Neglect-zero effects at the semantics-pragmatics interface

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NØthing 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 rather consequence of pragmatic enrichment
- 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 as crucial pragmatic factor
- Main conclusion: deviations from classical logic consequence of pragmatic enrichments albeit not of the canonical Gricean kind

Nihil website

`https://projects.illc.uva.nl/nihil/`

Nihil team

MA, Anttila, Brinck Knudstorp, Degano, Klochowicz & Ramotowska (+ more collaborators including Sbardolini)

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 in the attic *or* in the garden $\rightsquigarrow$ speaker doesn't know which [Grice 1989]

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

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

Novel hypothesis: neglect-zero

- FC and ignorance inferences are [≠ semantic entailments]
  - Not the result of Gricean reasoning [≠ conversational implicatures]
  - Not the effect of applications of covert grammatical operators [≠ 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]

[1] Johnson-Laird (1983) *Mental Models*. Cambridge University Press.

Novel hypothesis: neglect-zero

Illustrations

(6) Every square is black.

a. Verifier: [■, ■, ■]
b. Falsifier: [■, □, ■]
c. Zero-models: [ ]; [△, △, △]; [◇, ▲, ◇]; [▲, ▲, ▲]

(7) Less than three squares are black.

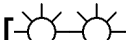
a. Verifier: [■, □, ■]
b. Falsifier: [■, ■, ■]
c. Zero-models: [ ]; [△, △, △]; [◇, ▲, ◇]; [▲, ▲, ▲]; [□, □, □]

- Cognitive difficulty of zero-models confirmed by experimental findings from number cognition and has been 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]
  - existential import & other principles operative in Aristotelian logic (*every A is B* $\Rightarrow$ *some A is B*; *not (if A then not A)*) [MA, 2023]
- Core idea: tendency to neglect zero-models, assumed to be operative in ordinary conversation, explains FC and related inferences

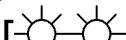
Novel hypothesis: neglect-zero

Illustrations

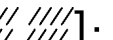
(8) It is raining.

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

(9) It is snowing.

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

(10) It is raining or snowing.

a. Verifier: [| ]
b. Falsifier: []
c. Zero-models: []; []

- Two models in (10-c) are **zero-models** because they verify the sentence by virtue of an empty witness for one of the disjuncts
- Ignorance effects arise because such zero-models are cognitively taxing and therefore disregarded

Comparison with competing accounts

	Ignorance inference	**FC inference**	**Scalar implicature**
Neo-Gricean	reasoning	reasoning	reasoning
Grammatical view	debated	grammatical	grammatical
Nihil	neglect-zero	neglect-zero	—

Ignorance, free choice and scalar implicatures

- Scalar implicatures compatible with ignorance and free choice:

(11) Pat ate the cake or the ice-cream $\rightsquigarrow$

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

b. P didn't eat both **(scalar implicature)**

(12) Pat may eat the cake or the ice-cream $\rightsquigarrow$

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

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

- Ignorance and free choice are incompatible

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

BSML: teams and bilateralism

- Team semantics: formulas interpreted wrt a set of points of evaluation (a team) rather than single ones [Väänänen 2007; Yang & Väänänen 2017]

Classical vs team-based modal logic

$[M = \langle W, R, V \rangle]$

- Classical modal logic: (truth in worlds)

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

- Team-based modal logic:

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

Bilateral state-based modal logic (BSML)

