

# On the monotonicity of attitudes: NPIs and clausal embedding\*

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## 1. Introduction

- This talk is concerned with the question of **modeling monotonicity in attitude reports**: how should our semantics capture the entailments like in (1)?

- (1) a. Katya believes that Anton snowboarded last Friday.  
b.  $\rightsquigarrow$  Katya believes that Anton snowboarded.

- We will use Negative Polarity Items (NPIs) to probe this question, since NPIs are sensitive to monotonicity (Fauconnier 1975, Ladusaw 1979, a.m.o.).
- Our empirical focus is the contrast in (2), first noticed by Sharvit (2023): in negated belief reports, NPIs cannot be licensed in *relative* clauses modifying objects like *the rumor*, (2a), but they are licensed in *complement* clauses composing with such noun phrases, (2b).

(2) **Sharvit’s Puzzle**

- a. \*Katya doesn’t believe [the rumor [that Anton has **ever** spread]].  
b. Katya doesn’t believe [the rumor [that Anton has **ever** snowboarded]].

- The impossibility of the NPI in (2a) is expected on the basis of monotonicity properties of singular definite descriptions; but that (2b) is fine is unexpected.

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★ **Questions:**

- What explains the contrast between (2a) and (2b), and what does it tell us about monotonicity in attitude reports?
- How do different theories of clausal embedding fare with respect to Sharvit’s puzzle — can they be made to account for this data?

★ **This talk:** [extended handout: <https://patrickdelliott.com/pdf/phlip.pdf>]

- Certain approaches to clausal embedding make bad predictions (Sharvit 2023).
- Proposal: modeling monotonicity with the help of *incrementality* (Krifka 1998).
- Solving the puzzle: *Equality Semantics* of CP embedding (Moulton 2009, Elliott 2017, Bondarenko 2022) + *Incrementality* (Krifka 1998).
- **Implication:** attitude reports don’t inherently involve universal quantification.

## 2. Semantics of Clausal Embedding

- Our starting point — *believe* is a verb, and has event-related properties, (3).
- (3)
- a. Alice believed in ghosts *for two weeks*.
  - b. When I saw this, I *suddenly/immediately/quickly* believed in ghosts.
- We assume an event-based treatment of attitude verbs — specifically, we adopt *Neo-Davidsonian* Logical Forms whereby arguments are introduced via *thematic functions* (Castañeda 1967).
- (4)  $\exists e [\text{believe}_w(e) \wedge \text{HOLDER}_w(e) = \mathbf{Alice} \wedge \dots]$
- Where do CP complements fit into this picture?
  - **Kratzer’s insight:** clauses can be modeled as predicates of individuals/eventualities (Kratzer 2006, 2013, 2016).
  - Two prominent implementations of this idea:  
(i) Subset Semantics; (ii) Equality Semantics.

## 2.1. Subset semantics

- **Decomposing attitudes** (Kratzer 2006, 2013, 2016):  
Certain entities are associated with a unique *propositional content*.  
This propositional content can be retrieved via **CONT**: a partial function from eventualities/individuals to propositions.
- An embedded clause denotation after Kratzer:

(5) **Subset Semantics:**

$$\llbracket \text{that } p \rrbracket^w = \lambda x . \text{CONT}_w(x) \subseteq p$$

(6) Verbs, like nouns, are just *predicates* (neo-Davidsonianism):

- a.  $\llbracket \text{believe} \rrbracket^w = \lambda e . \text{believe}_w(e)$
- b.  $\llbracket \text{belief} \rrbracket^w = \lambda x . \text{belief}_w(x)$

(7) Modifying the event argument of the verb (Elliott 2017):

$$\begin{aligned} & \llbracket \text{Alice believes that there are ghosts} \rrbracket^w \\ &= \exists e \left[ \begin{array}{l} \text{believe}_w(e) \wedge \text{HOLDER}_w(e) = \mathbf{Alice} \\ \wedge \text{CONT}_w(e) \subseteq \{ w' \mid \text{there are ghosts in } w' \} \end{array} \right] \end{aligned}$$

(8) Modifying the individual argument of the noun (Kratzer 2006, Moulton 2009):

$$\begin{aligned} & \llbracket \text{the belief that there are ghosts} \rrbracket^w \\ &= \iota x (\text{belief}_w(x) \wedge \text{CONT}_w(x) \subseteq \{ w' \mid \text{there are ghosts in } w' \}) \end{aligned}$$

- The Kratzerian perspective provides a straightforward theory of how nouns compose with clauses without positing ambiguity (cf. Sharvit 2023).

