# N∅thing is Logical

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Slides: https://www.marialoni.org/resources/BielefeldMay25.pdf

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# N∅thing is logical (Nihil)

- Goal of the project: a formal account of a class of natural language inferences which deviate from classical logic
- Common assumption: these deviations are not logical mistakes, but consequence of pragmatic enrichments (Grice)
- Strategy: develop *logics of conversation* which model next to literal meanings also pragmatic factors and the additional inferences which arise from their interaction
- Novel hypothesis: **neglect-zero** tendency (a cognitive bias rather than a conversational principle) as crucial factor
- Main conclusion: deviations from classical logic consequence of pragmatic enrichments albeit not (always) of the canonical Gricean kind

# Non-classical inferences

## Free choice (FC)

(1) $\Diamond(\alpha \vee \beta) \rightsquigarrow \Diamond\alpha \wedge \Diamond\beta$

(2) Deontic FC inference [Kamp 1973]

a. You may go to the beach *or* to the cinema.
b. $\rightsquigarrow$ You may go to the beach *and* you may go to the cinema.

(3) Epistemic FC inference [Zimmermann 2000]

a. Mr. X might be in Victoria *or* in Brixton.
b. $\rightsquigarrow$ Mr. X might be in Victoria *and* he might be in Brixton.

## Ignorance

(4) The prize is either in the garden *or* in the attic $\rightsquigarrow$ speaker doesn't know where [Grice 1989, p.45]

(5) ? I have two *or* three children.

- In the standard approach, ignorance inferences are conversational implicatures
- Less consensus on FC inferences analysed as conversational implicatures; grammatical scalar implicatures; semantic entailments; . . .

# Novel hypothesis: neglect-zero

- FC and ignorance inferences are [$\neq$ semantic entailments]
  - Not the result of Gricean reasoning [$\neq$ conversational implicatures]
  - Not the effect of applications of covert grammatical operators [$\neq$ grammatical (scalar) implicatures]
- But rather a consequence of something else speakers do in conversation, namely,

  NEGLECT-ZERO
  when interpreting a sentence speakers create structures representing reality[1] and in doing so they systematically neglect structures which verify the sentence by virtue of an empty configuration (*zero-models*)

- Tendency to neglect zero-models follows from the difficulty of the cognitive operation of evaluating truths with respect to empty witness sets [Nieder 2016; Bott *et al*, 2019[2]]

[1] Johnson-Laird (1983) *Mental Models*. Cambridge University Press.
[2] Bott, O., Schlotterbeck, F. & Klein U. 2019. Empty-set effects in quantifier interpretation. *Journal of Semantics*, 36, 99–163.

# Novel hypothesis: neglect-zero

## Illustration

(6) Less than three squares are black.
  a. Verifier: [■, □, ■]
  b. Falsifier: [■, ■, ■]
  c. Zero-models: [□, □, □]; [■, ■, ■]; [△, △, △]; [▲, ▲, ▲]; . . .

Zero-models in (6-c) verify the sentence by virtue of an empty set of black squares

- Cognitive difficulty of zero-models confirmed by experimental findings and connected to / argued to explain:
  - the special status of 0 among the natural numbers [Nieder, 2016]
  - why downward-monotonic quantifiers are more costly to process than upward-monotonic ones (*less* vs *more*) [Bott *et al*, 2019]
- Core idea of Nihil project: tendency to neglect zero-models explains
  - FC, ignorance and related inferences [MA, 2022]

    (7) a. You may do A or B $\rightsquigarrow$ You may do A and you may do B
        b. A or B $\rightsquigarrow$ speaker doesn't know which

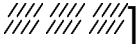
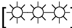
  - Principles operative in Aristotelian logics [MA, 2023; MA & vOrmondt 2023]

    (8) a. every A is B $\rightsquigarrow$ some A is B [*existential import*]
        b. NEVER: if not A, then A [*Aristotle's Theses*]
        NEVER: if A, then not A

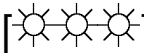
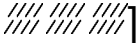
# Novel hypothesis: neglect-zero effects on disjunction

## Illustrations

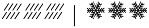
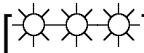
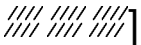
(9) It is raining.

