The semantics and processing of correlatives

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Plan

- review semantics and pragmatics of correlatives across various ontological domains
  (temporal, modal, individual and degree domains; focus on Indo-European; based on Brasoveanu 2012 and references therein)
- discuss uniqueness effects exhibited by correlatives, sketch an analysis in Plural Dynamic Semantics
- discuss the topic-comment matching constraint, and analyze it as a processing-level phenomenon, similar to cataphora resolution processes
  (building on the framework in Brasoveanu and Dotlačil in prep.)

Plan

Correlatives across domains
- Correlatives in the temporal domain: *when*-clauses
- Modal correlatives: conditionals
- Correlatives in the individual domain
- Degree correlatives: comparative correlatives

Uniqueness effects in correlatives
- The definite/unique interpretation
- The universal/non-unique interpretation
- Correlatives in Plural Dynamic Semantics

Topic-comment matching as a processing-level constraint

Summary and future directions

Correlatives – working definition

"[B]iclausal topic-comment structures [...] [in which] the dependent clause introduces one or more topical referents to be commented on by the matrix clause, where each topical referent must be picked up by – correlated with – an anaphoric proform." (Bittner, 2001, p. 39)

Correlative constructions – interesting for 3 reasons:

- syn/sem interface: quantifier-binding semantics without syntactic c-command, like donkey sentences; syntactically, they are adjunctions, just like topicalizations (*Megan, I like her*)

(1) $[_{IP}\ [_{CP}$ which^{x} girl is standing$]$ $[_{IP}$ that$_{x}$ one is tall $]\ ]$

- sem/prag interface: universal/quantificational vs. definite/referential variation in interpretation
- sem/psycholing interface: constraint requiring all topics to be picked up in the matrix

Temporal correlatives: *when*-clauses

"A *when*-clause behaves rather like one of those phrases that are used to explicitly change topic [...] [it] does not require a previously established temporal focus, but rather brings into focus a novel temporal referent." (Moens and Steedman, 1988, pp. 22-23)

- referential, definite interpretation, as in (2) (from Moens and Steedman 1988) and (3) (from Partee 1984)

(2) When they built the 39^{th} Street bridge {a local architect drew up the plans / they used the best materials / they solved most of their traffic problems}.

(3) When the Smiths threw a party, they invited all their friends.

Temporal correlatives: *when*-clauses (ctd.)

- quantificationally interpreted, as in (4) and (5)

(4) Back in New Orleans, when the Smiths threw a party, they invited all their friends.

(5) When the Smiths throw a party, they invite all their friends.

How can we put together:

- the topic-comment structure of referentially-interpreted *when*-clauses
- the availability of quantificational interpretations for these structures

Same question arises for correlatives in other ontological domains.

Modal correlatives: conditionals

"[E]xplicit *if*-clauses may introduce some hypothetical scenario by definite reference, just as *when*-clauses introduce a time. Such hypotheses may be recovered for modals, within and across sentences, as shown by [(6)] (from the Brown Corpus)." (Stone, 1997, p. 6)

(6) New York Central Railroad president Alfred E. Perlman said Tuesday his line would face the threat of bankruptcy if the Chesapeake & Ohio and Baltimore & Ohio Railroads merge. Perlman said bankruptcy would not be an immediate effect of the merger, but could possibly be an ultimate effect. (Stone, 1997)

Modal correlatives: conditionals (ctd.)

If-conditionals can also be interpreted quantificationally:

"[In (7)] the scenarios evoked by the antecedent and described in the consequent vary across many different concertgoers.

[In [(8)] the antecedent contains a constituent *if*-clause, *if an enemy captures it*, that varies across submarines. At the same time, the modal *will* in the consequent describes a scenario that includes this capture of the submarine. [This is] an analogue of donkey anaphora for modals." (Stone, 1997, pp. 6-7)

(7) If a concertgoer arrives late, he or she will not be permitted into the auditorium until intermission. (Stone, 1997)

(8) If a submarine cannot self-destruct if an enemy captures it, the enemy will learn its secrets. (Stone, 1997)

Conditionals as modal correlatives: Warlpiri

Warlpiri correlative structures are ambiguous between a modal and an individual-level interpretation (Bittner 2001):

(9) Maliki-rli kaji-ngki yarlki-rni nyuntu
dog-ERG SAME.TOPIC-3SG.2SG bite-NONPAST you
ngula-ju kapi-rna luwa-rni ngajulu-rlu.
DEM-TOP FUT-1SG.3SG shoot-NONPAST me-ERG

A. 'As for **the** dog that bites you, I'll shoot **it**.' (individual)
B. '**If** a dog bites you, **then** I'll shoot it.' (modal)

"The dependent clause of [(9)] – with the complementizer *kaji* [...] – introduces a topical referent of some type [...] a contextually prominent individual [(9A)] [or] a prominent possibility [(9B)].