## 2.2. Equality Semantics

- Putting aside some immediate concerns, another option we might consider is *Equality Semantics* (Moulton 2009, 2015, Elliott 2017, 2020, Bondarenko 2022):

(9) **Equality Semantics**

$$\llbracket \text{that } p \rrbracket^w = \lambda x . \text{CONT}_w(x) = p$$

- As with Kratzer's subset semantics, CPs are predicates of contentful events and individuals, and can compose with both verbs and nouns via Predicate Modification (Elliott 2017):

$$(10) \quad \llbracket \text{Alice believes that there are ghosts} \rrbracket^w = \\ \exists e [\text{believe}_w(e) \wedge \text{EXP}(e) = \mathbf{Alice} \wedge \text{CONT}_w(e) = \{w' \mid \text{there are ghosts in } w'\}]$$

$$(11) \quad \llbracket \text{the belief that there are ghosts} \rrbracket^w = \\ \iota x (\text{belief}_w(x) \wedge \text{CONT}_w(x) = \{w' \mid \text{there are ghosts in } w'\})$$

- An immediate drawback of equality semantics is that it fails to capture entailments like (1), repeated below as (12).

- (12) a. Katya believes that Anton snowboarded last Friday.  
b.  $\rightsquigarrow$  Katya believes that Anton snowboarded.

(13) *Equality Semantics*: ✗ (12) not captured

- a.  $\llbracket \text{Katya believes that Anton snowboarded last Friday} \rrbracket^w = \\ \exists e \left[ \begin{array}{l} \text{believe}_w(e) \wedge \text{EXP}(e) = \mathbf{Katya} \\ \wedge \text{CONT}_w(e) = \{w' \mid \text{Anton snowboarded last Friday in } w'\} \end{array} \right]$
- b.  $\llbracket \text{Katya believes that Anton snowboarded} \rrbracket^w = \\ \exists e \left[ \begin{array}{l} \text{believe}_w(e) \wedge \text{HOLDER}(e) = \mathbf{Katya} \\ \wedge \text{CONT}_w(e) = \{w' \mid \text{Anton snowboarded in } w'\} \end{array} \right]$

- Subset Semantics, on the other hand, captures the entailment in (12).
- **Equality Semantics is inherently non-monotonic:** without additional assumptions, existence of an entity with content  $q$  does not tell us anything about existence of an entity of the same sort with content  $p$ , even if  $q$  entails  $p$ .
- If Equality Semantics can't capture simple entailments like in (12), why pursue it? We won't have time to explore this topic in detail, but here's a non-exhaustive summary of relevant work:
- **Motivations for Equality Semantics:**
  - Equality Semantics captures the impossibility of clause stacking/true CP conjunction (Moulton 2009, Bassi & Bondarenko 2021);
  - Subset, but not Equality Semantics interacts poorly with the semantics of the definite article (Elliott 2017, 2020, Bondarenko & Elliott 2023);
  - Equality Semantics captures lack of entailment with noun-modifying CPs (Bondarenko 2021, 2022);
- In sum, we have two theories of the semantics of clausal embedding, both of which make some good predictions and some bad predictions — notably, Subset Semantics is monotonic whereas Equality Semantics is non-monotonic.

### 3. Incorrect Predictions of Existing Theories

#### 3.1. Background on NPI licensing

- Following much existing work, we assume that the acceptability of a weak NPI is contingent on the monotonicity of its local environment.
- In particular, we adopt the following licensing condition for weak NPIs (see Crnič 2019 and the references therein):

(14) **Condition for licensing weak NPIs**

A sentence containing a weak NPI is acceptable only if the weak NPI is dominated by a constituent that is Strawson Downward Entailing (SDE) and not Strawson Upward Entailing (SUE) with respect to its restrictor.

- The definition above, crucially for our purposes, is stated in terms of Strawson Entailment (von Stechow 1999).

(15) **Strawson entailment (informal def.)** ( $\Rightarrow_s$ )

$\phi \Rightarrow_s \psi$  iff when  $\phi$  and  $\psi$ 's presuppositions are satisfied,  $\phi$  entails  $\psi$ .