- a. Verifier: []
- b. Falsifier: []
- c. Zero-models: none

(10) It is snowing.

- a. Verifier: []
- b. Falsifier: []; []; ...
- c. Zero-models: none

(11) It is raining or snowing.

- a. Verifier: [] [⇐ "split" state]
- b. Falsifier: []
- c. **Zero-models**: []; []

- Split state in (11-a): simultaneously entertains different (possibly conflicting) alternatives;
- Two zero-models (11-c): verify the sentence by virtue of an empty witness for one of the disjuncts;
- Core idea: ignorance effects arise because such zero-models are cognitively taxing and therefore disregarded.

# A new conjecture: no-split

## A closer look at the disjunctive case

(12) It is raining or snowing.

a. Verifier: [//// //// //// | ❄❄❄] [⇐ "split" state]

b. Falsifier: [☼☼☼]

c. **Zero-models**: [//// //// ////]; [❄❄❄]

- Split states: multiple alternatives processed in a parallel fashion ↦ also a cognitively taxing operation (increasing working memory load)

  NO-SPLIT CONJECTURE [Klochowicz, Sbardolini & MA 2025]
  the ability to split states (entertain multiple alternatives) is developed late

- Combination of neglect-zero + no-split can explain non-classical inferences observed in pre-school children [Singh *et al* 2016; Cochard 2023; Bleotu *et al* 2024]

  (13) The boy is holding an apple or a banana = The boy is holding an apple and a banana $(\alpha \vee \beta) \equiv (\alpha \wedge \beta)$

  (14) The boy is not holding an apple or a banana = The boy is neither holding an apple nor a banana $\neg(\alpha \vee \beta) \equiv \neg\alpha \wedge \neg\beta$

  (15) Liz can buy a croissant or a donut = Liz can buy a croissant and a donut $\Diamond(\alpha \vee \beta) \equiv \Diamond(\alpha \wedge \beta)$

# Free choice, ignorance, conjunctive *or* and scalar implicatures

- Scalar implicatures compatible with FC and ignorance (but not with conj *or*):

(16) Pat may eat the cake or the ice-cream $\mapsto \Diamond(\alpha \vee \beta)$ $\rightsquigarrow$

a. Pat may choose which $\mapsto \Diamond\alpha \wedge \Diamond\beta$ **(free choice)**

b. Pat may not eat both $\mapsto \neg\Diamond(\alpha \wedge \beta)$ **(scalar implicature)**

c. Pat may eat both $\mapsto \Diamond(\alpha \wedge \beta)$ **(conjunctive *or*)**

(17) Pat ate the cake or the ice-cream $\mapsto (\alpha \vee \beta)$ $\rightsquigarrow$

a. Speaker doesn't know which **(ignorance)**

b. Pat didn't eat both $\mapsto \neg(\alpha \wedge \beta)$ **(scalar implicature)**

c. Pat ate both $\mapsto (\alpha \wedge \beta)$ **(conjunctive *or*)**

- Ignorance and free choice are incompatible

(18) Pat may eat the cake or the ice-cream, I don't know which
$\not\rightsquigarrow$ Pat may choose which **(free choice cancellation)**

## Comparison with competing accounts[3]

| | **Ignorance inference** | FC **inference** | **Scalar implicature** | **Conjunctive *or*** |
|---|---|---|---|---|
| Neo-Gricean | reasoning | reasoning | reasoning | — |
| Grammatical view | debated | grammatical | grammatical | grammatical |
| Nihil | neglect-zero | neglect-zero | — | negl-z + no-split |

## Experiments

- Degano *et al* 2025: Neo-Gricean vs Nihil on **ignorance inference**
- Bott, Klochowicz, *et al* (24, 25): Nihil vs competitors on disjunction & quantifiers

[3] Neo-Gricean: Horn, Soames, Sauerland, ... Grammatical view: Chierchia, Fox, Singh *et al*, ...