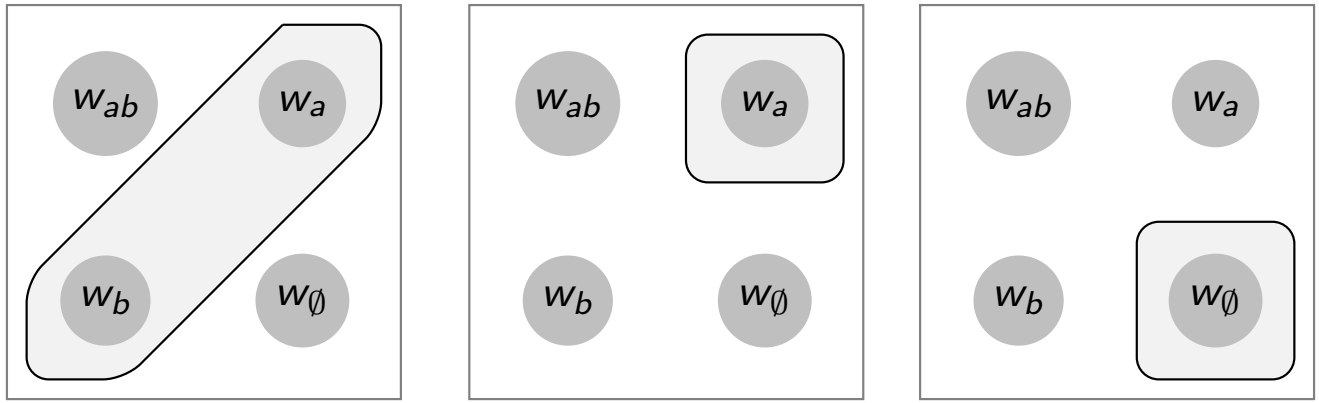
- Teams $\mapsto$ information states [Dekker93; Groenendijk$^+$96; Ciardelli$^+$19]
- Assertion & rejection conditions modeled rather than truth [Anderson & Belnap75; Rumfitt00]

$$M, s \models \phi, \text{ “}\phi \text{ is assertable in } s\text{”}, \quad \text{with } s \subseteq W$$
$$M, s \models\!\!\!| \phi, \text{ “}\phi \text{ is rejectable in } s\text{”}, \quad \text{with } s \subseteq W$$

- In BSML inferences relate speech acts rather than propositions and therefore might diverge from classical semantic entailments

Neglect-zero effects in BSML: split disjunction

- A state s supports a **disjunction** $\phi \vee \psi$ iff s is the union of two substates, each supporting one of the disjuncts



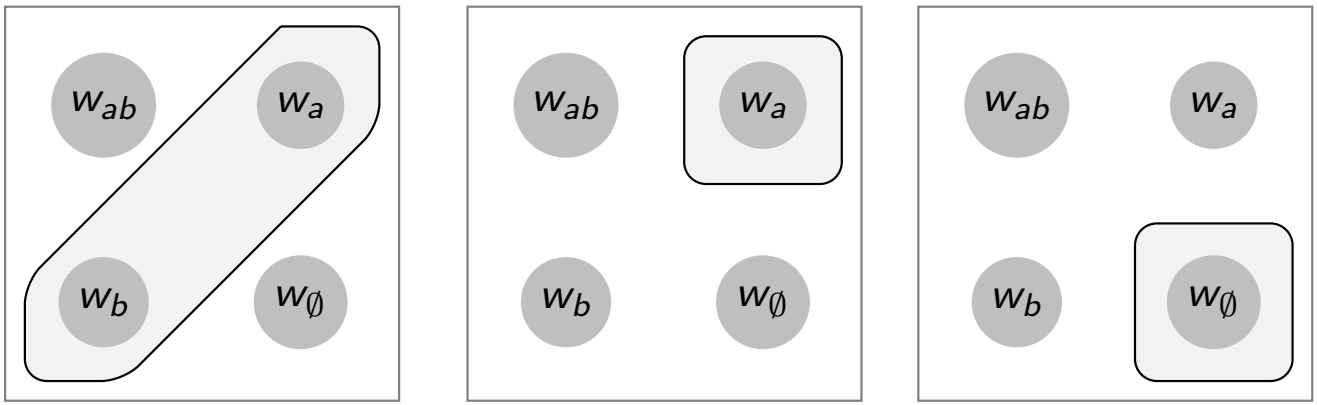
(a) No-zero verifier (b) Zero-model (c) Falsifier