- We need to demand that the context is not SUE, e.g., because of singular definite descriptions: note that even under negation, NPIs are not licensed in them, (16).
- They create an environment that is always both SDE *and* SUE, (17): if  $P$  is true and  $Q$ 's presupposition is true, then the definites “*the student with loud friends*” and “*the student with friends*” pick out the same individual, making  $Q$  true.

(16) \*[The student with any friends] didn't leave.

<p>(17) The student with loud friends did not leave. (<math>P</math>)  <math>\Rightarrow_s</math> The student with friends did not leave. (<math>Q</math>)</p> <p>a. The student with loud friends did not leave.          b. There is a unique student with friends.          c. <math>\rightarrow</math> The student with friends did not leave.</p>	<p><u><math>P \Rightarrow_s Q, \checkmark SUE</math></u></p> <p><math>P</math> is true  <math>Q</math>'s presupposition is true  <math>Q</math> is true</p>
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#### 3.2. Predictions

- Let us now get back to Sharvit's puzzle, and see how the two theories fare.
- **Desideratum:** explain the contrast between (18) and (19).

- (18) *NPIs within Relative Clauses*
- \*Katya believes [the rumor [that Anton ever spread]].
  - \*Katya doesn't believe [the rumor [that Anton ever spread]].
- (19) *NPIs within Complement Clauses*
- \*Katya believes [the rumor [that Anton has ever snowboarded]].
  - Katya doesn't believe [the rumor [that Anton has ever snowboarded]].

	POS (19a)	NEG (19b)
Subset Semantics	✓ SUE, ✓ SDE *	✓ SUE, ✓ SDE *
Equality Semantics	✗ SUE, ✗ SDE *	✗ SUE, ✗ SDE *
Desideratum	✓ SUE, ✗ SDE *	✗ SUE, ✓ SDE OK

Table 1: Predictions of theories for complement clauses within definite DPs

- Let us first establish why the relative clauses are predicted to be ✓ *SUE*, ✓ *SDE*, and thus why (18a)–(18b) is an expected pattern.
- Here is how this approach to NPIs explains the ungrammaticality of (18b): the presupposition of the definite determiner makes the sentence under negation a SUE environment, and thus the condition for licensing NPIs is not met.

- (20)  $P = \textit{Katya doesn't believe the rumor that Anton spread last Friday}$ ,  
 $Q = \textit{Katya doesn't believe the rumor that Anton spread}$ .
- $\underline{P \textit{ is true: } \exists!x[\textit{rumor}_w(x) \wedge \textit{Anton spread } x \textit{ last Friday in } w]}$   
 $\neg\exists e \left[ \begin{array}{l} \textit{believe}_w(e) \wedge \textit{HOLDER}_w(e) = \mathbf{Katya} \wedge \textit{THEME}_w(e) \\ = (\iota x[\textit{rumor}_w(x) \wedge \textit{Anton spread } x \textit{ last Friday in } w]) \end{array} \right]$
  - $\underline{Q's \textit{ presupp. is true: } \exists!x[\textit{rumor}_w(x) \wedge \textit{Anton spread } x \textit{ in } w]}$
  - $\underline{\textit{Assume that } Q \textit{ is false, then the following is true:}}$   
 $\exists e[\textit{believe}_w(e) \wedge \textit{HOLDER}_w(e) = \mathbf{Katya} \wedge$   
 $\textit{THEME}_w(e) = (\iota x[\textit{rumor}_w(x) \wedge \textit{Anton spread } x \textit{ in } w])]$
  - We have arrived at a contradiction:  
Because *the rumor that Anton spread* and *the rumor that Anton spread last Friday* must be the same rumor.  
Hence,  $Q$  must be true, and  $P \Rightarrow_s Q$ .

- Under the Subset Semantics, the same logic extends to complement clauses:

- (21)  $P = \textit{Katya doesn't believe the rumor that Anton snowboarded last Friday}$ ,  
 $Q = \textit{Katya doesn't believe the rumor that Anton snowboarded}$ ,  
 $p = \{w' \mid \textit{Anton snowboarded last Friday in } w'\}$ ,  
 $q = \{w' \mid \textit{Anton snowboarded in } w'\}$

- a. *P is true*:  $\exists!x[\text{rumor}_w(x) \wedge \text{CONT}_w(x) \subseteq p]$
- b. *Q's presupp. is true*:  $\exists!x[\text{rumor}_w(x) \wedge \text{CONT}_w(x) \subseteq q]$
- c. Because *the rumor that Anton snowboarded last Friday* and *the rumor that Anton snowboarded* must be the same rumor, the logic is the same as before. Thus,  $\mathbf{P} \Rightarrow_s \mathbf{Q}$ .