# Modelling cognitive biases in a team semantics

- Natural language sentences translated into formulas of a classical logical language interpreted in a team semantics where we can model biases

## Team semantics

- Formulas interpreted wrt a set of points of evaluation (a team) rather than single ones [Hodges 1997; Väänänen 2007]
  - Classical modal logic: $[M = (W, R, V)]$

$$M, w \models \phi, \text{ where } w \in W$$

  - Team-based modal logic:

$$M, t \models \phi, \text{ where } t \subseteq W$$

- Two crucial features
  - The empty set is among the possible teams: $\emptyset \subseteq W$
  - Multi-membered teams can model split states

## Neglect-zero & no-split bias

- Neglect-zero modelled via non-emptiness atom $\text{NE}$ which disallows empty teams as possible verifiers

$$M, t \models \text{NE} \text{ iff } t \neq \emptyset$$

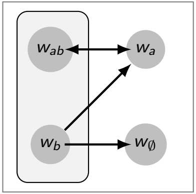
- No-split modelled via flattening operator $\text{F}$ which induces pointwise evaluations and therefore avoids simultaneous processing of alternatives

$$M, t \models \text{F}\phi \text{ iff for all } w \in t : M, \{w\} \models \phi$$

# BSML: Classical Modal Logic + NE

### Language

$$\phi := p \mid \neg\phi \mid \phi \vee \phi \mid \phi \wedge \phi \mid \Diamond\phi \mid \mathrm{NE}$$




### Bilateral team semantics

Given a Kripke model $M = \langle W, R, V \rangle$ & states $s, t, t' \subseteq W$

$$
\begin{array}{rcl}
M, s \models p & \text{iff} & \text{for all } w \in s : V(w,p) = 1 \\
M, s \dashv p & \text{iff} & \text{for all } w \in s : V(w,p) = 0 \\
M, s \models \neg\phi & \text{iff} & M, s \dashv \phi \\
M, s \dashv \neg\phi & \text{iff} & M, s \models \phi \\
M, s \models \phi \vee \psi & \text{iff} & \text{there are } t, t' : t \cup t' = s \ \& \ M, t \models \phi \ \& \ M, t' \models \psi \\
M, s \dashv \phi \vee \psi & \text{iff} & M, s \dashv \phi \ \& \ M, s \dashv \psi \\
M, s \models \phi \wedge \psi & \text{iff} & M, s \models \phi \ \& \ M, s \models \psi \\
M, s \dashv \phi \wedge \psi & \text{iff} & \text{there are } t, t' : t \cup t' = s \ \& \ M, t \dashv \phi \ \& \ M, t' \dashv \psi \\
M, s \models \Diamond\phi & \text{iff} & \text{for all } w \in s : \exists t \subseteq R[w] : t \neq \emptyset \ \& \ M, t \models \phi \\
M, s \dashv \Diamond\phi & \text{iff} & \text{for all } w \in s : M, R[w] \dashv \phi \\
M, s \models \mathrm{NE} & \text{iff} & s \neq \emptyset \\
M, s \dashv \mathrm{NE} & \text{iff} & s = \emptyset \qquad\qquad [\text{where } R[w] = \{v \in W \mid wRv\}]
\end{array}
$$

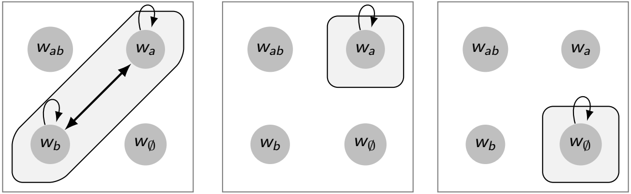
Entailment: $\phi_1, \ldots, \phi_n \models \psi$ iff for all $M, s$: $M, s \models \phi_1, \ldots, M, s \models \phi_n \Rightarrow M, s \models \psi$

Proof Theory: See Anttila, MA, Yang, *Notre Dame J For Log* (2024).