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

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

Neglect-zero effects in BSML: enriched disjunction

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



(a) $\models [a \vee b]^+$ (b) $\not\models [a \vee b]^+$ (c) $\dashv\models [a \vee b]^+$

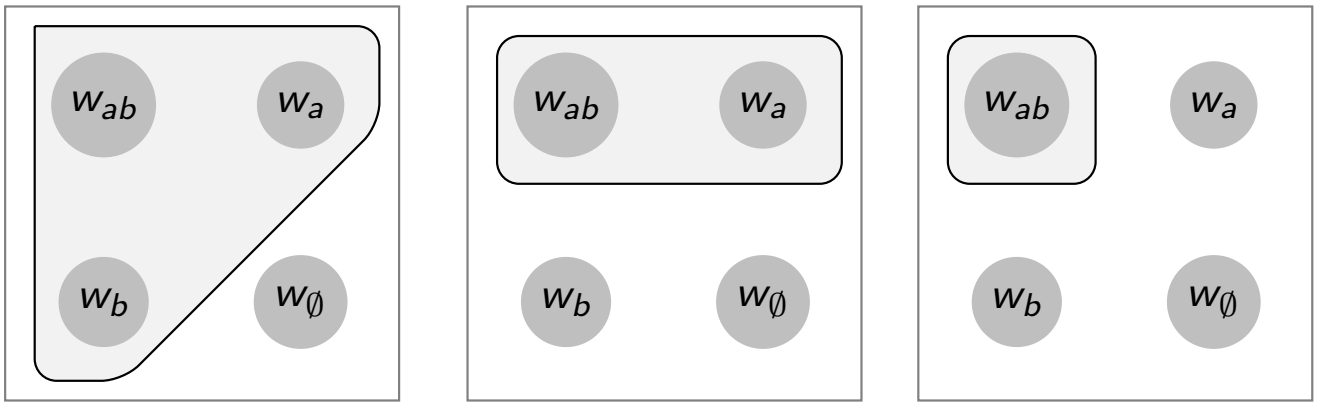
- An enriched disjunction requires both disjuncts to be live possibilities

(14) It is raining or snowing $\rightsquigarrow$ It might be raining and it might be snowing **(epistemic) possibility**

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

Neglect-zero effects in BSML: possibility vs uncertainty

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



(d) $\models [a \vee b]^+$ (e) $\models [a \vee b]^+$ (f) $\models [a \vee b]^+$

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

[Degano *et al*, 2023]

(15) 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 $\neg\Box_e\neg\alpha \wedge \neg\Box_e\neg\beta$)

- Only possibility derived as neglect-zero effect:
  - $\{w_{ab}, w_a\} \models \Diamond_e a \wedge \Diamond_e b$, but $\not\models \neg\Box_e a$ & $\not\models \neg(a \wedge b)$
  - $\{w_{ab}, w_a\}$: a no-zero model supporting possibility but neither uncertainty nor scalar implicature [no-zero non-scalar verifier]

Two derivations of full ignorance

1. Neo-Gricean derivation [Sauerland 2004]

   (i) Uncertainty derived through quantity reasoning

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

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

   (ii) Possibility derived from uncertainty and quality about assertion

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

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

2. Nihil derivation

   (i) Possibility derived as neglect-zero effect

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

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

   (ii) Uncertainty derived from possibility and scalar reasoning

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

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

Novel hypothesis: neglect-zero

Comparison with competing accounts

	Ignorance inference	**FC inference**	**Scalar implicature**
Neo-Gricean	reasoning	reasoning	reasoning
Grammatical view	debated	grammatical	grammatical
Nihil	neglect-zero	neglect-zero	—

- **Ignorance:** Neo-Gricean vs Nihil predictions
  - Neo-Gricean: No possibility without uncertainty
  - Nihil: Possibility derived independently from uncertainty

Argument 1 in favor of neglect-zero

- Experimental findings in agreement with Nihil predictions[2]
  - Using adapted mystery box paradigm, compared conditions in which
    - both uncertainty and possibility are false [zero-model]
    - uncertainty false but possibility true [no-zero non-scalar model]
  - Less acceptance when possibility is false (95% vs 44%)
  - Evidence that possibility can arise without uncertainty

[2] Degano, Marty, Ramotowska, Aloni, Breheny, Romoli & Sudo. Presented at SuB & XPRAG 2023.