- **Note why this entailment holds:**

It holds because if there is a unique individual whose content *entails*  $p$ , and  $p$  entails  $q$ , then that very same individual will be the individual whose content entails  $q$ . I.e.,  $\mathbf{P}$  and  $\mathbf{Q}$  have the same assertion.

- Equality Semantics also makes bad predictions, but for the opposite reason: it predicts the environment to be neither SUE nor SDE. Let us illustrate the lack of SDE-ness with the sentence under negation.

- (22)  $P = \text{Katya doesn't believe the rumor that Anton snowboarded,}$   
 $Q = \text{Katya doesn't believe the rumor that Anton snowboarded last Friday,}$   
 $p = \{w' \mid \text{Anton snowboarded in } w'\},$   
 $q = \{w' \mid \text{Anton snowboarded last Friday in } w'\}$
- a. *P is true*:  $\exists!x[\text{rumor}_w(x) \wedge \text{CONT}_w(x) = p]$   
 $\neg\exists e[\text{belief}_w(e) \wedge \text{HOLDER}_w(e) = \mathbf{Katya} \wedge$   
 $\text{THEME}_w(e) = (\iota x[\text{rumor}_w(x) \wedge \text{CONT}_w(x) = p])]$
  - b. *Q's presupp. is true*:  $\exists!x[\text{rumor}_w(x) \wedge \text{CONT}_w(x) = q]$
  - c. *This is compatible with Q being false*:  
 $\exists e[\text{belief}_w(e) \wedge \text{HOLDER}_w(e) = \mathbf{Katya} \wedge$   
 $\text{THEME}_w(e) = (\iota x[\text{rumor}_w(x) \wedge \text{CONT}_w(x) = q])]$

- Since Equality Semantics doesn't account for monotonicity, *the rumor that Anton snowboarded* doesn't have to be the same entity as *the rumor that Anton snowboarded last Friday*. And so the truth of  $\mathbf{P}$  and  $\mathbf{Q}$  are independent.

★ **Summing up:**

- Both theories make bad predictions—they cannot capture the monotonicity of the environment that is empirically observed.
- Subset Semantics wrongly predicts that the context is both SUE and SDE.
- Equality Semantics wrongly predicts that the context is neither SUE nor SDE.

## 4. Monotonicity and Incrementality of Content

**Our proposal:** monotonicity can be grafted onto an equality semantics via a property that attitudinal eventualities may have: *incrementality of Content* (cf. incrementality in Krifka 1998). This will provide a solution to the Sharvit’s puzzle.

### 4.1. Incrementality

- Our proposal will relate to the fact that contentful entities (including eventualities and individuals) have a *rich mereological structure*.
- (23) a. Part of what Tanya believes is that Anton can ski.  
b. Part of Tanya’s belief is that Anton can ski.
- **Questions:**
    1. How does the part-whole structure of contentful entities relate to the part-whole structure of their *Contents*?
    2. How does it relate to the part-whole structure of their *Themes*?
  - Krifka (1998): proposal specifically for incremental themes, e.g.:
- (24) **Incremental Theme:** *Julia ate the apple.*  
→ Every proper part of the apple maps onto a proper subevent of the eating, and every proper subevent of eating maps onto a proper subpart of the apple.
- (25) **Not an Incremental Theme:** *Julia saw the apple.*  
↯ Every proper subevent of seeing maps onto a proper subpart of the apple.
- In order to capture the relationship between the *parts of eating* and *parts of the apple*, Krifka defines two homomorphism-like properties that thematic functions (like THEME or PATH) may satisfy.
  - In order to account for the monotonicity of *believe*, we generalize Krifka’s proposal to the contents and themes of *believings*. Concretely, we motivate the following properties of CONT and THEME functions:<sup>1</sup>

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<sup>1</sup>These are special cases of Krifka’s more general proposal. The notions in their full generality are provided below, but this won’t be relevant to the following discussion:

- (i) A function  $f : D \rightarrow D'$  satisfies **Mapping-to-Subparts-of-the-Inputs** iff:  
 $(f(x) = y \wedge y' < y) \rightarrow \exists x' \in D[x' < x \wedge f(x') = y']$   $\forall x \in D, \forall y, y' \in D'$
- (ii) A function  $f : D \rightarrow D'$  satisfies **Mapping-to-Subparts-of-the-Outputs** iff:  
 $(f(x) = y \wedge x' < x) \rightarrow \exists y' \in D'[y' < y \wedge f(x') = y']$   $\forall x, x' \in D, \forall y \in D'$