**Illustrations** $\{w_{ab}, w_b\} \not\models a$; $\{w_{ab}, w_b\} \models b$; $\{w_\emptyset\} \not\models a$; $\{w_\emptyset\} \not\models b$; $\emptyset \models a$; $\emptyset \models b$

# Neglect-zero effects in BSML: split disjunction

- A state $s$ supports a **disjunction** $(\alpha \vee \beta)$ iff $s$ is the union of two substates, each supporting one of the disjuncts




(a) Verifier (b) **Zero-model** (c) Falsifier

Figure: Models for $(a \vee b)$.

- $\{w_a\}$ verifies $(a \vee b)$ by virtue of an empty witness for the second disjunct, $\{w_a\} = \{w_a\} \cup \emptyset$ & $M, \emptyset \models b$ [$\mapsto$ **zero-model**]
- Main idea: define neglect-zero enrichments, $[\ ]^+$, whose core effect is to rule out such zero-models
- Implementation: $[\ ]^+$ defined using $\text{NE}$ ($s \models \text{NE}$ iff $s \neq \emptyset$), which models neglect-zero in the logic

# BSML: neglect-zero enrichment

## Non-emptiness

$\text{NE}$ is supported in a state if and only if the state is not empty

$$\begin{array}{lll} M, s \models \text{NE} & \text{iff} & s \neq \emptyset \\ M, s \;=\!\!| \; \text{NE} & \text{iff} & s = \emptyset \end{array}$$

## Neglect-zero enrichment

For $\text{NE}$-free $\alpha$, $[\alpha]^+$ defined as follows:

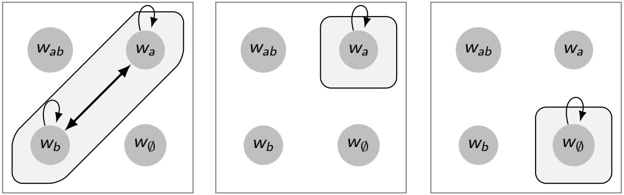
$$\begin{array}{rcl} [p]^+ & = & p \wedge \text{NE} \\ [\neg\alpha]^+ & = & \neg[\alpha]^+ \wedge \text{NE} \\ [\alpha \vee \beta]^+ & = & ([\alpha]^+ \vee [\beta]^+) \wedge \text{NE} \\ [\alpha \wedge \beta]^+ & = & ([\alpha]^+ \wedge [\beta]^+) \wedge \text{NE} \\ [\Diamond\alpha]^+ & = & \Diamond[\alpha]^+ \wedge \text{NE} \end{array}$$

$[\;]^+$ enriches formulas with the requirement to satisfy $\text{NE}$ distributed along each of their subformulas

# Neglect-zero effects in BSML: enriched disjunction

- *s* supports an **enriched disjunction** $[\alpha \vee \beta]^+$ iff *s* is the union of two non-empty substates, each supporting one of the disjuncts

$$[\alpha \vee \beta]^+ = (\alpha \wedge \mathrm{NE}) \vee (\beta \wedge \mathrm{NE}) \wedge \mathrm{NE}$$




(a) $\models [a \vee b]^+$ (b) $\not\models [a \vee b]^+$ (c) $=\!\!| \; [a \vee b]^+$

- An enriched disjunction requires both disjuncts to be live possibilities

(19) It is raining or snowing $\rightsquigarrow_{nz}$ It might be raining and it might be snowing
$[\alpha \vee \beta]^+ \models \Diamond_e \alpha \wedge \Diamond_e \beta$ (where *R* is state-based)

## Formal characterization of neglect-zero effects

$\alpha \rightsquigarrow_{nz} \beta$ ($\beta$ is a neglect-zero effect of $\alpha$) iff $\alpha \not\models \beta$ but $[\alpha]^+ \models \beta$

# Neglect-zero effects in BSML: main results

- In BSML $[\ ]^+$-enrichment has non-trivial effect only when applied to *positive* disjunctions[4]
  - $\mapsto$ we derive FC and related effects (for enriched formulas);
  - $\mapsto$ $[\ ]^+$-enrichment vacuous under single negation.