Novel hypothesis: neglect-zero

Comparison with competing accounts

	Ignorance inference	**FC inference**	**Scalar implicature**
Neo-Gricean	reasoning	reasoning	reasoning
Grammatical view	debated	grammatical	grammatical
Nihil	neglect-zero	neglect-zero	—

Argument 2 in favor of neglect-zero

- Cognitive plausibility: differences between FC and scalar implicatures [Chemla & Bott, 2014; Tieu et al, 2016]:

	processing cost	**acquisition**
FC inference	low	early
scalar implicature	high	late

- Possible explanation for neo-Gricean or grammatical view:
  - Scalar alternatives less accessible [Singh et al, 2016]
- Still low cost and early acquisition of FC
  - Hard to explain on neo-Gricean or grammatical view
  - Expected on neglect-zero hypothesis:
    - FC inference follows from the assumption that when interpreting sentences language users neglect zero-models
    - Zero-models neglected because cognitively taxing

What about scalar implicatures?

- No evidence of scalar implicatures in Degano *et al* (2023) experiment (sentence-picture verification task)
- Verification tasks arguably test production (speaker-oriented) rather than interpretation (hearer-oriented) (Degen & Goodman, 2014)
- Conjecture:
  - Production (speaker-oriented): only neglect-zero operative
  - Interpretation (hearer-oriented): neglect-zero + scalar reasoning
- First try: Neglect-zero + neo-Gricean strategies (Gazdar 1979)

	Possibility	FC **inference**	**Scalar implicature**
Nihil 1	neglect-zero	neglect-zero	reasoning

- But lack of explanation for following cases:

(24) Mary is working at her paper or seeing some of her students $\rightsquigarrow$ not all of her students (Chierchia 2004)

(25) Mary read some or all of the books (Chierchia et al, 2012)

(26) Jane came or Jane and Maria came $\rightsquigarrow$ Jane alone or Jane & Maria

What about scalar implicatures?

- Second try: Neglect-zero + local **exh** (or **pex**, Del Pinal *et al*, 2021):

	Possibility	FC **inference**	**Scalar implicature**
Nihil 2	neglect-zero	neglect-zero	grammatical

- A simpler notion than ordinary **exh** (Fox 2007):

(27) **exh**$(\phi) = \phi \wedge \neg\alpha$, for each relevant ϕ-alternative α s.t. $\neg\alpha$ (contextually) consistent with ϕ

No reference to IE (innocent exclusion): $\neg a$ consistent with $a \vee b$, but inconsistent with $[a \vee b]^+$, since $[a \vee b]^+ \models \Diamond_e a$

- Other possible advantages:
  - Possibly simplified theory of ϕ-alternatives (only scalar and focal)
  - No need of recursive **exh** (or **pex***) for FC
- Back to our questions: (i) Why no evidence of scalar implicatures in our experiment? (ii) Why scalar implicatures more costly than FC?
- Possible answers:
  - Neglect-zero: constant pragmatic-cognitive factor, can be suspended but at a cost;
  - **exh**/**pex**: optional grammatical device, can be suspended at zero cost if disambiguation problem is resolved by context (verification task), otherwise it normally applies but with additional disambiguation costs

Novel hypothesis: neglect-zero

Comparison with competing accounts of FC inference

	NS FC	**Dual Prohib**	**Universal FC**	**Double Neg**	**WS FC**
Neo-Gricean	yes	yes	no	?	no
Grammatical	yes	yes*	yes	no*	no*
Semantic	yes	no*	yes	no*	no
Neglect-zero	yes	yes	yes	yes	yes