The topical referent is picked up in the matrix comment by a topic oriented anaphoric demonstrative *ngula-ju*, which is likewise type-neutral. These readings [...] have essentially the same semantic representation, up to logical type." (Bittner, 2001, p. 39)

Correlatives across domains: Marathi

Marathi correlative morphology is sensitive to type (Andrews, 1985):

ǰa 'which'	ǰevha 'when'	ǰithe 'where'	jər 'if'	jəri 'although'
tya 'that'	tevha 'then'	tithe 'there'	tər 'then'	təri 'even so'

(10) ǰa mula-ni ǰa muli-ca dueš kela, tya-ni
which boy-INST which girl-GEN hatred did, DEM.M-INST
ti-la marli.
DEM.F-DAT killed
'The boy who hated the girl killed her.'

(11) mĩ ǰevha alo, tevha to joplela hota.
I.INST when came, then he sleeping was
'When I arrived, he was sleeping.'

Correlatives across domains: Marathi (ctd.)

(12) ǰithe sawəli hoti, tithe Ram bəsla.
where shade was, there Ram sat down
'Where there was shade, Ram sat down.'

(13) jər to ithə yel, tər mi tya-la goḷi marin.
if he here comes, then I.INST he-DA bullet kill.FUT
'If he comes here, then I'll kill him.'

(14) jəri tya-ni majha kutrya-la marlə, təri
although he-INST me.GEN dog-DAT killed, even so
mə-la to awəṛto.
me-DAT he likes.
'In spite of the fact that he killed my dog, I still like him.'

Correlatives in the individual domain: Sanskrit

Classical Sanskrit also has correlatives over individuals, including multiply-headed correlatives (Andrews, 1985):

(15) yasya yat paitṛkam ritkam, sa
who.GEN what.NOM paternal.NOM inheritance.NOM, he.NOM
tad gṛhnĭta, netaraḥ.
that.ACC should get, not another

'If someone has something as a paternal inheritance, then he should get it and not someone else.'

(16) yena yāvān yathā ′dharma dharma
who.INST to what extent in what manner injustice justice
veha samīhitia, sa eva tatphalam būnkte
or is done, he exactly the fruits thereof enjoy.FUT
tathā tāvad amutra vai
in that way to that extent in the other world indeed

'If someone does good or evil to some extent and in some way, then he shall enjoy the fruits thereof in the next world to that extent and in that way.'

Correlatives in the individual domain: Sanskrit (ctd.)

"If the reader [...] feels at a loss as to how to interpret them, then there is a simple algorithm for constructing a paraphrase. Replace the *wh* words with [*some*-based indefinites] and recast the relative clause as a conditional. [...]

[M]ultiple headed relative clauses in Sanskrit characteristically have this property of being 'generic' statements of laws. One might think, therefore, to derive them from conditionals in some fashion. While this might suffice in Sanskrit, we will find Marathi examples of multiple headed and multiple *wh*-worded relative clauses which are not generic, but rather referential." (Andrews, 1985, pp. 96-97)

Constraint on single or multiply headed correlatives

"[E]ach coordinate of the n-tuple of topical referents introduced by the dependent clause must be picked up by an anaphor in the matrix comment. [This correspondence] need not be one-one[,] split antecedents are permitted [(17)].

[D]angling topical referents in the dependent clause which the matrix comment fails to address [are not permitted (18)]. [(19)] is good because *jis*, is replaced with *ek* one." (Bittner 2001, pp. 40-41; see Andrews 1985; Dayal 1996; McCawley 1992)

(17) Jo laRkii jis laRke-se baat kar rahii hai, ve dost
which girl which boy-INST talk do PROG is, DEM.PL friends
haiN.
are

'As for the girl and the boy she is talking to, they are friends.'

(18) *Jo laRkii jis laRke-se baat kar rahii hai, vo lambii hai.
which girl which boy-INST talk do PROG is, DEM tall.SG.F is

'As for the girl and the boy she's talking to, she is tall.'

(19) Jo laRkii ek laRke-se baat kar rahii hai, vo lambii hai.
which girl one boy-INST talk do PROG is, DEM tall.SG.F is

'As for the girl who's talking to a boy, she is tall.'

Constraint on (multiply-headed) correlatives (ctd.)

The constraint that every *wh*-topic has to be anaphorically picked up and commented on by the matrix clause becomes obvious only with individual-based correlatives.

- there always is a temporal/modal anaphor in the matrix clause of temporal/modal correlatives: tense/mood morphology

We account for this in the processing part – main idea:

- *wh*-morphology + topicalization syntax: overt realization of a processing TOPIC-PRESENT feature, encoded in the goal representation of the (goal-driven) parsing process
- this feature triggers an active search for a pronoun; similar to cataphora resolution processes
- makes sense that *wh*-morphology is recruited for this:
  - it triggers an active search for a gap in relative clauses and other filler-gap dependencies (Stowe 1986; Traxler and Pickering 1996; Wagers et al. 2009 a.o.)