## After enrichment

- We derive both wide and narrow scope FC inferences:
  - Narrow scope FC: $[\Diamond(\alpha \vee \beta)]^+ \models \Diamond\alpha \wedge \Diamond\beta$
  - Universal FC: $[\forall x \Diamond(\alpha \vee \beta)]^+ \models \forall x(\Diamond\alpha \wedge \Diamond\beta)$
  - Double negation FC: $[\neg\neg\Diamond(\alpha \vee \beta)]^+ \models \Diamond\alpha \wedge \Diamond\beta$
  - Wide scope FC: $[\Diamond\alpha \vee \Diamond\beta]^+ \models \Diamond\alpha \wedge \Diamond\beta$ (if $R$ is indisputable)
- while no undesirable side effects obtain with other configurations:
  - Dual prohibition: $[\neg\Diamond(\alpha \vee \beta)]^+ \models \neg\Diamond\alpha \wedge \neg\Diamond\beta$

## Before enrichment

- The NE-free fragment of BSML is equivalent to classical modal logic (ML):

$$\alpha \models_{BSML} \beta \text{ iff } \alpha \models_{ML} \beta \qquad [\text{if } \alpha, \beta \text{ are NE-free}]$$

[if $\alpha$ is NE-free: $M, s \models \alpha$ iff for all $w \in s : M, \{w\} \models \alpha$]

- But we can capture the infelicity of epistemic contradictions [Yalcin, 2007] by putting team-based constraints on the accessibility relation:
  1. Epistemic contradiction: $\Diamond\alpha \wedge \neg\alpha \models \bot$ (if $R$ is state-based)
  2. Non-factivity: $\Diamond\alpha \not\models \alpha$

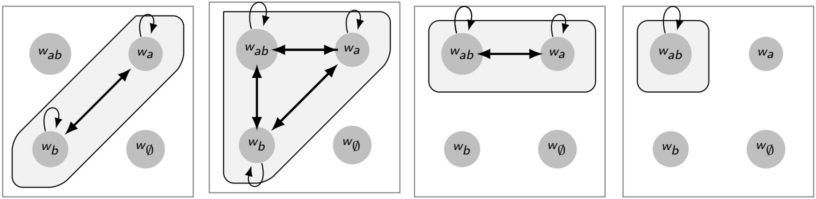
[4] MA (2022) Logic and Conversation: the case of free choice. *Semantics and Pragmatics* 15(5).

## Formal characterization zero and no-zero models

$(M, s)$ is a zero-model for $\alpha$ iff $M, s \models \alpha$, but $M, s \not\models [\alpha]^+$

$(M, s)$ is a no-zero verifier for $\alpha$ iff $M, s \models [\alpha]^+$

## Many no-zero verifiers for enriched disjunction




(d) no-zero & scalar $\models \neg(a \wedge b)$

(e) no-zero, non-scalar $\not\models \neg(a \wedge b)$

(f) no-zero, non-scalar & no-uncertain $\not\models \neg\Box_e a$

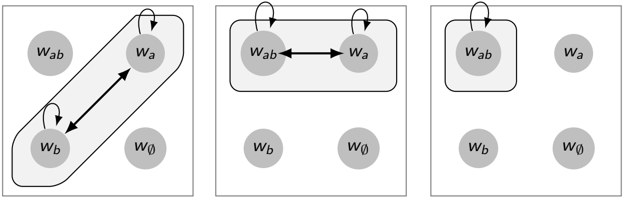
(g) no-zero, non-scalar, no-uncertain & no-split $\models (a \wedge b)$

Figure: Models for enriched $[a \vee b]^+$.

