Dialogue across the Lifespan

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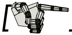
- Synthesis of antecedents (speech act theory, language games, formal semantics, conversational analysis, ...)
- Modified Turing test: dialogical relevance and multimodal interaction
- Uniform formal framework: TTR and KoS
- *Across the lifespan*: Combining E and I language (memory structures, brain networks, ...)

Today's Lecture

1. Some features of QNPs: predication, anaphora, clarification request answering potential ➔ witness-based quantification resting on set-triples
2. But there are also referential, 'demonstrative' QNPs: *Look []! Every x …*
3. Pointing: from direct reference to visual attention (cf. DGB's ViSit)

- In all languages (generalization from English, German, Hebrew; see WALS for further support) verbs and adjectives and other predicates combine freely with all types of NPs:

  (1) a. Jill saw Bo/every student/most students
      b. Bo/every student/most students is/are pleasant
      c. A grain of sand/that grain of sand will be trapped in my shoe

- So we should expect there to be a uniform way of predication, applicable to all NPs.

- All types of NPs give rise to pronominal anaphora:

  (2) a. Jill saw Bo/every student/most students. He/they was/were happy.

  b. Bo/every student/most students is/are pleasant. As long as s/he / they have eaten a nice breakfast.

  c. A grain of sand/that grain of sand will be trapped in my shoe. It will be difficult to find there.

- All NPs can give rise to clarification interaction:

(3) A: Did Bo leave? B: BO? Who is Bo?
➔ *Is it BO$_i$ that you are asking whether i left?*
➔ *Who do you mean by ‘Bo’?*

(4) a. A: Most students support the proposal? B: What do you mean ‘most students’?
b. A: Everyone was there. B: Everyone?

- Natural language meanings need to satisfy a constraint that is much more concrete than compositionality, namely *incrementality*: natural language input is processed word by word (and indeed at a higher, sub-lexical latency).

(5) A: Move the train …
B: Aha
A: …from Avon …
B: Right
A: …to Danville. (Trains corpus)

(6a, b, c) exemplify a contrast between three reactions to an 'abandoned' utterance: in (6a) B asks A to elaborate, whereas in (6b) she asks him to complete her unfinished utterance; in (6c) B indicates that A's content is evident and he need not spell it out. (6a, b, c) requires us to associate a content with A's incomplete utterance which can either trigger an elaboration query (6a), a query about utterance completion (6b), or an acknowledgement of understanding (6c).

(6) a. A(i): John … Oh never mind. B(ii): What about John/What happened to John? A: He's a lovely chap but a bit disconnected.

b. A(i): John … Oh never mind. B(ii): John what? A: burnt himself while cooking last night.

c. A: Bill is … B: Yeah don't say it, we know.

Basic Desiderata

- We need a theory of QNP meaning that can:
  1. Provide a uniform account of predication
  2. Deal with intra-/inter-sentential anaphora
  3. Explain clarificational potential
  4. Be (potentially) incremental

Basic Desiderata

- We need a theory of QNP meaning that can:
    1. Provide a uniform account of predication
    2. Deal with intra-/inter-sentential anaphora
    3. Explain clarificational potential
    4. Be (potentially) incremental
- Our theory of QNP meaning should also:
    5. Explicate scope ambiguity
    6. Explicate intensional readings of indefinites
    7. Cover negation of NPs

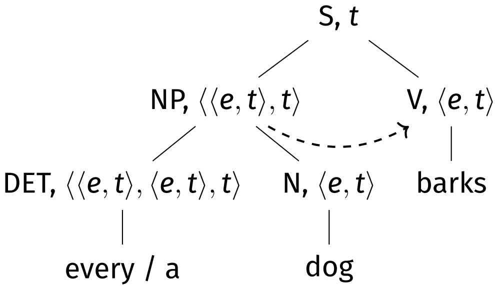
...but this is beyond the scope of this lecture (see Lücking and Ginzburg, 2022 for more on this)

- *Fido barks* is translated into the simple predication $bark'(f)$, and *Every dog barks* is represented by $\forall x[dog'(x) \rightarrow bark'(x)]$.
- A problem with the latter formula is that there is no direct counterpart for the NP *every dog* within the logical form.
- We want two have two building blocks: $every'(dog'(x))$ and $bark'(x)$
- And if we have, what is their predicational relation?
- Two options:
  1. NP as argument of VP, as usual (which then must be modified to take some higher-order argument, not just individuals).
  2. Or: VP as argument of NP.
- Montague's (Montague, 1974) move: package the quantificational meaning into the QNP (captures the wanted 'building block') and let it select for predicational arguments.