1. Mapping-to-Subparts-of-the-Inputs (MSI) for CONT

*The part-whole structure of a contentful entity preserves the part-whole structure of its content.*

2. Mapping-to-Subparts-of-the-Outputs (MSO) for THEME

*The part-whole structure of the theme of a believing preserves the eventuality's part-whole structure.*

- Our proposal for verbs like *believe* then amounts to the following: their Content exhibits MSI, and their Theme exhibits MSO.

## 4.2. Content and monotony

- **The idea informally:** *If there's a believing  $e$  with content  $q$ , and part of what  $q$  conveys is that  $p$ , then there's a part of  $e$  which conveys  $p$ .*
- Let's say that it's true that "Tanya believes that Anton can ski, and Mitya can snowboard". Since *part of* the conjunctive proposition is that *Anton can ski*, then there's a sub-part of Tanya's belief which conveys this as its content.

(26) **MSI of Content**

$$\text{CONT}(y) = q \wedge p < q \rightarrow \exists x \in D_e [x < y \wedge \text{CONT}(x) = p] \quad \forall y \in D_e, \forall q, p \in D_{st}$$

- We take *parthood* for propositions to be based on classical entailment:<sup>2</sup>

(27) Parthood for propositions (entailment-based):

$$p \leq q := p \supseteq q$$

( $p$  is a part of  $q$  iff  $p$  is entailed by  $q$ )

- Let's see how this captures monotonicity for simple attitude-reports.

(28) Patrick believes that it's raining heavily.

$$\exists e \left[ \begin{array}{l} \text{HOLDER}(e) = \mathbf{Patrick} \\ \wedge \text{believe}_w(e) \wedge \text{CONT}_w(e) = \{ w' \mid \text{it's raining heavily in } w' \} \end{array} \right]$$

- In order for this existential statement to be true, it must have a *verifier*, let's call this eventuality **b**.

(29)  $\text{CONT}_w(\mathbf{b}) = \{ w' \mid \text{it's raining heavily in } w' \}$

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<sup>2</sup>It can easily be verified that the *superset* relation satisfies the requirements of a mereological parthood relation, namely, it's *reflexive*, *transitive*, and *anti-symmetric*.

- Due to MSI: for every proper part  $p$  of the proposition  $q = \textit{it's raining heavily}$  (i.e., for every *superset* of  $q$ ), there must be a proper part of  $\mathbf{b}$  with content  $p$ .
- This guarantees the existence of, e.g., the following sub-believings of Patrick:<sup>3</sup>

$$(30) \quad \begin{aligned} \text{a. } & \text{CONT}_w(\mathbf{b}') = \{ w \mid \textit{it's raining in } w \} \\ \text{b. } & \text{CONT}_w(\mathbf{b}'') = \{ w \mid \textit{it's raining or snowing in } w \} \\ \text{c. } & \text{CONT}_w(\mathbf{b}''') = \{ w \mid \textit{it's raining or not raining in } w \} \end{aligned}$$

- Each of these sub-believings verifies a corresponding belief-report, where the content of Patrick's belief is entailed by *it's raining heavily*, e.g., (30a) verifies:

$$(31) \quad \begin{aligned} & \text{Patrick believes it's raining.} \\ & \exists e' \left[ \text{HOLDER}(e') = \mathbf{Patrick} \right. \\ & \quad \left. \wedge \text{believe}_w(e') \wedge \text{CONT}_w(e') = \{ w' \mid \textit{it's raining in } w' \} \right] \end{aligned}$$

- Thus, imposing MSI on the CONTENT of *believe* renders *believe* monotonic.
- The corollary is that a *negated* belief-report creates a DE environment:

$$(32) \quad \begin{aligned} & \text{Patrick doesn't believe that it's raining.} \\ & \neg \exists e \left[ \text{HOLDER}(e) = \mathbf{Patrick} \right. \\ & \quad \left. \wedge \text{believe}_w(e) \wedge \text{CONT}_w(e) = \{ w' \mid \textit{it's raining in } w' \} \right] \end{aligned}$$