1. Neglect-zero enrichment does not derive scalar implicatures;
2. Neglect-zero enrichment neither derives no-uncertain inferences $\mapsto$ in contrast to standard neo-Gricean approach to ignorance $\Leftarrow$
3. No-split verifiers compatible with neglect-zero enrichments
   - **No-split conjecture**: only no-split verifiers accessible to 'conjunctive' pre-school children. [Klochowicz, Sbardolini, MA]

# Neglect-zero effects in BSML: possibility vs uncertainty

- More no-zero verifiers for $a \vee b$:




(a) scalar (b) no-uncertain (c) no-split

- Two components of full ignorance ('speaker doesn't know which'):[5]

(20) It is raining or it is snowing $(\alpha \vee \beta) \rightsquigarrow$

a. Uncertainty: $\neg\Box_e\alpha \wedge \neg\Box_e\beta$

b. Possibility: $\Diamond_e\alpha \wedge \Diamond_e\beta$ (equiv $\neg\Box_e\neg\alpha \wedge \neg\Box_e\neg\beta$ )

- **Fact:** Only possibility derived as neglect-zero effect:
  - $[a \vee b]^+ \models \Diamond_e a \wedge \Diamond_e b$, but $[a \vee b]^+ \not\models \neg\Box_e a \wedge \neg\Box_e b$ ($R$ is state-based)
  - $\{w_{ab}, w_a\} \models [a \vee b]^+$, but $\not\models \neg\Box_e a$
  - $\{w_{ab}\} \models [a \vee b]^+$, but $\not\models \neg\Box_e a$; $\not\models \neg\Box_e b$

[5] Degano, Marty, Ramotowska, MA, Breheny, Romoli, Sudo. *Nat Lang Sem*, 2025.

# Two derivations of full ignorance

1. Standard neo-Gricean derivation [Sauerland 2004]

(i) Uncertainty derived through quantity reasoning

(21) $\alpha \vee \beta$ ASSERTION

(22) $\neg\Box_e\alpha \wedge \neg\Box_e\beta$ UNCERTAINTY (from QUANTITY)

(ii) Possibility derived from uncertainty and quality about assertion

(23) $\Box_e(\alpha \vee \beta)$ QUALITY ABOUT ASSERTION

(24) $\Rightarrow \Diamond_e\alpha \wedge \Diamond_e\beta$ POSSIBILITY

2. Neglect-zero derivation

(i) Possibility derived as neglect-zero effect

(25) $\alpha \vee \beta$ ASSERTION

(26) $\Diamond_e\alpha \wedge \Diamond_e\beta$ POSSIBILITY (from NEGLECT-ZERO)

(ii) Uncertainty derived from possibility and scalar reasoning

(27) $\neg(\alpha \wedge \beta)$ SCALAR IMPLICATURE

(28) $\Rightarrow \neg\Box_e\alpha \wedge \neg\Box_e\beta$ UNCERTAINTY

# Neo-Gricean vs neglect-zero explanation

## Contrasting predictions of competing accounts of ignorance

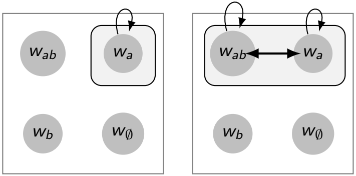
- Neo-Gricean: No possibility without uncertainty
- Neglect-zero: Possibility derived independently from uncertainty

## Experimental findings [Degano *et al* 2025]

- Using adapted mystery box paradigm, compared conditions in which
  - both uncertainty and possibility are false [**zero-model**]
  - uncertainty false but possibility true [no-zero, no-uncertain model]
- Less acceptance when possibility is false (95% vs **44%**)

⇒ Evidence that possibility can arise without uncertainty

- A challenge for the traditional neo-Gricean approach




(d) **zero-model** (e) no-uncertain

Figure: Models for $(a \vee b)$

# Neglect-zero effects on quantifiers

- So far focus on disjunction (propositional BSML)
- NEXT: neglect-zero effects on quantifiers (first order qBSML$^{\rightarrow}$)[6]
- Same methodology (summarized below) but now we work with a first order language and teams are defined as sets of world-assignment pairs

## Summary neglect-zero effects in team semantics

- Natural language sentences translated into formulas $\alpha$ of a classical logical language
- Logical language interpreted in a team semantics where we can model neglect-zero (via NE)

$$\alpha: \text{ literal meaning} \quad [\alpha]^+: \text{ neglect-zero enriched meaning}$$