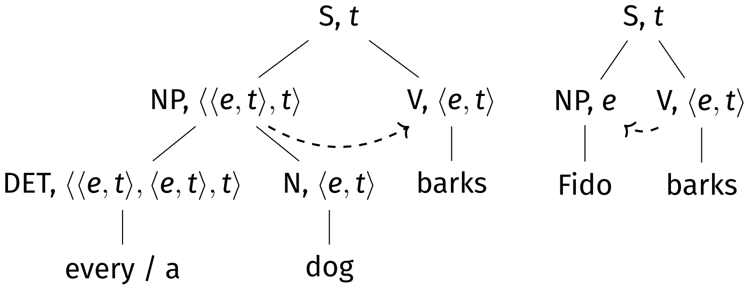
Compositionality and PL1 II

- The logical form of *Every dog barks* still is $\forall x[dog'(x) \rightarrow bark'(x)]$.
- But the meaning of the subject NP *every dog* can be extracted as $\lambda P \forall x[dog'(x) \rightarrow P(x)]$, that is, the set of properties P which every dog has.
- Likewise for other QNPs, so a general compositional treatment is achieved, e.g. *a dog* $\mapsto \lambda P \exists x[dog'(x) \wedge P(x)]$, the set of properties at least some dog has.

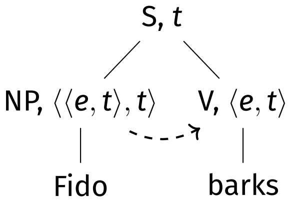
VPs as arguments of subject QNPs



But what about proper names? Different predicational direction for referential and quantificational subjects:



- Technically there is a simple solution: Just package the referential NPs like the QNPs: Fido $\mapsto \lambda P.P(f)$
- If we do this, all's good derivationwise: *Fido barks* $\rightarrow$



- Relational view following 'Montague's move(s)': **every**(*dog*)(*barks*), where the quantifier word expresses a **relation** between the restrictor set (N) and the scope set (V).
- Uniform meaning of QNPs: sets of subsets of the domain of discourse *U* such that:

(1) a. $[\![\text{every NP}]\!] = \{[\![X]\!] \subseteq U : [\![NP]\!] \subseteq [\![X]\!]\}$

b. $[\![\text{most NP}]\!] = \{[\![X]\!] \subseteq U : |[\![X]\!] \cap [\![NP]\!]| > |[\![X]\!]^{-} \cap [\![NP]\!]|\}$

c. $[\![\text{no NP}]\!] = \{[\![X]\!] \subseteq U : [\![NP]\!] \cap [\![X]\!] = \emptyset\}$

d. $[\![\text{two NP}]\!] = \{X \subseteq U : [\![NP]\!] \cap X \text{ contains two members}\}$

e. … and so on

➔ The standard analysis in formal semantics following Barwise and Cooper (1981)

- On this view, an individual is represented in terms of its properties.
- Good: a representation like $\lambda P.P(f)$ is consonant with the view that we represent people in terms of a bunch of properties they have.
- Baddish: What about the ‘thinginess’ of proper name bearers? Does the complex property predication correspond to the way we think / is cognitively plausible? [➔ entity memory, Lect. 5]

- How to evaluate a sentence of the form Q(N)(VP)?
- Sieving: Q separates VP denotations into those that do and those that do not combine with the QNP to produce a true sentence.
- Do we have to check **all** VP denotations there are? No! We can restrict ourselves to those VP elements that are also elements of the NP (**conservativity**). [Memo: To verify whether all dogs bark we don't need to care about cats.]
- But checking whether *Fido barks* involves constructing all sets $\lambda P.P(f)$ to which f belongs and then seeing whether the set of barkers is one of these sets.
- This clearly does not correspond to the reasoning process actually used by a native speaker of English to verify such an utterance.

Sieves and witnesses II

- Witness-based reasoning (Barwise and Cooper, 1981): consider some 'deputy' set w of the NP denotation: if w is also part of the VP denotation (eventually obeying restrictions imposed by the quantifier relation), then the sentence is true.
- w is known as **witness set**.

Talking about QNPs I

- Ginzburg and Cooper (2004) and Purver and Ginzburg (2004) argue in detail that the clarificational potential of an utterance *u* includes the question in (7), this can become the (maximal) question under discussion, and serve to resolve non-sentential clarification questions.

