Substitution Puzzles

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Setting the Scene

Frege's Puzzle

- Why is substitution of co-referential terms sometimes informative (Frege 1892)?

1. Cassius Clay is Cassius Clay.
2. Cassius Clay is Muhammad Ali.
3. Kim believes that Cassius Clay was a great boxer.
4. Kim believes that Muhammad Ali was a great boxer.
5. Kim doesn't believe that Cassius Clay is Muhammad Ali.

Sense & Opacity

- Frege's own solution was that in addition to a reference, nominals have a *sense*, or 'mode of presentation'.

- A Fregean sense is 'a way of picking out the referent'.

- In informative identity statements, like (2), the Fregean solution is thus that the identity statement is actually a statement about identity of senses.

- Similarly, in certain contexts, such as those involving propositional attitudes, it is these distinct senses that block substitutability.

- Frege's puzzle is thus clearly related to the problem of *referential opacity* in the study of propositional attitudes (Quine 1953, 1956, 1960).

Overview

- I will focus on linguistic aspects of co-reference and substitution, rather than the many important philosophical questions raised by the phenomena, although we will also inevitably touch on some of the philosophical foundations.
- I have three main goals:

  1. To show that substitution puzzles are quite general and can arise without embedding and without distinct terms

  2. To argue that a better way of thinking about substitution involves a notion of *perspective*

  3. To informally sketch a formal approach to perspective based on a construct from category theory: *monads*

The Scope of the Problem

Foreshadowing

- The substitution puzzles are standardly characterized as involving two factors:
    - Embedding under a modal or propositional attitude expression, such as *believe*
    - Co-referential but distinct terms, such as *Cassius Clay* and *Muhammad Ali*
- It has been shown in the literature that neither of these factors is necessary for substitution puzzles or related puzzles to arise, which yields a typology of four major classes of substitution puzzles.

Distinct Terms,
No Embedding

Simple Sentences

- Saul (1997: 102, fn.1): lack of substitutability can hold even in ‘simple sentences’ that ‘contain no attitude, modal or quotational constructions’

- Assuming it is common knowledge that Clark Kent is Superman’s secret identity, she notes that if (6) is true, substitution of Clark Kent for Superman seems to render (7) false (Saul 1997: 102, (1) & (1*)):

    6. `Clark Kent went into the phone booth, and Superman came out.`

    7. `Clark Kent went into the phone booth, and Clark Kent came out.`

- With respect to this pair, an obvious out presents itself: Why would someone say (7) if they meant (6)?

    - That is, it seems that we could say these sentences are in fact semantically synonymous (so (7) is not false when (6) is true), but pragmatically distinct.

- This is in fact basically what Saul argues (Braun and Saul 2002, Saul 2007): namely, what is mistaken is our intuition that (6) is true while (7) is false.

Perspectives

- Consider instead the following sentence:

  8. `Mary Jane loves Peter Parker, but she doesn’t love Spider-Man.`

- Let’s assume that the time of evaluation is a point in the stories before Mary Jane knows that Peter Parker is Spider-Man.
  - There is a non-contradictory reading of this sentence.
- According to the theory presented in Saul (2007), this sentence is simply false, but that seems to entirely set aside Mary Jane’s say in the matter, which seems problematic.

Perspectives

- It would be very strange to insist that if Mary Jane loves Peter Parker, then she really does love Spider- Man.

  - She certainly wouldn't agree to that.

- In short, (8) shows a lack of substitutability in a grammatically very simple sentence and this lack of substitutability does not yield as readily to a pragmatic explanation as do Saul's examples.

- Instead, (8) seems to crucially involve Mary Jane's *perspective*.

Guises

- This last observation also distinguishes our approach from one where a sentence like (8) is interpreted as simply saying that Mary Jane loves only one *guise* of the entity that corresponds to Peter Parker but not another one (Castañeda 1972, 1989, Heim 1998).

- One might object that people love entities not guises.

- Something like this seems at play in the criticism of MacColl (1905a,b) by Russell (1905: 491).

Guises

- As a linguist, I feel neither prepared nor compelled to enter that debate, but a simple guise-based theory in fact makes false empirical predictions, which a linguist should be prepared to discuss.

- If it is indeed the case that different co-referring expressions simply pick out different guises of the same individual, then a sentence like (9) should have a non-contradictory reading, but this does not seem to be the case (assuming it is indeed Peter Parker who is Spider-Man at the time; i.e. there has been no passing of the mantle or any such thing):

9. # Dr. Octopus killed Spider-Man but he didn't kill Peter Parker.