Ref. vs. quant. individual-based correlatives

Referential vs. quantificational contrast for individual-based correlatives overtly marked in Hindi by habitual morphology (Dayal, 1995, 1996):

(20) jo laRkii lambii hai, vo khaRii hai.
which girl tall is, DEM standing is

'The one girl that is tall is standing.'

(21) bus-meN aam taur-pe kaun-sii laRkii khaRii hotii hai?
bus-in ordinary way-on which.F girl.F standing.F be-HAB.F be.PRS.SG

'Ordinarily, which girl stands on the bus?'

jo laRkii lambii ho-tii hai, vo khaRii
which girl tall be-HAB.F is, DEM standing
ho-tii hai.
be-HAB.F is

'It is the girl who is tall that stands.' (Tall girls generally stand)

Ref. vs. quant. individual-based correlatives (ctd.)

Ref. vs. quant. contrast not morphologically realized in Romanian:

- similar to the ref. vs. quant. contrast for Eng. *when*-clauses

(22) Care fată şi = a = uitat ieri haina, pe aceea o = caută tatăl ei.
Which girl her.DAT = HAS = forgotten yesterday coat.the, PE DEM.F.SG her.ACC = look for father.the her.GEN

'The father of the girl that forgot her coat yesterday is looking for her.'

(23) Pe care om l = a = interogat Securitatea, în acela nu mai am încredere.
PE which person him.ACC = HAS = interrogated security.the, in DEM.M.SG not anymore have.1.SG trust

'I do not trust any person (whatsoever) that the secret police interrogated.'

Ref. vs. quant. readings in multiple-topic correlatives

(24) jis laRkii-ne jis laRke-ke saath khel-aa, us-ne
which girl-Erg which boy-with together play-pfv DEM-Erg
us-ko haraa-yaa.
DEM-Acc defeat-pfv

'Every girl that played against a boy is such that (she played against exactly one boy and) she defeated the one boy she played against.' (Dayal, 1996)

(25) Cine ce mîncare şi=a=adus, pe aceea
Who what food REFL.Dat=HAS=brought PE DEM.F.SG
o=va=mînca.
it.Acc=WILL.3sg eat

'Everyone will eat whatever food they brought with them.'

Across-the-board universal reading clearer in Romanian examples like:

- *Care ce problemă şi=a=ales, pe aceea o=va=rezolva* (Everyone will solve whatever problem, i.e., all & only the problems, they chose)
- *Care ce subiect şi=a=ales, despre acela trebuie să=scrie* (Everyone must write about whatever topic, i.e., all & only the topics, they chose)

Ref. vs. quant. comparative correlatives

(26) Cu cît e mai înalt fratele decît sora,
With how much is more tall brother.the than sister.the,
(tot) cu atît e mai înalt tatăl decît mama.
(also) with that much is more tall father.the than mother.the
'The brother is taller than the sister by a certain amount and the father is taller than the mother by the same amount.'

(26) is true iff

(*i*) brother taller than sister and father taller than mother
(no conditionality 'if the brother is taller than the sister . . . ')

(*ii*) difference in height between brother and sister is the same as difference in height between father and mother
(correlative *equates* two differentials; particularly clear with particle *tot*)

Differentials, e.g., *2 in* in *Gabby is 2 in taller than Linus*:
phrases that specify difference between two measurements.

Ref. vs. quant. comparative correlatives (ctd.)

(27) Cu cît e un avocat mai agresiv, cu
With how much is a lawyer more aggressive, with
atît e mai eficient.
that much is more efficient
'The more aggressive a lawyer is, the more efficient s/he is.'

Two interpretations for (27):

(*i*) if lawyer x is more aggressive than lawyer y by a certain amount, then x is more efficient than y by a corresponding amount

(*ii*) if lawyer x is more aggressive at time t than at time t' by a certain amount, then x is more efficient at t than at t' by a corresponding amount

Not clear these are two distinct readings: maybe there's a way to think of (ii) is a refinement of (i),
examining aggressiveness/efficiency at various times, not just at a single (contextually salient) time.

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Summary and future directions

Correlatives: problems and solutions

Three problems:

(*i*) compositionality problem on the syn/sem side: the universal/quantificational reading does not require c-command

(*ii*) variability of 'uniqueness effects' on the sem/prag side: interaction between uniqueness effects and habitual morphology in Hindi/pragmatics of quant. in Romanian

(*iii*) the constraint that every *wh*-topic has to be anaphorically picked up and commented on by the matrix clause (sem/psycholing side)

Three proposals:

(*i*) dynamic semantics: specifically designed to compositionally capture syntactically non-local quantificational dependencies like donkey anaphora

(*ii*) definite vs. universal readings follow from the absence/presence of distributivity over plural info states (sets of variable assignments)

(*iii*) *wh*-morphology + topicalization structure are the overt realization of a processing-level trigger for an active search for a pronoun, similar to cataphora resolution processes