  (7) What did you mean as the content of *u*?

- Hence, *answers* to such questions provide indications as to intended content.
- For clarification questions triggered by proper names as in (8) a resolving answer communicates an individual, in (8b) identified via its location:

(8) a. Christopher: Could Simon come round tomorrow?
Phillip: Simon?
Jane: Mm mm. Simon Smith.

(BNC, KCH, 48–51, slightly modified)
Phillip: Oh! Simon. (pause dur=6) I don't know if we're gonna go out.

b. Dave: O'Connors again.
Keith: O'Connors?
Dave: Yeah
Keith: Where's that?
Dave: [provides address]
Keith: [repeats address]

(BNC, KCY, 1183–86)

- What, then, for the clarificational potential of QNPs?

- Purver and Ginzburg (2004) show that answers to clarification questions (CQs) about QNPs communicate individuals and sets of individuals (as in (9a,b)), and even function denoting NPs.
- However, there is no evidence of *talk* about GQs (the contents associated with QNPs according to GQT).

(9) a. Terry: Richard hit **the ball** on the car.
Nick: **What ball**? *[⇝ What ball do you mean by 'the ball'?]*
Terry: **James [last name]'s football.** [→ individual]
(BNC KR2, 862–866)

b. Richard: No I'll commute **every day**
ANON 6: **Every day?** *[⇝ Is it* ***every*** *day you'll commute?]*
[⇝ Is it every ***day*** *you'll commute?]*
[⇝ Which days do you mean by "every day"?]
Richard: as if, er **Saturday and Sunday**
Anon 6: And **all holidays**? [→ set of days]
Richard: Yeah [*pause*]
(BNC KSV, 257–261)

- **Note:** Accepted answers in terms of individuals and sets, not sets of sets.

- As is widely accepted, the antecedent contents allow for two kinds of witnesses, a so-called *maximal set* and a *reference set*.
- Both are exemplified in (10), where the plural pronoun in (10 a) refers back to environmentalists that actually took part in the rally (the *reference set*, or *refset*), and the plural pronoun in (10 b) picks up an antecedent which denotes the totality of environmentalists that could have come (the *maximal set*, or *maxset*).

  (10) a. Only seventy environmentalists came to the rally …
  b. … but they raised their placards defiantly.
  c. … although they had all received an invitation.

- When the antecedent NP involves a downward monotone quantifier even a further witness can be picked out (Nouwen, 2003):

(11) Few environmentalists came to the rally. They went to a football game instead.

- The plural pronoun from the second sentence in (11) refers back to those environmentalists that stayed away from the rally.
- Accordingly, (11) is an instance of *complement set anaphora*, or *compset* anaphora.
- Just as denotations can be used to delimit the clarification potential of QNPs, maxset, refset and compset stake out their anaphoric potential.

→ In sum: evidence for **witness-based quantification**

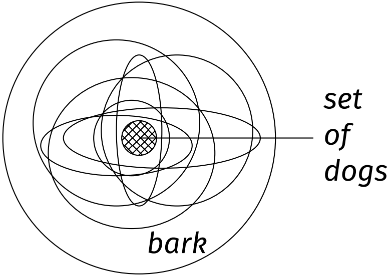
More systematically: How to detect denotations?

Referential Transparency (RT) (Lücking and Ginzburg, 2022)

The semantic representation of an NP is referentially transparent if

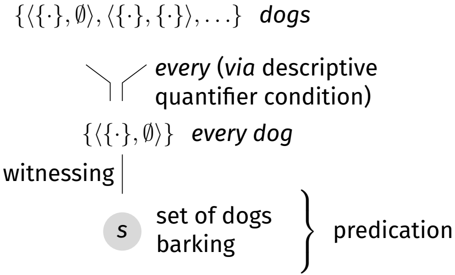
a. it provides antecedents for **pronominal anaphora**
b. it provides the semantic type asked for by a **clarification request**
c. it provides an attachment site for **co-verbal gestures** [multimodal extension of anaphora]
d. its content parts can be identified and **addressed**.

Generalized Quantifier



true iff the set of dogs is contained in the set of barking things. (Note: set of sets model is difficult to reconcile with clarifications)

Referential Transparency Theory (RTT)



true iff (i) there is a *situation* or *event s* which involves *witnesses* of the extension of the plural type *dogs*, (ii) the witnesses comply to the descriptive condition of *every*, and (iii) the situation can be classified as a *barking* one.