- The existence of a verifier for *Patrick believes that it's raining heavily* would falsify (32), since thanks to the guarantees imposed by MSI of Content, it would entail the existence of a verifier for *Patrick believes that it's raining*.
- Since we've created monotonicity, NPIs in negated belief-reports are explained:

$$(33) \quad \text{Mitya doesn't believe that Anton has } \textit{ever} \text{ snowboarded.}$$

### 4.3. Theme and MSO

- MSO-exhibiting THEME relation holds for *believing*-eventualities:  
*If there's a believing  $e$  whose THEME is the rumor  $y$ , then for any subevent of  $e$  there is a sub-rumor of  $y$  that is its THEME.*

$$(34) \quad \begin{aligned} & \mathbf{MSO of Theme} \\ & \text{THEME}(e') = y \wedge e < e' \rightarrow \exists x \in D_e [x < y \wedge \text{THEME}(e) = x] \\ & \quad \quad \quad \forall e, e' \in D_e, \forall y \in D' \end{aligned}$$

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<sup>3</sup>We assume that every part of a *believing-of-Patrick* event is also a *believing-of-Patrick* event.

- *If Katya believes the rumor that Anton snowboarded on Friday, then all of the sub-beliefs of this believing event have subparts of the rumor that Anton snowboarded on Friday as their THEMES.*
- **NB:** We do NOT assume that part-whole structure of believing events is isomorphic with their *durations*—proper parts of beliefs can have the same duration as the belief (*we can have many related beliefs at any given time interval!*).
- Expressions like *partially*, (35), suggest that this is on the right track: e.g., (35) can be true if Mary believes  $p$  but not  $q$ , but it cannot imply that Mary is temporally part way through a  $p$ -and- $q$ -believe state.

(35) Mary partially believes  $p$  and  $q$ .  
 $\neq$  Mary is part way through a duration of a believing event  
with content  $p$  and  $q$ .

#### 4.4. Theme-Event Content Matching

- Our final ingredient is the observation that verbs like *believe* involve a special relation between the content of the THEME and the content of the event: from the sentence with the DP we infer that the sentence with the CP is true, (36a)-(36b).
- This is not true of all verbs: e.g. cf. *imagine* in (37a)-(37b).<sup>4</sup>

(36) a. Katya believes the rumor that Anton snowboarded.  
b.  $\rightsquigarrow$  Katya believes that Anton snowboarded.

(37) a. Katya imagines the rumor that Anton snowboarded.  
b.  $\not\rightarrow$  Katya imagines that Anton snowboarded.

- We suggest that this entailment arises from the *Theme-Event Content Matching* restriction, (38), that some verbs place on their internal arguments: that the content of the THEME be the same as the content of the event that they describe.

(38) **THEME-EVENT CONTENT MATCHING (TECM)**  
TECM holds for a predicate of contentful events  $P$  iff:  
 $\forall x, e \in \mathbf{Dom}(\mathbf{CONT}), (P(e) \wedge \mathbf{THEME}(e) = x) \rightarrow \mathbf{CONT}(e) = \mathbf{CONT}(x)$

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<sup>4</sup>Uegaki (2016) lists the following verbs that do and do not allow such entailment:

- |     |  |      |  |
|-----|--|------|--|
| (i) | DP $\Rightarrow$ CP<br>believe, accept, trust, deny,<br>(dis)prove, validate | (ii) | DP $\not\Rightarrow$ CP<br>know, discover, report, predict |
|-----|--|------|--|

## 4.5. Resolving Sharvit's puzzle

- Now we have all the ingredients to solve Sharvit's puzzle: MSI of CONTENT, (39), MSO of THEME, TECM, (41).

$$(39) \quad \text{MSI of Content} \quad \forall y \in D_e, \forall q, p \in D_{st} \\ \text{CONT}(y) = q \wedge p < q \rightarrow \exists x \in D_e [x < y \wedge \text{CONT}(x) = p]$$

$$(40) \quad \text{MSO of Theme} \quad \forall e, e' \in D_e, \forall y \in D' \\ \text{THEME}(e') = y \wedge e < e' \rightarrow \exists x \in D_e [x < y \wedge \text{THEME}(e) = x]$$

$$(41) \quad \text{TECM: } \forall x, e : (P(e) \wedge \text{THEME}(e) = x) \rightarrow \text{CONT}(e) = \text{CONT}(x)$$

- In (42) we provide the proof that the Sharvit's sentences will come out as SDE.