Russellian analysis of definite descriptions

Russellian analysis of definite descriptions: maximality + singleton ⇒ uniqueness

(28) The chair Leif brought is wobbly. (Kadmon, 1990)

$$\underbrace{\exists x[\textsc{chair}(x) \wedge \textsc{bring}(\textsc{leif}, x)}_{\text{existence}} \quad \wedge$$

$$\underbrace{\underbrace{\forall y[\textsc{chair}(y) \wedge \textsc{bring}(\textsc{leif}, y)}_{\text{maximality}} \rightarrow \underbrace{y = x]}_{\text{singleton}} \quad \wedge \quad \textsc{wobbly}(x)]}_{\text{uniqueness}}$$

(29) With set variables:

$$\underbrace{\exists X[X \neq \varnothing}_{\text{existence}} \quad \wedge$$

$$\underbrace{\underbrace{X = \{y : \textsc{chair}(y) \wedge \textsc{bring}(\textsc{leif}, y)\}}_{\text{maximality}} \quad \wedge \quad \underbrace{|X| = 1}_{\text{singleton}} \quad \wedge \quad \textsc{wobbly}(X)]}_{\text{uniqueness}}$$

The account of uniqueness effects in correlatives

Definite/unique interpretations of Hindi and Romanian correlatives arise as a consequence of

(*i*) maximality contributed by the wh-indefinite in the topic/subordinate clause
(*ii*) the singleton requirement contributed by the singular demonstrative in the comment/matrix clause

(30) jo^{X} laRkii lambii hai, vo$_{X}$ khaRii hai
[which girl tall be.prs, DEM standing be.prs]

$$\exists X[X \neq \varnothing \quad \wedge \quad \underbrace{X = \{y : \textsc{girl}(y) \wedge \textsc{tall}(y)\}}_{\text{maximality}} \quad \wedge \quad \underbrace{|X| = 1}_{\text{singleton}}]_{\text{uniqueness}} \quad \wedge \quad \textsc{standing}(X)]$$

This account does not conflate Russellian definites (or universal quantifiers) and maximal indefinites that are topics in correlatives:

- definites maximize only over restrictor property (same with universal quantifiers)
- maximal indefinites maximize over both restrictor and nuclear scope property
- the singleton requirement is not part of the meaning maximal indefinites

Deriving universal/non-unique interpretations

Universal/non-unique int. arises by interposing a distributivity operator contributed by habitual morphology between:

(*i*) maximal wh-indefinite in subordinate clause

(*ii*) singleton requirement contributed by sing. dem. in matrix

Distributivity operator neutralizes singleton requirement ⇒ maximality of wh-indefinite delivers universal/non-unique int.

(31) jo^{X} laRkii lambii ho-tii hai, **ho-tii** vo$_{X}$ khaRii [~~ho-tii~~] hai
[which girl tall be-hab.f be.prs, **be-hab.f** DEM standing be.prs]

$$\exists X[X \neq \varnothing \quad \wedge \quad \underbrace{X = \{y : \textsc{girl}(y) \wedge \textsc{tall}(y)\}}_{\text{maximality}} \quad \wedge \quad \underbrace{\forall x \in X}_{\text{distributivity}} \quad [\underbrace{|\{x\}| = 1}_{\text{singleton}}$$

$$\underbrace{\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad}_{\text{universal interpretation}}$$

$$\wedge \quad \textsc{standing}(X)]]$$

Deriving universal/non-unique interpretations (ctd.)

Wait, habitual morphology contributes dist. over individuals?
It doesn't: it contributes distributivity over cases/situations.

- only indirectly over the individuals featured in these cases/situations

Main idea:

- (32) exhibits the same kind of distributivity, i.e., ...
- we 'zoom in' on each case/situation under consideration
- we go dynamic to capture cross-sentenial dependencies, which solves the syn/sem problem
  - the existential + maximization in the adjunct clause can stay put

(32) a. Every chess set comes with a^x spare pawn.
b. It$_x$ is taped to the top of the box. (Sells, 1985)

"[A] case may be regarded as the tuple of its participants; and these participants are values of the variables [i.e., anaphors] that occur free in the open sentence modified by the [possibly covert] adverb. In other words, we are taking the cases to be the admissible assignments of values to these variables" (Lewis, 1975, pp. 5-7)

Correlatives in Plural Dynamic Semantics

Definite/unique single-topic correlative:

(33)

jo^x laRkii lambii hai,		vo$_x$		khaRii hai
which girl tall be.prs,		DEM		standing be.prs
$\mathbf{max}^x(\text{GIRL}(x) \wedge \text{TALL}(x))$	$\wedge$	$\mathbf{singleton}(x)$	$\wedge$	$\text{STANDING}(x)$
x		x		
$girl_1$	$\Rightarrow$	$girl_{1/2/3}$		$\{girl_1, girl_2, girl_3\}$
$girl_2$		$girl_{1/2/3}$		is a singleton, i.e.:
$girl_3$		$girl_{1/2/3}$		$girl_1 = girl_2 = girl_3$

$\mathbf{max}^x$ is dynamic λ-abstraction:

(*i*) we extract the set of individuals satisfying the formula in the scope of the $\mathbf{max}^x$ operator (this is the static part)

(*ii*) we store it under x and pass it on to the next clause (this is the dynamic part)

Correlatives in Plural Dynamic Semantics (ctd.)