- Our proposal: set/ind-based model of quantified noun phrases (QNPs).

NP_{sem}

$$\left[\begin{array}{ll} \text{q-params} : & \left[\begin{array}{ll} \textit{maxset} & : \textit{Set}(\textit{Ind}) \\ \text{c1} & : \overrightarrow{\textit{Ppty}}(\text{maxset}) \text{ [plural property]} \\ \textit{refset} & : \textit{Set}(\textit{Ind}) \\ \textit{compset} & : \textit{Set}(\textit{Ind}) \\ \text{c2} & : \text{union(maxset, refset, compset)} \end{array}\right] \\ \text{q-cond} & : \textit{Rel}(|\text{q-params.refset}|, |\text{q-params.compset}|) \\ \text{q-persp} & : \text{refset}{=}\emptyset \vee \text{refset} \neq \emptyset \vee \text{none} \end{array}\right]$$

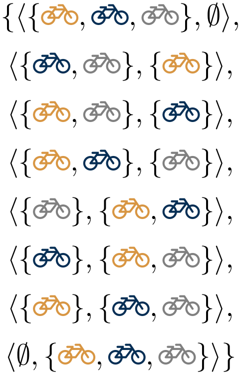
- Every component is referentially transparent, that is, directly relates to clarification requests or pronominal anaphora and is addressable *via* its label.

Sets p of ordered set bipartition

An ordered set bipartition b of a set s is a pair of disjoint subsets of s including the empty set such that the union of these subsets is s. Form: $\langle$refset, compset$\rangle$

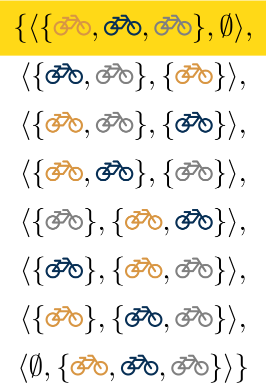
$$
\begin{aligned}
[\downarrow \text{Bicycle}] = \{\textcolor{orange}{\text{🚲}}, \textcolor{blue}{\text{🚲}}, \textcolor{gray}{\text{🚲}}\}.\ p([\downarrow \text{Bicycle}]) = \{ & \langle\{\textcolor{orange}{\text{🚲}}, \textcolor{blue}{\text{🚲}}, \textcolor{gray}{\text{🚲}}\}, \emptyset\rangle, \\
& \langle\{\textcolor{blue}{\text{🚲}}, \textcolor{gray}{\text{🚲}}\}, \{\textcolor{orange}{\text{🚲}}\}\rangle, \\
& \langle\{\textcolor{orange}{\text{🚲}}, \textcolor{gray}{\text{🚲}}\}, \{\textcolor{blue}{\text{🚲}}\}\rangle, \\
& \langle\{\textcolor{orange}{\text{🚲}}, \textcolor{blue}{\text{🚲}}\}, \{\textcolor{gray}{\text{🚲}}\}\rangle, \\
& \langle\{\textcolor{gray}{\text{🚲}}\}, \{\textcolor{orange}{\text{🚲}}, \textcolor{blue}{\text{🚲}}\}\rangle, \\
& \langle\{\textcolor{blue}{\text{🚲}}\}, \{\textcolor{orange}{\text{🚲}}, \textcolor{gray}{\text{🚲}}\}\rangle, \\
& \langle\{\textcolor{orange}{\text{🚲}}\}, \{\textcolor{blue}{\text{🚲}}, \textcolor{gray}{\text{🚲}}\}\rangle, \\
& \langle\emptyset, \{\textcolor{orange}{\text{🚲}}, \textcolor{blue}{\text{🚲}}, \textcolor{gray}{\text{🚲}}\}\rangle\}
\end{aligned}
$$

Q-cond sieves

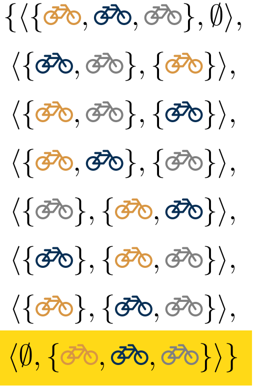


- **most**: $|\text{refset}| \gg |\text{compset}|$
  most(bicycles)