Kill and *Murder*

- If we substitute *murder* for *kill* in (9), the result is not infelicitous:

  10. `Dr. Octopus murdered Spider-Man but he didn't murder Peter Parker.`

- Unlike *kill*, *murder* involves intention, but it is not a propositional attitude verb and there is no obvious evidence of embedding.

- Whatever analysis we give must also not lose sight of the fact that there are genuine cases of contradiction that must still be derivable, such as the following:

  11. `# Dr. Octopus punched Spider-Man but he didn't punch Spider-Man.`

- Our claim is that what unites *murder* and *love* versus *kill* and *punch* is the fact that the subject/agent's *perspective* is part of the interpretation for the former, but not the latter.

- In other words, *murder* and *love* are perspectival verbs, whereas *kill* and *punch* are not.

Non-Distinct Terms, Distinct Beliefs (Embedding)

The Paderewski Puzzle

- Kripke (1979) presents a puzzle that is closely related to the substitutability puzzle, but which relates to the second factor mentioned above: whether the terms involved must be distinct.

- He considers the case of 'phonetically identical tokens of a single name'.

- He provides the example of an individual, Peter, who has learned that *Paderewski* was the name of an accomplished Polish pianist. The following then seems true:

    12. Peter believes that Paderewski had musical talent.

- Peter then hears of a Polish politician named *Paderewski*, and concludes that this is a different person, since he has no reason to believe that politicians make good musicians.

- Given that in fact the same Paderewski was in fact both a politician and a pianist, is the following true or not?

    13. Peter believes that Paderewski had no musical talent.

- Kripke argues that this is a true paradox and we can neither conclude that (13) is true nor false, given the situation.

Fiengo & May's Indices

- Fiengo and May (1998) deny Kripke's conclusion on the basis of a theory of reference that crucially holds that names do not directly refer but only do so once part of linguistic expressions, which bear distinguishing indices,such as '[NP_1 Paderewski]'.

- What the speaker believes is characterized by statements of the following form (Fiengo and May 1998: 388): '[NP_i X]' has the value NP_i

- They also propose the following principle:

  14. **Singularity Principle**
      If cospelled expressions are covalued, they are coindexed.

- For Fiengo and May, then, there are two distinct Paderewski indexations at play for Peter, which means that the two "cospelled" instances of Paderewski are not covalued, given the Singularity Principle.

F&M's Paderewski Proposal

- Fiengo and May (1998:399) ask us to consider a version of the Paderewski puzzle in which the speaker believes that John believes that there are two people named Paderewski, but the speaker herself believes that there is only one (contextually relevant) person named Paderewski.

- The speaker may then say, without contradiction, (15a), which has the Fiengo and May logical form (15b), and (16a), which has the logical form (16b).

- Thus, the beliefs of John are distinguished by the indexation.

15. a. John believes that Paderewski is a genius.
    b. John believes that [Paderewski$_1$ is a genius and 'Paderewski$_1$' has the value Paderewski$_1$]

16. a. John does not believe that Paderewski is a genius.
    b. John does not believe that [Paderewski$_2$ is a genius and 'Paderewski$_2$' has the value Paderewski$_2$]

F&M's Paderewski Proposal

- Similarly, so long as Peter believes there are two Paderewskis, he can simultaneously believe that one had musical talent while the other did not.

- If and once he realizes that these two are the same person, then the Singularity Principle requires that the two Paderewski expressions bear the same index and Peter could no longer believe both without contradiction.

Interpreted Logical Forms

- The informal theory that Fiengo and May (1998) put forward seems to us to be closely related to the Interpreted Logical Form theory of Larson and Ludlow (1993), who Fiengo and May fail to cite.