Universal/non-unique single-topic correlative:

(34) jo^x laRkii lambii ho-tii hai, **ho-tii** vo$_x$ khaRii [~~ho-tii~~] hai
[which girl tall be-hab.f be.prs, **be-hab.f** DEM standing be.prs]

$$\mathbf{max}^x(\textsc{girl}(x) \wedge \textsc{tall}(x)) \quad \wedge \quad \mathbf{dist} \quad (\mathbf{singleton}(x) \wedge \textsc{standing}(x))$$

$$\begin{array}{|c|}\hline x \\ \hline girl_1 \\ \hline girl_2 \\ \hline girl_3 \\ \hline \end{array} \quad \Rightarrow \quad \left\{ \begin{array}{ll} \begin{array}{|c|}\hline x \\ \hline girl_1 \\ \hline \end{array} & \{girl_1\} \text{ is a singleton} \\ \begin{array}{|c|}\hline x \\ \hline girl_2 \\ \hline \end{array} & \{girl_2\} \text{ is a singleton} \\ \begin{array}{|c|}\hline x \\ \hline girl_3 \\ \hline \end{array} & \{girl_3\} \text{ is a singleton} \end{array} \right\}$$

- the **dist**(ributivity) operator is contributed by habitual morphology
- **dist** breaks the input set of sequences/cases into singleton subsets
- then, it requires the formula in its scope to be evaluated relative to each such singleton subset
- **dist** neutralizes/ensures the vacuous satisfaction of $\mathbf{singleton}(x)$

Correlatives in Plural Dynamic Semantics: summary

So, variable uniqueness effects in correlatives follow from:

(*i*) maximality over cases/situations contributed by wh-indefinites

(*ii*) singleton requirement contributed by singular anaphors, which applies to the set of cases/situations relative to which the anaphor is interpreted

(*iii*) granularity level of the quantification denoted by the entire correlative construction

Granularity level specified:

- semantically in Hindi (+/- habitual morphology)
- pragmatically in Romanian

Because we work with cases/situations, account generalizes to multiple-topic correlatives:

- unselective maximization, or multiply-selective maximization
- keep unselective distributivity, or make it multiply-selective to get the mixed universal + unique reading of certain multiple wh-correlatives

Granularity of quantification/distributivity over cases

Similar to pragmatics of dist. over individuals, events etc.

- e.g., free higher-order variables for covers

Independent evidence from a different kind of construction (Krifka, 1990):

(35) Four thousand ships passed through the lock last year.

(35) "has two readings [...] the object-related reading says that there are four thousand ships which passed through the lock last year [...]

the event-related reading says that there were four thousand events of passing through the lock by a ship last year.

The [former] reading presupposes the existence of (at least) four thousand ships [...]. In the [latter] reading, there might be fewer ships in the world." (Krifka, 1990, p. 487)

- parallel to the way we interpret **singleton** in correlatives
- object-related, individual-based reading ⇒ definite int.
- event-related, case/situation-based reading ⇒ universal int.

Granularity of quantification/distributivity over cases

Granularity level for examples like (35) is pragmatically constrained:

"[I]t is no accident that the best examples of [event-related readings] concern situations in which there are too many individuals to keep track of easily [...]. It is much more difficult to get [such a] reading [for (35)] when only a small number of ships are involved.

[For example, consider] the Chicago River–Lake Michigan sightseeing route, which we can assume is plied by just four sightseeing ships. It would be odd to say that *Four thousand sightseeing ships passed through the lock last year* even if each of the four ships did go through 1000 times" (Barker, 1999, pp. 689-690)

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Previous semantic analyses of correlatives

- Dayal (1995) examines habitual single-topic correlatives in Hindi, suggests an account in terms of minimal situations (Heim, 1990) feasible
- Dayal (1996) rejects idea in Andrews (1985) that correlatives are similar to donkey conditionals because:
  - "in a correlative construction the number of wh expressions must match the number of demonstratives anaphoric to them. This, of course, is not true of conditionals" (Dayal, 1996, p. 198)
  - static or dynamic approaches to donkey sentences available at the time failed to capture the definite vs. universal interpretations
- Bittner (2001): an 'aboutness' presupposition captures that correlatives, but not conditionals, have to anaphorically refer back to all the wh-indefinites in the topic clause
- alternatively (Ivan Sag, p.c.): correlatives involve wh-extraction similar to extraction from coordination structures (Pollard and Sag, 1994); 'topic-comment matching': only across-the-board extraction is possible from coordination islands

A processing account of topic-comment matching

Main idea:

- we independently need processing mechanisms to capture pronoun anaphora / cataphora resolution
- topic-comment matching leverages the same mechanisms
- we only need an additional TOPIC feature to turn on, needed for all topicalization structures (e.g., Eng.: *Megan, I like her*)

A processing account of topic-comment matching (ctd.)