Argument 3 in favor of neglect-zero hypothesis

- Empirical coverage: FC sentences give rise to a complex pattern of inferences

(28)

a. $\Diamond(\alpha \vee \beta) \rightsquigarrow \Diamond\alpha \wedge \Diamond\beta$ [Narrow Scope FC]

b. $\neg\Diamond(\alpha \vee \beta) \rightsquigarrow \neg\Diamond\alpha \wedge \neg\Diamond\beta$ [Dual Prohibition]

c. $\forall x\Diamond(\alpha \vee \beta) \rightsquigarrow \forall x(\Diamond\alpha \wedge \Diamond\beta)$ [Universal FC]

d. $\neg\neg\Diamond(\alpha \vee \beta) \rightsquigarrow \Diamond\alpha \wedge \Diamond\beta$ [Double Negation FC]

e. $\Diamond\alpha \vee \Diamond\beta \rightsquigarrow \Diamond\alpha \wedge \Diamond\beta$ [Wide Scope FC]

- Captured by neglect-zero approach implemented in BSML[3]
- Most other approaches need additional assumptions

[3] MA (2022). Logic and conversation: the case of FC. *Sem & Pra*, 15(5).

The data

(29) Dual Prohibition [Alonso-Ovalle 2006, Marty *et al.* 2021]

a. You are not allowed to eat the cake or the ice-cream.
$\rightsquigarrow$ You are not allowed to eat either one.

b. $\neg\Diamond(\alpha \vee \beta) \rightsquigarrow \neg\Diamond\alpha \wedge \neg\Diamond\beta$

(30) Universal FC [Chemla 2009]

a. All of the boys may go to the beach or to the cinema.
$\rightsquigarrow$ All of the boys may go to the beach and all of the boys may go to the cinema.

b. $\forall x\Diamond(\alpha \vee \beta) \rightsquigarrow \forall x(\Diamond\alpha \wedge \Diamond\beta)$

(31) Double Negation FC [Gotzner *et al.* 2020]

a. Exactly one girl cannot take Spanish or Calculus.
$\rightsquigarrow$ One girl can take neither of the two and each of the others can choose between them.

b. $\exists x(\neg\Diamond(\alpha(x) \vee \beta(x)) \wedge \forall y(y \neq x \rightarrow \neg\neg\Diamond(\alpha(y) \vee \beta(y)))) \rightsquigarrow$
$\exists x(\neg\Diamond\alpha(x) \wedge \neg\Diamond\beta(x) \wedge \forall y(y \neq x \rightarrow (\Diamond\alpha(y) \wedge \Diamond\beta(y))))$

(32) Wide Scope FC [Zimmermann 2000, Hoeks *et al.* 2017]

a. Detectives may go by bus or they may go by boat.
$\rightsquigarrow$ Detectives may go by bus and may go by boat.

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

c. $\Diamond\alpha \vee \Diamond\beta \rightsquigarrow \Diamond\alpha \wedge \Diamond\beta$

Neglect-zero effects in BSML: predictions

After pragmatic 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 pragmatic enrichment

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

$$\alpha \models_{BSML^\emptyset} \beta \text{ iff } \alpha \models_{CML} \beta \qquad [\alpha, \beta \text{ are NE-free}]$$

- 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: $\Diamond\alpha \not\models \alpha$