- Larson and Ludlow (1993: 336) provide the following cute and memorable, but ultimately unconvincing example:

- **Context: Jason is from New York and does not know how the name Harvard is pronounced in a Boston accent.**

  17. Jason believes that [Harvard is a fine school].

- Using [harvard] to indicate Jason's pronunciation of *Harvard* and [hahvahd] to indicate the Boston pronunciation, Larson and Ludlow point out that, given this context, (18) is true, while (19), is false:

  18. Jason believes that [[harvard] is a fine school].

  19. Jason believes that [[hahvahd] is a fine school].

The Example is Problematic

- Why is this unconvincing?
  - For Jason, [harvard] and [hahvahd] are just different words.
- The fact that they are different pronunciations of the same word is etymological knowledge that is irrelevant to Jason's synchronic knowledge of language.
- Coincidence of spelling is similarly irrelevant — a criticism that applies to Fiengo and May's Singularity Principle, too (cf. 'cospelled expressions' in their definition).
- Kripke in fact characterized things much more aptly when he wrote of 'phonetically identical tokens of a single name': homophony is what's at stake, not homography.

Disentangling Paderewski

- A more satisfactory analysis of these kinds of linguistic puzzles rests on disentangling two different phenomena that seem at play in Paderewski puzzles.

- Kripke's conclusion that we are dealing with a paradox seems motivated by the interplay between the perspectival dimension introduced by the verb *believe* together with the ambiguous nature of the name *Paderewski* in the context of Peter's lexicon.

- In this case we not only have different perspectives regarding the interpretation of a term (the speaker's and Peter's), but the two interpretations also have different cardinalities (i.e., before he is enlightened, Peter has two lexical entries for Paderewski, whereas the speaker has one).

Disentangling Paderewski

- Given that Peter can use the name Paderewski to refer to two different (from Peter's perspective) entities, in an example like (12) (**`Peter believes that Paderewski had musical talent`**) it is not possible to resolve whether we are talking about Peter's belief with regard to the pianist entity or the politician one.

- Therefore (12) seems to lack a determinate truth value: It is true with respect to Paderewski the politician, but false with respect to Paderewski the musician.

- We have competing interpretations, but each one is fully interpretable and can be assigned a truth value.

- Of course, this move itself only makes sense if the two instances of the name Paderewski in fact do not refer to one and the same entity for Peter, which is not possible for Kripke, given his assumptions about how the names refer (directly to entities in the world).

Identity Statements: Delusions and Hucksters

- The observations that homophonous terms and simple sentences can likewise lead to the substitutability puzzle and related puzzles is thus established in the literature.

- But it seems to us that we can drive the point home in an even simpler way, by starting with basic identity statements involving two homophonous tokens of the same name, avoiding accents and bypassing Paderewskis.

- Statements such as the following are normally taken to be uninformative tautologies:

  20. Sandy is Sandy.

- If this is true, then a statement like the following should mean that Kim does not believe a tautology (which would make Kim entirely irrational under normal assumptions):

  21. Kim doesn't believe that Sandy is Sandy.

- Let us call the reading where Kim does not believe a tautology an *unsatisfiable* reading.

Capgras Syndrome

- However, sentences like (21) (**`Kim doesn't believe that Sandy is Sandy`**) also have satisfiable readings in the right context:

> 22. **`Context:`** `Kim suffers from Capgras Syndrome, also known as the Capgras Delusion, a condition "in which a person holds a delusion that a friend, spouse, parent, or other close family member has been replaced by an identical-looking impostor." (Wikipedia)`

- In this context, it is clear that one instance of Sandy is interpreted from the speaker's perspective, call this $\textbf{Sandy}_{\sigma}$ (where σ is the speaker index) and the other from Kim's, call this $\textbf{Impostor}_{\textbf{kim}}$. The speaker is then asserting that Kim does not believe that $\textbf{Impostor}_{\textbf{kim}} = \textbf{Sandy}_{\sigma}$.

- In a sense, then, this is a simple, limiting case of the puzzles we have been looking at.

The Indiana Pi Bill

- Consider the following piece of American history:

> 23. **Context:** In 1897 Dr. Edwin J. Goodwin presented a bill to the Indiana General Assembly for "[. . .] introducing a new mathematical truth and offered as a contribution to education to be used only by the State of Indiana free of cost". (Wikipedia)

- He had copyrighted that $\pi = 3.2$ and offered this "new mathematical truth" for free use to the State of Indiana (but others would have to pay to use it).

- At the appropriate historical juncture, it is clear that the following sentence had a satisfiable reading:

> 24. Dr. Goodwin doesn't believe that pi is pi.

- Dr. Goodwin was a huckster, but given the context, it seems that (24) accurately reported his beliefs.

A Standard Scopal Solution?

- It may be tempting to explain these facts in terms of a *de re/de dicto* distinction based on compositional scope, as in Montague Semantics (Montague 1973), but that kind of analysis is too permissive and generates readings that are unavailable.