How is this really different? We can think of this as simply a processing level implementation of Bittner's 'aboutness' presupposition, or ...

Proposal (extreme formulation, but simple/clear):

- we can think of anaphora/presupposition in general as properly processing-level phenomena that guide/constrain memory retrieval processes associated with incremental interpretation
- that is, they guide/constrain the cognitive process of integration, or linking, of new and old/stored semantic information
  - if anaphora/presupp. guide memory retrieval processes, world knowledge, a.k.a. the "pragmatics of anaphora/presupp. resolution," comes in naturally (world knowledge is stored in declarative memory)
- anaphora/presupp. have sem. effects, but are not semantics *per se*
- the proper way to analyze them is as a part of the processing component of a broad theory of natural language interpretation

A processing framework for anaphora and presupposition

- based on chapter 9 of Brasoveanu and Dotlačil (in prep.).
- very close in spirit to the DRT account of presupposition (Kamp, 2001a,b; van der Sandt, 1992, a.o.)
- Kamp (2001b), with its extended argument for and extensive use of preliminary representations (representations which include unresolved presuppositions) is a particularly close idea

Anaphora/presupposition as processing phenomena

Outstanding problem for the theory of presupposition in Kamp (2001b):

"[S]emanticists of a model-theoretic persuasion may want to see a formal semantics of [...] preliminary representations. [...] [T]he possibility of such a semantics is limited.

To define a syntax of preliminary representations [...] which characterizes them as the expressions of a given representation formalism (or as data structures of a certain form) is not too difficult. [F]or those preliminary representations [...] in which all presuppositions appear in the highest possible position, an intuitively plausible model-theoretic semantics can be stated without too much difficulty.

But for representations with presuppositions in subordinate positions [...] I very much doubt that one is to be had." (Kamp, 2001b, pp. 250-51)

The solution proposed here:

- asking for a semantics of preliminary representations is a category error
- they are not semantic representations, but processing-level representations that support incremental interpretation mechanisms

Donkey cataphora

Donkey cataphora: "a configuration in which a pronoun precedes and depends for its interpretation on an indefinite that does not c-command it." (Elbourne 2009, p. 1)

(36) If it enters his territory, a pirate usually attacks a ship. (Chierchia 1995, p. 130)

(37) If it spots a mouse, a cat attacks it. (Chierchia 1995, p. 130)

(38) If a foreigner asks him for directions, a person from Milan replies to him with courtesy. (Chierchia 1995, p. 130)

(39) John won't eat it if a hamburger is overcooked. (Elbourne 2009, p. 3)

Donkey cataphora

Certain configurations are not acceptable (Elbourne 2009, p. 2):

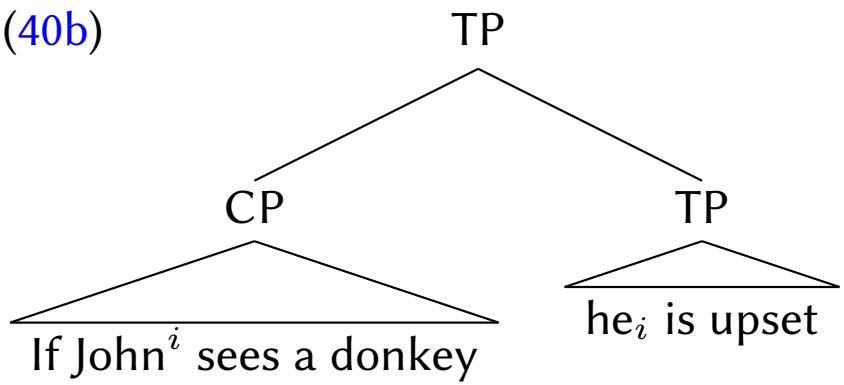
(40) a. John^i is upset if he$_i$ sees a donkey.

b. If John^i sees a donkey, he$_i$ is upset .

