\}$$

In the dynamic dimension, we adopt the system of Krifka (2023), who supposes a layered syntactic structure sensitive to the level of Speech Act interpretation. Against the background of his system of syntacticising the performative aspects of propositional meanings, we derive the use-conditional aspects of the XNEG-featuring propositions under ALM.

Therefore, according to our analysis, expressions featuring expletive negation under *almost* derive their meaning due to EXH which asserts both the negative and proximal component as at-issue content.

To pin down of the surprisal profile of the expressions we inspect here, to which the exclamative effect is inherently related (which is typically assumed to express surprise, to begin with), we additionally contend that the inner layer of the Speech Act structure contains a SURPRISE operator in the J(udge)-head, developed by Krifka (2024:58n28).

In a dynamic sense, then, ALM-XNEG expressions are speakers' committments to updating the common ground with as propositions which those speakers judge as surprising.

## §5 Discussion.

Let us summarise and attempt make sense holistically of the project we started.

### §5.1 *Summary.*

The regular (REG), as opposed to XNEG-featuring, expressions differ in several ways, which we can designate as critical loci of parametric variation.

(17)

| underlying structure | $\cdots\left[\cdots\ \underset{[\pm\text{SURP}]}{\text{J}^0}\ \left[_{\text{TP}}\ \underset{[\pm]}{\text{EXH}}\ \left[\ \underset{[\pm]}{\text{XNEG}}\ \cdots\ \right]\right]\right]$ | | |
|---|---|---|---|
| REG | − | − | − |
| XNEG | + | + | + |

### §5.2 *Outlook.*

Our primary goal, pinning down formally the semantics of XNEG expressions under ALM, is made more prominent through considering other related expressions void XNEG-marking but which give rise to the same scopal inference.

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# Presupposition, domain restriction and trivalent conditionals

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There are systematic parallels between presupposition projection and modal domain restriction. For instance, information in a conditional antecedent can filter a presupposition in the consequent, and also restrict the domain of a modal in the consequent. In disjunctions, information in the left disjunct can filter a presupposition in the right disjunct, and also restricts the domain of a model in the right disjunct. Right-to-left filtering in disjunction is also possible, if somewhat more restricted; so is domain restriction, with similar restrictions. All of this cries out for a unified theory of the two. And it makes trouble for Lewis/Kratzer-style theories in which domain restriction is a lexical feature of conditionals, suggesting it should be an indirect result of the effects that conditionals and other operators on local contexts.

The best unified theory to date is Klinedinst & Rothschild 2012 ('Connectives without truth-tables'). I'll present this theory and two variants of the satisfaction theory of presupposition that it could be paired with: the popular trivalent theory, and a pragmatic account due to Karttunen (1974, 'Presupposition and linguistic context'). I'll also point out some reasons to be dissatisfied with Klinedinst & Rothschild's proposal, particularly with the domain semantics for modals that it presupposes and with its predictions about the probabilities of conditionals.

To resolve these problems, I propose to derive a trivalent semantics for conditionals—originally proposed by de Finetti in 1936—from a theory of local contexts. This gets the right predictions about probabilities of conditionals and gives us a non-stipulative treatment of modal domain restriction within a relational semantics for modals, following directly from the nonstandard treatment of conjunction and disjunction that the trivalent theory requires. This approach has an interesting theoretical consequence: the only plausible treatment of conjunction for the trivalent theory generates terrible predictions when combined with a trivalent theory of presupposition. To get the facts about conditionals and domain restriction right, we are forced to adopt Karttunen's pragmatic treatment of presupposition projection.