- For example, suppose Dr. Goodwin had had a rival — let's call him Dr. Badwin — in the Indiana General Assembly trying to push an alternative bill proposing that π equals 3.15.

A Standard Scopal Solution?

- A *de re/de dicto* analysis in this case would generate a reading for (24) (**`Dr. Goodwin doesn't believe that pi is pi`**) such that there is at least one belief world of Dr. Goodwin's in which true π does not equal 3.15.

    - But this is too weak an interpretation for Dr. Goodwin's actual beliefs: none of his belief worlds are such that he believes π is 3.15 — that's Dr. Badwin's belief.

        - In other words, there is a stronger requirement on compositional interpretation than we would get, in the general case, by simply treating terms as ambiguous, where the ambiguity is a property of the term itself.

        - Rather, they are potentially ambiguous in different ways for different speakers.

- One way to capture this is our method of allowing interpretation to be anchored to different agents' potentially differing perspectives.

The True Empirical Problem Space

	Simple	Embedded
Same Term	`# Dr. Octopus punched Spider-Man but he didn't punch Spider-Man.`	`Kim doesn't believe Sandy is Sandy.`

Distinct Term	`Mary Jane loves Peter Parker but she doesn't love Spider-Man.`
	
	`# Dr. Octopus killed Spider-Man but he didn't kill Peter Parker.`
		`Kim doesn't believe Cassius Clay is Muhammad Ali.`

Informal Formal Analysis

A ‘Standard’ Approach?

LFs with Perspectives

- Our analysis depends crucially on the availability of different points of view during the interpretation process (*perspectives*).

- One simple formalization of this idea is to make the interpretation function that maps expressions to meanings have an additional parameter representing a perspective.

- Therefore, in order to interpret an expression α, we would need both an assignment function (as is standard) and a perspective index.

- This would allow a treatment in a Logical Form semantics à la Heim & Kratzer (1998).

Adding Perspective Indices

- We would then need revised rules for *functional application* and *predicate abstraction* that take these perspective indices into account.
- In such a system all expressions are interpreted with respect to a perspective index.
- For non-contentious expressions, such indices are not used for determining the denotation of an expression, yielding a constant interpretation.
- For contentious expressions, the index is used to yield different values

$$[\![\text{Mary Jane}]\!]^{g,i} = \mathbf{mj}_\sigma$$

$$[\![\text{Peter Parker}]\!]^{g,i} = \mathbf{pp}_\sigma$$

$$[\![\text{Spider-Man}]\!]^{g,i} = \begin{cases} \mathbf{sm}_{\mathtt{mj}} \text{ if } i = \mathtt{mj} \\ \mathbf{pp}_\sigma \text{ if } i = \sigma \end{cases}$$

Ambiguous Logical Forms

- We would also need to differentiate between perspectival verbs, like *love,* and non-perspectival verbs, like *punch*.

- I'll leave the details aside here, but having added perspectives to the meta-language, this necessitates a syncategorematic definition for *love*, but a standard categorematic definition for *punch*.

- The result is that if an instance of a contentious expression, e.g. a name like *Spider-Man*, is evaluated outside the scope of *love*, it is interpreted from the speaker's perspective, but if it is evaluated inside the scope of *love*, it is interpreted from the subject's perspective.

Ambiguous Logical Forms

- A sentence like **`Mary Jane loves Spider-Man`** thus has two LFs:

    1. One in which *Spider-Man* is evaluated from the speaker's perspective, such that the sentence is true (since for the speaker *Spider-Man* and *Peter Parker* have the same denotation)

    2. Another in which *Spider-Man* is evaluated from Mary Jane's perspective, such that the sentence is false (since for Mary Jane *Spider-Man* and *Peter Parker* have distinct denotations)

Costs of the LF Approach

1. The lexicon is generalized to the worst case, having introduced perspective indices everywhere.

2. The rules for functional application and predicate abstraction had to be modified/rendered more complicated.

Costs of the LF Approach

3. We were forced to adopt syncategorematic rules for interpreting special expressions like the verb *love*.

    - We could obtain a categorematic treatment of perspectival expressions like *love* by lifting all lexical meanings to be functions from perspectives to extensions, but this once again comes at the cost of generalizing the lexicon to the worst case.

    - In other words, on the LF approach there is a tension between categorematicity of perspectival expressions and lexical parsimony.