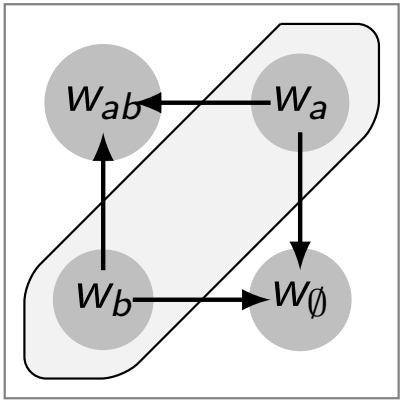
BSML: deontic vs epistemic modals

Proposal

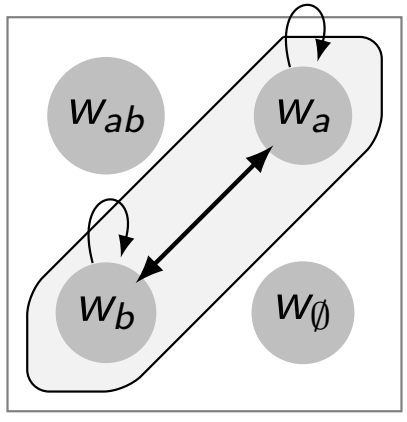
- Epistemics: R is state-based
- Deontics: R is possibly indisputable (e.g. in performative uses)

Team-sensitive constraints on accessibility relation

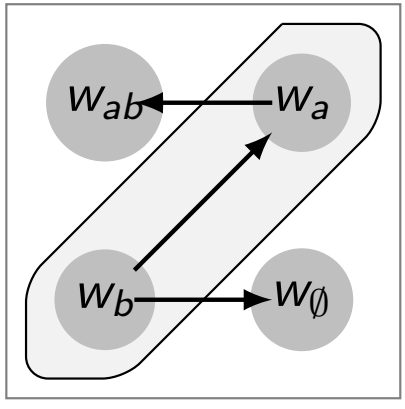
- R is indisputable in (M, s) iff $\forall w, v \in s : R[w] = R[v]$
  $\mapsto$ all worlds in s_M access exactly the same set of worlds
- R is state-based in (M, s) iff $\forall w \in s : R[w] = s$
  $\mapsto$ all and only worlds in s_M are accessible within s_M



(g) indisputable



(h) state-base (and so also indisputable)



(i) neither

BSML predictions: epistemic and deontic FC

- Narrow scope FC: $[\Diamond(\alpha \vee \beta)]^+ \models \Diamond\alpha \wedge \Diamond\beta$
- Wide-scope FC: $[\Diamond\alpha \vee \Diamond\beta]^+ \models \Diamond\alpha \wedge \Diamond\beta$ [if R is indisputable]

Epistemic modals

- R is **state-based**, therefore always indisputable:

(33) He might either be in London or in Paris. [+fc, narrow]
(34) He might be in London or he might be in Paris. [+fc, wide]

$\Rightarrow$ narrow and wide scope FC always predicted for pragmatically enriched epistemics

Deontic modals

- R **sometimes indisputable**, e.g. in performative uses

$\Rightarrow$ narrow scope FC always predicted for enriched deontics

$\Rightarrow$ wide scope FC only predicted if speaker is informed about what is permitted/obligatory [Pesetsky *et al.* 2017]

Further consequence: all cases of (overt) FC cancellations involve a wide scope configuration in a context where indisputability is not warranted

BSML predictions: overt FC cancellations

- Examples of overt FC cancellations:

(35) You may eat the cake or the ice-cream, I don't know which $\not\rightsquigarrow$ You may eat the cake

(36) You may eat the cake or the ice-cream, it depends on what John has taken $\not\rightsquigarrow$ You may eat the cake [Kaufmann 2016]

- Sluicing in (35) and inquisitive *it* in (36) arguably trigger wide scope disjunction in their antecedent [Fusco 2019, Pinton & MA 2022]

(37) You may eat the cake or the ice-cream, I don't know which (you may eat). [wide, –fc]

(38) You may eat the cake or the ice-cream, it (= what you may eat) depends on what John has taken. [wide, –fc]

- Sketch of analysis (in BSML + inquisitive disjunction $\mathbin{/\!\!/}$):

(a) which/what you may eat $(\Diamond\alpha \mathbin{/\!\!/} \Diamond\beta) \mapsto \boxed{\begin{array}{c}\Diamond\alpha\\ \hline \Diamond\beta\end{array}}$