- Formal characterisation of zero-models and neglect-zero effects:
  - A zero-model for $\alpha$ is one which verifies $\alpha$ but does not verify $[\alpha]^+$

    $$(M, t) \text{ zero-model for } \alpha \text{ iff } M, t \models \alpha \text{ but } M, t \not\models [\alpha]^+$$

  - $\beta$ is a neglect-zero effect of $\alpha$ iff $\beta$ follows only if we rule out possible zero-models of $\alpha$:

    $$\alpha \rightsquigarrow_{nz} \beta \text{ iff } \alpha \not\models \beta \text{ but } [\alpha]^+ \models \beta$$

[6] MA & vOrmondt, Modified numerals and split disjunction. *J of Log Lang and Inf* (2023)

# Neglect-zero effects on quantifiers

## Predictions of qBSML$^{\rightarrow}$

(29) Less than three squares are black $\mapsto \forall xyz((Sx \wedge Bx \wedge \dots) \rightarrow (x = y \vee \dots))$

- a. Verifier: [■, □, ■]
- b. Falsifier: [■, ■, ■]
- c. Zero-models: [□, □, □]; [▲, ▲, ▲]; . . . $\rightsquigarrow_{nz}$ there are black squares

(30) Every square is black. $\mapsto \forall x(Sx \rightarrow Bx)$

- a. Verifier: [■, ■, ■]
- b. Falsifier: [■, □, ■]
- c. Zero-models: [△, △, △]; [▲, ▲, ▲]; . . . $\rightsquigarrow_{nz}$ there are squares

(31) No squares are black. $\mapsto \forall x(Sx \rightarrow \neg Bx)$

- a. Verifier: [□, □, □]
- b. Falsifier: [■, □, □]
- c. Zero-models: [△, △, △]; [▲, ▲, ▲]; . . . $\rightsquigarrow_{nz}$ there are squares

(32) Every square is red or white. $\mapsto \forall x(Sx \rightarrow (Rx \vee Wx))$

- a. Verifier: [■, □, ■]
- b. Falsifier: [■, □, ■]
- c. Zero-models: [■, ■, ■]; [□, □, □]; . . . $\rightsquigarrow_{nz}$ there are white & red squares

These predictions tested in Bott, Klochowicz, Schlotterbeck *et al* (2024, 2025)

# Experimenting with quantifiers and disjunction

## Four non-classical interpretations

(33)
- a. Some of the squares are black ⇒ not all of the squares are black [UB]
- b. Each square is red or white ⇒ there are white squares and red squares [DIST]
- c. Less than 3 squares are black ⇒ there are some black squares [ES-scope]
- d. Less than 3/every/no squares are black ⇒ there are some squares [ES-restrictor]

## Three competing accounts

| | UB | DIST | ES-scope | ES-restrictor |
|---|---|---|---|---|
| Alternative-based | implicature | implicature | implicature | implicature |
| Bott *et al*, 2019 | — | — | neglect-zero | presupposition |
| Nihil | — | neglect-zero | neglect-zero | neglect-zero |

## Two experiments

- Exp 1: Answering questions about the emptyset (Bott *et al*, SuB 2024)
- Exp 2: Priming with zero-models (Klochowicz *et al*, CogSci 2025)

## Three main conclusions

1. Clear evidence that ES-restrictor is a presupposition (Exp 1)
2. Evidence that UB differs from both ES-scope and DIST (Exp1 and Exp2)
3. Some evidence that ES-scope and DIST involve the same cognitive process (Exp 2)

# Experimenting with quantifiers and disjunction

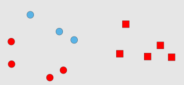
## Non-classical interpretations

(34)
a. Some of the squares are black ⇒ not all of the squares are black [UB]
b. Each square is red or white ⇒ there are white squares and red squares [DIST]
c. Less than 3 squares are black ⇒ there are some black squares [ES-scope]
d. Less than 3/every/no squares are black ⇒ there are some squares [ES-restrictor]