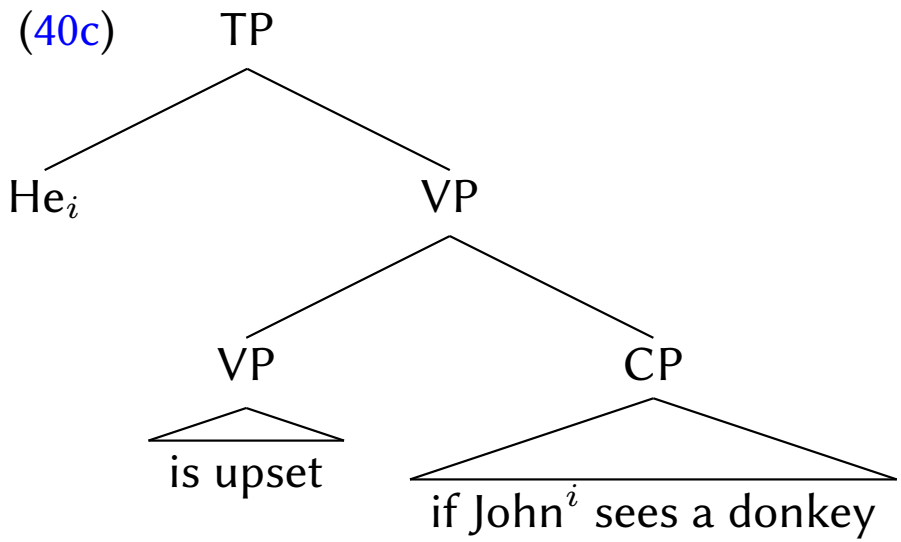
c. *He$_i$ is upset if John^i sees a donkey.

(40c) – presumably a Principle C violation given the low, VP-level adjunction site for sentence-final *if* -clauses.

(40b)



(40c)



Processing cataphora

- Kazanina et al. (2007) successfully used self-paced reading to show that a cataphoric pronoun triggers an active search for an antecedent in the following material
- furthermore, this search takes into account structural constraints (principle C) from an early stage
- that is, cataphoric dependencies are processed with a syntactically constrained search mechanism

  (similar to the mechanism used for processing long-distance *wh*-dependencies; Stowe 1986, Traxler and Pickering 1996, Wagers et al. 2009 a.o.)
- Kazanina et al. (2007) take the temporal priority of syntactic information to be evidence for the incremental and predictive nature of syntactic comprehension

Processing cataphora (ctd.)

- Brasoveanu and Dotlačil (2015), Brasoveanu and Dotlačil (in prep. Ch. 9): active search for a cataphoric antecedent for a pronoun / a presuppositional adverb like *again* is semantically modulated

(41) Jeffrey will argue with Danielle again AND he *argued* with her in the courtyard last night.

(42) Jeffrey will *argue* with Danielle again IF he *argued* with her in the courtyard last night.

Different resolution expectations triggered by the interaction of

- the presupposition trigger again, and
- the dynamic semantics (discourse accessibility) of the operators AND vs. IF

Processing framework for semantic representations

Main idea (in the spirit of Lewis and Vasishth 2005):

- use an independently motivated, general cognitive architecture (ACT-R, Anderson 2007; Anderson and Lebiere 1998)

  to give a mechanistic account of the specific task of simultaneous syntactic and semantic parsing

Cognitive architecture:

- abstract, symbolic structures to describe human behavior (the algorithmic level in Marr 1982)
- modular
- mainly fit to two types of data: latencies (reaction times) and accuracy (more recently, neurological data; Anderson 2007)
- well developed goal and memory structures, and ties to peripherals (visual, motor)

ACT-R

- two types of memory modules: DECLARATIVE MEMORY and PROCEDURAL MEMORY
- DECLARATIVE MEMORY: knowledge of facts, lexical knowledge ...
- PROCEDURAL MEMORY: productions – how to count, how to drive, how to interpret natural language incrementally ...
- productions – conditionalized actions (same form as production rules in CFGs, for example)
  - productions fire based on contents of buffers – the cognitive state; think of it as cognitive context, or "working memory"
  - productions trigger actions that update various components of the cognitive state