4. The approach is not particularly general: It doesn't connect the analysis of perspectival verbs formally to analyses of independent phenomena.

A Monadic Approach

Background:
Category Theory

- **Category theory** is ‘a general mathematical theory of structures and of systems of structures’ (SEP).

- **Categories** are the core notion of category theory. They focus on the ideas of functions/transitions (between objects) and their composition.

- **Functors** are maps between categories.

    - They map the objects of the input category to objects of the output category, and similarly for the mappings within the input category.

    - However, functors have a contract to fulfill: the patterns of composition in the input category must be preserved in the output category, which could also contain additional patterns of composition of its own.

    - The intuition is basically that a compositional system is enriched as a new compositional system, but one that still preserves the compositional properties of the first system.

Monads

- **Monads** are particular types of functors that support the notions of embedding and joining/composing/combining.

    - Embedding is at the heart of our notion of perspectives, and of our more general notion of *enriched meanings*: It provides a way of adding further information/complexity to a meaning such that the result still preserves the original meaning.

    - Joining provides a way to mitigate the resulting embeddings such that successive enrichment layers can be collapsed into a single layer without losing the enrichments.

    - Embedding and joining thus together provide a compositional form of meaning enrichment that is no more complex than necessary.

- **Formal intuition:** The monadic approach allows a basic compositional system to be embedded inside an enriched compositional system with perspectives such that perspectives are introduced only when/where needed.

Montague's Program

- Our use of monads derives from work on the semantics of programming languages in theoretical computer science.

- As such, it is very much in the spirit of Montague, who wanted to analyze the meaning of natural language in much the same terms as the analysis of formal languages.

  > *I reject the contention that an important theoretical difference exists between formal and natural languages.*
  > (Montague 1970)

- In other words: Our understanding of formal languages has grown more sophisticated, and so should our understanding of natural languages as formal languages.

The Reader Monad

- We will use the monad that describes values that are made dependent on some external parameter, commonly known in the functional programming literature as the **Reader** monad.

- This follows Shan (2001), who suggested the idea of using the Reader monad to model intensional phenomena in natural language.

- We represent linguistic expressions that can be assigned potentially different interpretations as functions from perspective indices to values.

Lexicon: Assumptions

- We construct a kind of lexicon that not only represents the linguistic knowledge of a single speaker but also her (possibly partial) knowledge of the language of other speakers.

- In other words, we construe lexicons to be aspects of the knowledge of language of individuals, and take standard circumlocutions like the “lexicon of English” to be atheoretical folk talk, if not simply incoherent.

- This is a well-established position in generative linguistics (Chomsky 1965, 1986, 2000, Jackendoff 1983, 1997, 2002, 2007).

Speaker's Lexicon

Word	Denotation	Type
Kim	$\mathbf{k}_\sigma$	e
Dr. Octopus	$\mathbf{o}_\sigma$	e
Mary Jane	$\mathbf{mj}_\sigma$	e
Peter Parker	$\mathbf{pp}_\sigma$	e
Cassius Clay	$\mathbf{cc}_\sigma$	e
not	$\lambda p.\neg p$	$t \to t$
but	$\lambda p.\lambda q.p \wedge q$	$t \to t \to t$
is	$\lambda x.\lambda y.x = y$	$e \to e \to t$
punch	$\lambda o.\lambda s.\mathbf{punch}(s,o)$	$e \to e \to t$

Word	Denotation	Type
believe	$\lambda c.\lambda s.\mathbf{believe}(s, c(\kappa(s)))$	$\Diamond t \to e \to t$
love	$\lambda o.\lambda s.\mathbf{love}(s, o(\kappa(s)))$	$\Diamond e \to e \to t$
Muhammad Ali	$\lambda i.\begin{cases}\mathbf{ma}_\mathtt{k} & \text{if } i = \mathtt{k},\\ \mathbf{cc}_\sigma & \text{if } i = \sigma\end{cases}$	$\Diamond e$
Spider-Man	$\lambda i.\begin{cases}\mathbf{sm}_i & \text{if } i = \mathtt{o} \text{ or } i = \mathtt{mj},\\ \mathbf{pp}_\sigma & \text{if } i = \sigma\end{cases}$	$\Diamond e$
Sandy	$\lambda i.\begin{cases}\mathbf{imp}_\mathtt{k} & \text{if } i = \mathtt{k},\\ \mathbf{s}_\sigma & \text{if } i = \sigma\end{cases}$	$\Diamond e$

The Action is in the Lexicon

- The lexicon represents the linguistic knowledge of the speaker, including her assumptions about other individuals' grammars.