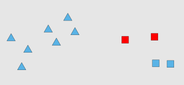
## Exp1: Bott et al, SuB 2024

- Question-answer task:

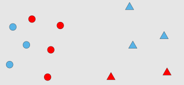
(35) Ist jedes Dreieck entweder rot oder blau? Ja/Nein/Komische Frage
(Is every triangle either red or blue?) Yes/No/Odd question



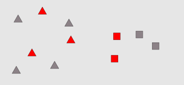
empty restr



DIST target (zero-model)



control ‘*yes*’



control ‘*no*’

- Main results:
  1. Evidence that ES-restrictor is a presupposition: questions in empty restrictor models uniformly perceived as odd
  2. ES-scope (37%) and DIST (23%) unaffected by question environment; UB much less available (10%, while 40% when unembedded)
  3. Inconclusive evidence on whether ES-scope and DIST had the same source

# Experimenting with quantifiers and disjunction

## Non-classical interpretations

(36) a. Some of the squares are black ⇒ not all of the squares are black [UB]
b. Each square is red or white ⇒ there are white and red squares [DIST]
c. At most 2 squares are black ⇒ there are some black squares [ES-scope, sup]
d. Less than 3 squares are black ⇒ there are some black squares [ES-scope, comp]

## Three competing accounts

| | UB | DIST | ES-scope | ES-restrictor |
|---|---|---|---|---|
| Alternative-based | implicature | implicature | implicature | implicature |
| Bott et al 2019 | — | — | neglect-zero | presupposition |
| Nihil | — | neglect-zero | neglect-zero | neglect-zero |

## Exp2: Klochowicz, Schlotterbeck *et al*, CogSci 2025, SuB 2025

- Tested whether frequency of strengthening in (36-d) changed after participants were primed to suspend other strengthenings in (36-a-c).
- Results:
  1. Semantic priming between DIST and ES-scope
  2. No priming between UB and ES-scope
  3. No trial-to-trial priming from ES-scope (sup) to ES-scope (com) but spill-over and adaptation effects

# Conclusions

- FC, ignorance, ES-scope: a mismatch between logic and language
- Grice's insight:
  - stronger meanings can be derived paying more "attention to the nature and importance to the conditions governing conversation"
- Nihil proposal: non-classical inferences consequences of cognitive biases
  - FC, ES-scope and related inferences as neglect-zero effects

    Literal meanings (classical fragment) + cognitive factor (NE) $\Rightarrow$ FC, possibility, ES-scope, DIST, etc

  - Conjunctive *or* as no-zero + no-split effect

    Literal meanings (classical fragment) + cognitive factors (NE, F) $\Rightarrow$ conjunctive *or*

- Implementation in (extensions of) BSML, a team-based modal logic
- Experiments provided some evidence in agreement with the neglect-zero hypothesis, but some inconclusive results:
  - EEG & eye-tracking experiment (Ramatowska *et al*);
  - Working memory and neglect-zero (double-task exp) (Ramatowska and MA)
- More experiments needed
  - Acquisition of zero (Ramatowska *et al*)
  - ...

# Collaborators & related (future) research

## Logic

Proof theory (Anttila, Yang); expressive completeness (Anttila, Knudstorp); bimodal perspective (Knudstorp, Baltag, van Benthem, Bezhanishvili); qBSML (van Ormondt); BiUS & qBiUS (MA); typed BSML (Muskens); connexive logic (Knudstorp, Ziegler & MA);. . .

## Language

FC cancellations (Pinton, Hui); modified numerals (vOrmondt); attitude verbs (Yan); conditionals (Flachs, Ziegler); questions (Klochowicz); quantifiers (Klochowicz, Bott, Schlotterbeck); indefinites (Degano); homogeneity (Sbardolini); acquisition (Klochowicz, Sbardolini); experiments (Degano, Klochowicz, Ramotowska, Bott, Schlotterbeck, Marty, Breheny, Romoli, Sudo, Szymanik, Visser); . . .

THANK YOU![7]

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