(b) $\Diamond\alpha \vee \Diamond\beta \equiv [\exists] \boxed{\begin{array}{c}\Diamond\alpha\\ \hline \Diamond\beta\end{array}} \not\equiv \Diamond(\alpha \vee \beta)$

Neglect-zero effects in BSML: further predictions

- Modal **D-inferences** are derived: [Ramotowska et al 2022]
  - $[\Box(\alpha \vee \beta)]^+ \models \Diamond\alpha \wedge \Diamond\beta$ (without $\neg\Box\alpha$, $\neg\Box\beta$)
- But **negative** FC is not predicted: [Marty et al 2022]
  - $[\neg\Box(\alpha \wedge \beta)]^+ \not\models \Diamond\neg\alpha \wedge \Diamond\neg\beta$
- In BSML logically equivalent sentences can have different neglect-zero effects, i.e., these effects are detachable:

$$\begin{aligned} \Diamond(\neg\alpha \vee \neg\beta) &\equiv \neg\Box(\alpha \wedge \beta) \\ [\Diamond(\neg\alpha \vee \neg\beta)]^+ &\not\equiv [\neg\Box(\alpha \wedge \beta)]^+ \end{aligned}$$

Only positive disjunction gives rise to FC inference:

$$\begin{aligned} [\Diamond(\neg\alpha \vee \neg\beta)]^+ &\models \Diamond\neg\alpha \wedge \Diamond\neg\beta \\ [\neg\Box(\alpha \wedge \beta)]^+ &\not\models \Diamond\neg\alpha \wedge \Diamond\neg\beta \end{aligned}$$

Negative FC (Marty et al., 2021, 2022)

- **Experimental research**: negative FC inferences exist but appear to be less available than positive FC:

(39) Negative FC

a. It is not required that Mia buys both apples and bananas $\rightsquigarrow$ It is not required that Mia buys apples and that Mia buys bananas

b. $\neg\Box(\alpha \wedge \beta) \rightsquigarrow \neg\Box\alpha \wedge \neg\Box\beta$ $\quad (\equiv \Diamond\neg\alpha \wedge \Diamond\neg\beta)$

- BSML$^+$: BSML + global pragmatic enrichment

$$\alpha \models_{BSML^+} \beta \text{ iff } [\alpha]^+ \models_{BSML} [\beta]^+$$

			BSML$^+$
Positive FC	$\Diamond(\alpha \vee \beta) \rightsquigarrow \Diamond\alpha \wedge \Diamond\beta$	**strong**	+
Negative FC	$\neg\Box(\alpha \wedge \beta) \rightsquigarrow \Diamond\neg\alpha \wedge \Diamond\neg\beta$	**weak**	-
D-inference	$\Box(\alpha \vee \beta) \rightsquigarrow \Diamond\alpha \wedge \Diamond\beta$	**strong**	+
Negative DI	$\neg\Diamond(\alpha \wedge \beta) \rightsquigarrow \Diamond\neg\alpha \wedge \Diamond\neg\beta$	**weak**	-
Low Negative FC	$\Diamond(\neg\alpha \vee \neg\beta) \rightsquigarrow \Diamond\neg\alpha \wedge \Diamond\neg\beta$	**strong**	+

Table: Comparison BSML$^+$ and experimental findings.