- Most lexical entries are standard, since we do not have to generalize to the worst case.

- So we do not need to change the type and denotation of lexical items that are not involved in the phenomena under discussion.

- For instance, logical operators such as *not* and *but* are interpreted in the standard way, as is a non-perspectival verb like *punch* or *kill*.

The Action is in the Lexicon

- Referring expressions that are possibly contentious, in the sense that they can be interpreted differently by the speaker and other individuals, instead have the monadic type ◊*e*.
    - This is reflected in their denotation by the fact that their value varies according to a perspective index.
- We use a special index σ to refer to the speaker's own perspective, and assume that this is the default index used whenever no other index is specifically introduced.
    - For example, in the case of the name *Spider-Man*, the speaker is aware of his secret identity and therefore interprets it as another name for the individual Peter Parker, while Mary Jane and Dr. Octopus consider Spider-Man a different entity from Peter Parker.

Speaker's Lexicon

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The Lexicon and Mental Representation

- We assume an internalist/representationalist semantics such that sentences are interpreted in a model in which all entities are mental entities, i.e. that there is no direct reference to entities in the world, but only to mental representations.

- Entities are therefore relativized with respect to the individual that mentally represents them, where entities that the speaker believes to be non-contentious are always relativized according to the speaker.

- This allows us to represent the fact that different individuals may have distinct equivalencies between entities.

    - For example, Kim in our model does not identify Cassius Clay with Muhammad Ali, but the speaker identifies them with each other.

The Lexicon and Mental Representation

- Therefore, the speaker's lexicon represents the fact that the speaker's epistemic model includes what the speaker knows about other individuals' models, e.g. that Kim has a distinct denotation (from the speaker) for Muhammad Ali, that Mary Jane has a distinct representation for Spider-Man, that Kim has a distinct representation for Sandy, etc.

- I should stress that this stance is not a necessary stance for our *formal* theory, but we think it is a sensible one, despite its potentially controversial nature.

    - With respect to our formal theory, it does not matter what the model for interpretation is a model *of*, whether a mental representation or reality.

The Lexicon and Mental Representation

- However, it is not immediately clear how to make sense of the notion of distinct denotations without a representational layer, especially in the Capgras or in the similar following example, which is inspired by the controversy surrounding an interview between Fox News personality Lauren Green and the scholar Reza Aslan.

25. Reza doesn't believe Jesus is Jesus.

- Aslan and Lauren Green were not in disagreement about which historical figure they were referring to, but rather about which properties that very same person had.

- In that context, it seems to us that Green's beef boiled down to the statement in (25).

Perspectival Predicates

- The other special lexical entries in our lexicon are those for perspectival verbs like *believe* and *love*.

- The two entries are similar in the sense that they both take an already monadic resource and actively supply a specific interpretation index that corresponds to the subject of the verb.

- The function κ maps each entity to the corresponding interpretation index, i.e.:

  26. $\kappa : e \rightarrow i$

- For example, in the lexical entries for *believe* and *love*, κ maps the subject to the interpretation index
  of the subject.

- Thus, the entry for *believe* uses the subject's point of view as the perspective used to evaluate its entire complement, while *love* changes the interpretation of its object relative to the perspective of its subject.

Sample Analyses

Distinct Terms, Embedding

5. Kim doesn't believe that Cassius Clay is Muhammad Ali.

- Cassius Clay is interpreted according to the speaker's index (the only interpretation for Cassius Clay, since it is non-contentious in our model).
- Muhammad Ali can be interpreted according to either Kim's index or the speaker's index (since it is contentious in our model).
- This yields two distinct readings:
  - Unsatisfiable reading

    27. $\neg$believe(k_σ,cc_σ = cc_σ)

  - Satisfiable reading

    28. $\neg$believe(k_σ,cc_σ = ma_k)

Non-Distinct Terms, Embedding

21. Kim doesn't believe that Sandy is Sandy.

- Sandy can either be interpreted according to Kim's perspective ($\mathbf{imp_k}$) or the speaker's ($\mathbf{s_\sigma}$).