$$(42) \quad \begin{aligned} &P = \textit{Katya doesn't believe the rumor that Anton snowboarded,} \\ &Q = \textit{Katya doesn't believe the rumor that Anton snowboarded last Friday,} \\ &p = \{ w' \mid \text{Anton snowboarded in } w' \} \\ &q = \{ w' \mid \text{Anton snowboarded last Friday in } w' \} \\ &a. \quad \underline{P \textit{ is true:}} \text{ Let } r_p = \iota x [\text{rumor}_w(x) \wedge \text{CONT}_w(x) = p] \\ &\quad \quad \quad \neg \exists e [\text{Believe}_w(e) \wedge \text{HOLDER}(e) = \textit{Katya} \wedge \text{THEME}(e) = r_p] \\ &b. \quad \underline{Q's \textit{ presupp. is true:}} \text{ Let } r_q = \iota y [\text{rumor}_w(y) \wedge \text{CONT}_w(y) = q] \\ &c. \quad \underline{\textit{Assume that Q is false. Then the following holds:}} \\ &\quad \quad \quad \exists e' [\text{believe}_w(e') \wedge \text{HOLDER}_w(e') = \textit{Katya} \wedge \text{THEME}_w(e') = r_q] \\ &d. \quad \underline{\textit{Instantiate } e' \textit{ in (42c) as } b_q; \textit{ By TECM:}} \\ &\quad \quad \quad \text{CONT}_w(b_q) = q \\ &e. \quad \underline{\textit{By MSI of Content from (42d), given that } p < q:} \\ &\quad \quad \quad \exists e [e < b_q \wedge \text{Holder}(e) = \textit{Katya} \wedge \text{CONT}_w(e) = p] \\ &f. \quad \underline{\textit{instantiate } e \textit{ as } b_p; \textit{ by MSO of Theme,}} \\ &\quad \quad \quad \underline{\textit{since } \text{THEME}_w(b_q) = r_q \textit{ and } b_p < b_q:} \\ &\quad \quad \quad \exists r [r < r_q \wedge \textit{Theme}(b_p) = r] \\ &g. \quad \underline{\textit{instantiate } r \textit{ as } r_{p'}; \textit{ by TECM from (42f):}} \\ &\quad \quad \quad \text{CONT}_w(r_{p'}) = p \\ &h. \quad \underline{\textit{By (42a), } r_{p'} = r_p, \textit{ and thus by existential generalization:}} \\ &\quad \quad \quad \exists e [\text{belief}_w(e) \wedge \text{HOLDER}(e) = \textit{Katya} \wedge \text{THEME}(e) = r_p] \\ &i. \quad \text{We have arrived at a contradiction: (42a) contradicts (42h).} \\ &\quad \quad \text{Thus, } Q \text{ cannot be false, and } \mathbf{P} \Rightarrow \mathbf{Q}. \text{ We correctly predict } \checkmark \text{ SDE.} \end{aligned}$$

- In the Sharvit’s example under negation, we want the sentence to be SDE and not SUE in order to explain why the NPI is licensed:

- (43) a. Katya doesn’t believe the rumor that Anton snowboarded.  
 b.  $\rightsquigarrow$  Katya doesn’t believe the rumor that Anton snowboarded last Friday.

- (44) a. Katya doesn’t believe the rumor that Anton snowboarded last Friday.  
 b.  $\not\rightarrow$  Katya doesn’t believe the rumor that Anton snowboarded.

- In (42) we see that we correctly predict (43) to be SDE: if we assume that  $P$  is true (*Katya doesn’t believe the rumor that Anton snowboarded*), but  $Q$  is false (*Katya believes the rumor that Anton snowboarded last Friday*), then Katya must have a belief whose THEME is the rumor that Anton snowboarded, (42h).
- But that violates our assumption that  $P$  is true — i.e., that Katya does not believe this rumor. Hence, the environment is SDE.
- Importantly, we do not predict the environment to be SUE:
  - Katya can believe a rumor whose content *equals*  $\{w' \mid \text{Anton snowboarded in } w'\}$ ;
  - ...but NOT believe a rumor whose content *equals*  $\{w' \mid \text{Anton snowboarded last Friday in } w'\}$ .
- Note that adopting Theme-Event Content Matching doesn’t help the Subset Semantics: it still predicts the environment in to be SUE.

- (45) a. Katya believes the rumor that Anton snowboarded.  
 b.  $\rightsquigarrow$  Katya believes that Anton snowboarded.