Comparison with two recent approaches

- Goldstein 2019: FC inferences derived by adding a homogeneity presupposition to the meaning of
  - possibility modal [alternative-based account, Gold19A]
  - disjunction [dynamic account, Gold19B]
- Bar-Lev & Fox 2020: FC inference derived by application of an exhaustivity operator (which includes alternatives on top of negating all the innocently excludable ones) [BLF20]

		BSML$^+$	Gold19A	Gold19B	BLF20
Positive FC	**strong**	+	+	+	+
Negative FC	**weak**	-	-	-	+
Possibility	**strong**	+	-	+	?
Negative Conjunction	**weak**	-	-	-	?
Wide Scope FC	?	+	-	+	-

Table: Comparison BSML$^+$ and alternative approaches

- BSML$^+$ & Gold19B seem the best options for strong inferences but needs to be supplemented with a theory deriving weak inferences;
- Within BSML we can derive both weak and strong inference patterns: BSML$^+ \mapsto$ strong & BSML$^* \mapsto$ weak

Modelling neglect-zero effects: different implementations

- More ways to model neglect-zero effects:
  - Syntactically, via pragmatic enrichment function $[\ ]^+$ defined in terms of $\text{NE} \mapsto$ BSML$^+$
  - Model-theoretically, by ruling out $\emptyset$ from the set of possible states $\mapsto$ BSML*
- Both implementations derive:
  - $\mapsto$ FC effects (narrow and wide scope FC, the latter with restrictions);
  - $\mapsto$ cancellations of FC effects under negation (dual prohibition).
- But empirical and conceptual differences:
  - Only BSML* predicts Negative FC: $\neg\Box(\alpha \wedge \beta) \rightsquigarrow \neg\Box\alpha \wedge \neg\Box\beta$
  - Only in BSML, where $[\ ]^+$ and $\emptyset$ are parts of the building blocks, locality and suspension of neglect-zero effects can be modeled
- Conjecture: neglect-zero can cause two kinds of effects:
  - (i) weak non-detachable effects (modelled by BSML*);
  - (ii) more robust detachable effects (modelled by *BSML*$^+$).

The resulting picture

- A pluralism of systems which can be used to model interpretation strategies & reasoning styles people may adopt in different circumstances:
  1. BSML$^{\emptyset}$: modelling logical-mathematical reasoning where neglect-zero effects are suspended;
  2. BSML^{+}: modelling strong (detachable) neglect-zero effects;
  3. BSML*: modelling weak (global, non-detachable) neglect-zero effects;
  4. ...
- Experimentally testable predictions arising from these conjectures

			BSML$^{\emptyset}$	BSML^{+}	BSML*
NS FC	$\Diamond(\alpha \vee \beta) \rightsquigarrow \Diamond\alpha \wedge \Diamond\beta$	s	-	+	+
Dual prohibition	$\neg\Diamond(\alpha \vee \beta) \rightsquigarrow \neg\Diamond\alpha \wedge \neg\Diamond\beta$	s	+	+	+
Negative FC	$\neg\Box(\alpha \wedge \beta) \rightsquigarrow \neg\Box\alpha \wedge \neg\Box\beta$	w	-	-	+
WS FC	$\Diamond\alpha \vee \Diamond\beta \rightsquigarrow \Diamond\alpha \wedge \Diamond\beta$	?	-	+	+

Table: Comparison BSML$^{\emptyset}$, BSML^{+} and BSML*.

Conclusions

- Free choice: 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"
- Standard implementation: two separate components
  - Semantics: classical logic
  - Pragmatics: Gricean reasoning

  Elegant picture, but, when applied to FC & ignorance inferences, empirically inadequate
- My proposal: FC and related inferences as neglect-zero effects

  Literal meanings (NE-free fragment) + pragmatic factors (NE) $\Rightarrow$ FC & possibility

  - Implementation in BSML (a team-based modal logic)
  - A pluralism of systems representing different reasoning styles:

    BSML^{*} vs BSML^{+} vs $\mathrm{BSML}^{\emptyset}$

Collaborators & related (future) research

Logic

Proof theory (Anttila, Yang, Knudstorp); expressive completeness (Anttila, Knudstorp); bimodal perspective (Knudstorp, Baltag, van Benthem, Bezhanishvili); qBSML (van Ormondt); BiUS & qBiUS (MA); typed BSML (Muskens); Aristotelian logic in qBSML$_{\rightarrow}$ (MA);...

Language

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

Thank You![4]

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