- This yields three distinct readings:

  - Unsatisfiable readings

    29. ¬believe($\mathbf{k_\sigma}$,$\mathrm{imp_k}$ = $\mathrm{imp_k}$)

    30. ¬believe($\mathbf{k_\sigma}$,$\mathbf{s_\sigma}$ = $\mathbf{s_\sigma}$)

  - Satisfiable reading

    31. ¬believe($\mathbf{k_\sigma}$,$\mathrm{imp_k}$ = $\mathbf{s_\sigma}$)

Non-Distinct Terms, No Perspectival Predicate

8. # Dr. Octopus punched Spider-Man but he didn’t punch Spider-Man.

- *Punch* is not perspectival, so Spider-Man must be interpreted according to the speaker’s index (**pp_σ**).

- This yields a single unsatisfiable/contradictory reading

34. $punch(o_\sigma)(pp_\sigma) \wedge \neg punch(o_\sigma)(pp_\sigma)$

Conclusion

A Semantics of Perspective

- We have offered a semantics of perspective that offers a solution to the substitutability puzzle in both simple and embedded contexts.

- Our solution extends to cases of distinct interpretations of tokens of the same name, which gives rise to a related puzzle. We exemplified this case with respect to simple identity cases, as in the Capgras, Indiana Pi Bill, and Aslan/Jesus examples.

- Our solution to these puzzles rests on an analysis in terms of a combination of different perspectives.

A Semantics of Perspective

- We have claimed that the switch to a different perspective is triggered by specific lexical items, such as propositional attitude verbs, but also verbs like love and murder which express some kind of perspective on the part of the subject of the verb towards its object, but which nevertheless cannot easily be argued to be opaque in their object position.

- The context switch is not obligatory, as witnessed by the multiple readings that the sentences discussed seem to have.

The Monadic Approach

- The formalization of our analysis is based on monads. The main idea of our formal implementation is that referring expressions that have a potential perspectival dependency can be implemented as functions from perspective indices to fully interpreted values.

- Similarly, the linguistic triggers for context switch are implemented in the lexicon as functions that can modify the interpretation context of their arguments.

- Monads allow us to freely combine these “enriched” meanings with standard ones, avoiding unilluminating generalization to the worst case.

The Monadic Approach

- We have inevitably had to take positions on some issues that are far from settled, but we do not mean these positions themselves to be our main contribution.

- Rather, it seems to us that philosophers and linguists are in broad agreement that in some linguistic contexts there seems to be an “extra something” involved in interpreting names, and other expressions; we have made a formal proposal about what that extra something could be: *perspectives*.

An Extension: Predicates

- A virtue of our analysis is that we can apply it to not just names and referring expressions, but to any natural language expression that may have different perspectival interpretations.

- This means that we can extend our analysis to other cases, such as the standard examples involving synonymous natural kind terms like *groundhog* and *woodchuck* (see, e.g., Fox and Lappin 2005) or *furze* and *gorse* (Kripke 1979) or of synonymous verbs, such as *photocopy* and *xerox* (Larson and Ludlow 1993).

Example

35. Elena loves dolphins, but she doesn't love marine mammals.

- Suppose Elena thinks that Flipper is a dolphin and Hoover is a seal, but she thinks only Hoover is a marine mammal; i.e., she thinks seals are marine mammals, but dolphins are not.

- Suppose also that the speaker and Elena are in agreement about which entities the names Flipper and Hoover refer to, so the names are not controversial.

- We do not mean to imply that this extension of our approach is trivial, since matters of compositionality of, e.g., *marine mammal*, have not been addressed here, but the extension is at least a natural candidate for further exploration.

Speaker's Lexicon

WORD	DENOTATION	TYPE
dolphin	$\{\mathbf{flipper}_\sigma\}$	$e \to t$
seal	$\{\mathbf{hoover}_\sigma\}$	$e \to t$
marine mammal	$\lambda i. \begin{cases} \{\mathbf{hoover}_\sigma\} & \text{if } i = \mathbf{mj}, \\ \{\mathbf{flipper}_\sigma, \mathbf{hoover}_\sigma\} & \text{if } i = \sigma \end{cases}$	$\Diamond(e \to t)$

Thank you!

For further details, including references and complete formalization, please see our paper, *Perspectives*, in *Semantics & Pragmatics* (semprag.org).

If you would like to play with an implemented version of the formalization, go to http://llilab.carleton.ca/~giorgolo/tp.html

Note: We've been having some trouble with our lab server, so it may be down when you try it. It was up at 17:49…