- This is because if there is a unique *rumor that Anton snowboarded last Friday* and a unique *rumor that Anton snowboarded*, due to the property in (46), they must be the same rumor, and the sentence still comes out SUE.
- Equality semantics avoids this issue: for it no *rumor that  $q$*  is a *rumor that  $p$* , (47).

(46)  $\forall w, \forall x, \forall p \supset q [Cont_w(x) \subseteq q \rightarrow Cont_w(x) \subseteq p]$

(47)  $\forall w, \forall x, \forall p \supset q [Cont_w(x) = q \rightarrow Cont_w(x) \neq p]$

## 5. Conclusion

- To sum up, our account has the following ingredients:
  1. *Mereological properties of events*:
    - their CONTENT exhibits Mapping-to-Subparts-of-Inputs;
    - their THEME exhibits Mapping-to-Subparts-of-Outputs;
  2. *Theme-Event Content-Matching*.
- We conjectured that *believing* eventualities satisfy the aforementioned mereological properties, and observe TECM.<sup>5</sup>
- MSI of CONTENT gave us an account of monotonicity of clause-embedding verbs.
- MSO of THEME and *Theme-Event Content-Matching* allowed us to capture how the contentful internal arguments of verbs like *believe* are related to the event argument of *believe*, and thus explain entailment patterns in complement clauses of THEME of *believe*, and provide a solution to Sharvit’s puzzle.
- **Next steps:** What predictions do we make beyond *believe*? See appendix A.

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<sup>5</sup>One might wonder “where” and “how” these properties of believing eventualities are encoded. It seems to us that they should be treated on par with other definedness conditions predicates place on their arguments, e.g., a requirement that an argument is animate, or doesn’t exist before the event. We can see at least two ways to encode these conditions: (i) state them as meaning postulates; (ii) encode in partiality of the functions that the  $\Theta$ -heads denote. We leave this issue open.

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## A. Beyond *believe*

- **Prediction about NPI licensing in Sharvit’s configuration:**

If a contentful eventuality  $e$  exhibits MSI for CONT, and furthermore  $e \in \text{Dom}(\text{THEME})$ , and TECM holds, then NPIs should be licensed in CPs combining with nouns in the following configuration:

*not [x Vs [the N CP]].*

- Here are verbs for which we think prediction is borne out: *accept* and *trust*.<sup>6</sup>

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<sup>6</sup>There are also verbs that contain inherent negation and are thus SDE, (i). If such verbs exhibit TECM, (ii), then NPIs are licensed in the Sharvit’s configurations for such verbs too, (iii).

- (i) a. John **denies** that it’s raining,

- (48) a. John **accepts** that it's raining heavily,  
#but he doesn't accept that it's raining.  
b. John **trusts** that it's raining heavily,  
#but he doesn't trust that it's raining.
- (49) a. John **accepts** the claim that it's raining.  
↗ John **accepts** that it's raining.  
b. John **trusts** the claim that it's raining.  
↗ John **trusts** that it's raining.
- (50) a. Mitya doesn't **accept** the rumor that Anton has ever been skiing.  
b. Mitya doesn't **trust** the rumor that Anton has ever been skiing.

- We also expect that if verbs denote predicates of events whose CONTENT exhibits MSI, but whose THEME arguments do not have the same CONTENT as they do, then NPIs shouldn't be licensed in the Sharvit's configuration.
- Two verbs potentially displaying this pattern:

- (51) a. John **remembers** that it's raining heavily,  
#but he doesn't **remember** that it's raining.  
b. John is **imagining** that it's raining heavily,  
#but he isn't **imagining** that it's raining.
- (52) a. John **remembers** the claim that it's raining.  
↗ John **remembers** that it's raining.  
b. John is **imagining** the claim that it's raining.  
↗ John is **imagining** that it's raining.
- (53) \*John doesn't remember the claim that Anton has ever been snowboarding.
- (54) \*John isn't imagining the claim that Anton has ever been snowboarding.

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- b. #but he doesn't deny that it's raining heavily.  
John **disproved** that it's raining,  
#but he didn't disprove that it's raining heavily.
- (ii) a. John **denies** the claim that it's raining.  
↗ John **denies** that it's raining.  
b. John **disproves** the claim that it's raining.  
↗ John **disproves** that it's raining.
- (iii) a. Mitya **denies** the rumor that Anton has ever been skiing.  
b. Mitya **disproves** the rumor that Anton has ever been skiing.