ACT-R + DRT

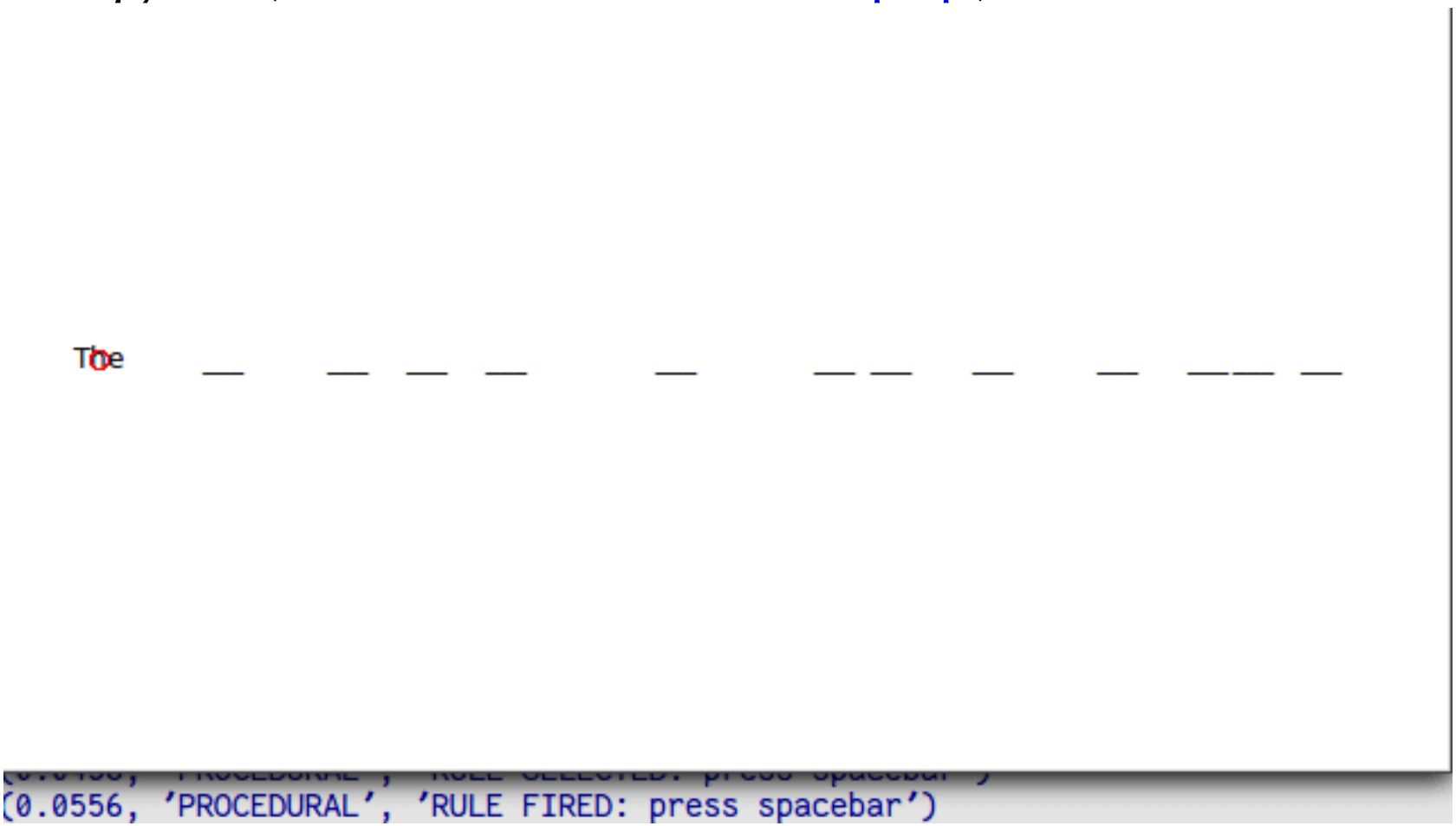
Distributing linguistic knowledge among components of the cognitive architecture:

- declarative memory – knowledge of the lexicon
- procedural memory – knowledge of grammar
- imaginal buffer holds the current syntactic parse
- goal buffer holds parsing expectations / predictions:
  - syntactic categories we expect to see next
  - features that trigger cataphoric searches
  - features that trigger searches for topic-matching anaphors
- semantic buffer A holds current DRS
- semantic buffer B holds unresolved presupposition DRS

An ACT-R model completing a self-paced reading task

(open the slides with Adobe Acrobat Reader to see the movie)

Red circle is the visual focus. Temporal trace incrementally produced by the model is visible in the background. Model built with *pyactr* (Brasoveanu and Dotlačil in prep.).



Cataphora resolution and topic-comment matching

- when encountering *again* (or a pronoun), attempt to resolve it
- that is, place a retrieval request to declarative memory that checks in parallel all accessible DRSs
- if no suitable DRS retrieved, mark *again* (or the pronoun) as cataphoric, that is, ...
- turn on a goal-buffer feature that says unresolved cataphora (event or entity) is present
- active search: upon encountering a potential antecedent (new verb for *again*, new NP for pronouns), check if cataphora can be resolved; if so, turn off the CATAPHORA-PRESENT feature
- topic-comment matching:
  - when encountering a wh-indefinite topic in a correlative, turn on a TOPIC-PRESENT feature
  - when encountering an anaphor in the comment, check if it matches the topic; if so, turn off the TOPIC-PRESENT feature

Summary and future directions

- reviewed semantics and pragmatics of correlatives across various ontological domains
- variable uniqueness effects in correlatives accounted for in a Plural Dynamic Semantics framework (other accounts possible)
- analyzed topic-comment matching constraint as a processing-level phenomenon, similar to cataphora resolution processes

Future directions:

- the processing of single/multiple-topic correlatives is largely understudied (see Foley and Wagers 2017 for a recent study); so is the processing of multiple-wh constructions in general
- building computationally explicit processing models for correlatives, fitting them to experimental data and doing theory comparison based on those quantitative fits would be substantial progress
- more generally: how much of the theory of presuppositions belongs in semantics proper, and how much is actually part of processing?

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