- **most**: $|\text{refset}| \gg |\text{compset}|$
  most(bicycles)
- **every**: $|\text{refset}| = |\text{maxset}|$
  every(bicycle)



- **most**: $|\text{refset}| \gg |\text{compset}|$
  most(bicycles)
- **every**: $|\text{refset}| = |\text{maxset}|$
  every(bicycle)
- **no**: $|\text{refset}| = \emptyset$
  no(bicycle)



- Significantly reduced logical space:
  for a universe of 2 elements there are 63 possible quantifiers, not 65,536 as in GQT (Lücking and Ginzburg, 2022)
- No quantifier raising needed ➔ incremental processing
- When sentences that contain quantificational arguments are presented as spoken input, the quantifiers are also interpreted in a fully incremental manner. ERP findings (Urbach, DeLong and Kutas, 2015; Freunberger and Nieuwland, 2016)

(12) a. A: Everyone … B: Who?
b. A: [enters class] No students … Oh, they're hiding.

- Few students left.
-

$$\left[\begin{array}{l}\text{sit} = \text{s1} : \textit{Rec} \\ \text{sit-type} = \left[\begin{array}{ll}\text{q-params} : & \left[\begin{array}{ll}\text{maxset} & : \textit{Set}(\textit{Ind}) \\ \text{co} & : \overrightarrow{\text{student}}(\text{maxset}) \\ \text{refset} & : \textit{Set}(\textit{Ind}) \\ \text{compset} & : \textit{Set}(\textit{Ind}) \\ \text{c1} & : \text{union(refset,compset,maxset)}\end{array}\right] \\ \text{q-cond} & : |\text{q-params.refset}| \ll |\text{q-params.compset}| \\ \text{nucl} & : \overrightarrow{\text{left}}(\text{q-params.refset}) \\ \text{anti-nucl} & : \neg\overrightarrow{\text{left}}(\text{q-params.compset}) \\ \text{q-persp} & : \text{refset} = \emptyset \text{ [empty set is part bipartition]}\end{array}\right] : \textit{RecType}\end{array}\right]$$

- The record type in (12 b) is referentially transparent since it provides discourse referents for refset and maxset anaphora.

Example II

- Since it also hosts a compset, it can act for compset anaphora — licensed by q-persp's feature value 'refset$=\emptyset$' .
- By means of negative predication on the compset (label 'anti-nucl'), ((12)) expresses that the students from the complement set did not leave.
- But what is q-params?

- Isn't quantification about describing, not referring?
- Recall DGB as cognitive state classification.
- We distinguish two sets of entities, following certain HPSG-originating approaches (Ginzburg and Purver, 2012)
  - dgb-params: need to be instantiated by witnesses
  - q-params: existentially quantified 'away'
- *A thief* [whoever s/he was] *stole my iPad.* ➔ Discourse referent of *thief* is part of q-params, that of *my iPad* is part of dgb-params and is **witnessed** (since I know my iPad although it is unfortunately gone right now)
- Crucial role in clarification interaction:

- [earlier example] Christopher: Could Simon come round tomorrow?
  Phillip: Simon?
  Jane: Mm mm. Simon Smith.

  (BNC, KCH, 48–51, slightly modified)
- Phillip cannot witness Simon (q-params) unless reference is clarified by Jane (moved to dgb-params)

- *quantificational*: refset is part of *q-params*.
  Example: *The thieves (whoever they are) escaped with the loot.*

$$a : \begin{bmatrix} \text{q-params} : \begin{bmatrix} \text{maxset} & : \mathit{Set}(\mathit{Ind}) \\ \text{c1} & : \overrightarrow{P}(\text{maxset}) \\ \text{refset} & : \mathit{Set}(\mathit{Ind}) \\ \text{compset} & : \mathit{Set}(\mathit{Ind}) \end{bmatrix} \\ \text{q-cond} : \text{Rel}(|\text{q-params.refset}|, |\text{q-params.compset}|) \end{bmatrix}$$

iff $a \in p([\downarrow P]) \wedge \text{Rel}(|a.\text{first}|, |a.\text{second}|) = 1$

- *plural reference*: refset is part of *dgb-params*.
  Example: *Look! Many men wearing big boots are stealing our lemons.*

$$
\text{a} : \begin{bmatrix} \text{dgb-params} : \begin{bmatrix} \text{maxset} & : \mathit{Set}(\mathit{Ind}) \\ \text{c1} & : \overrightarrow{P}(\text{maxset}) \\ \text{refset} & : \mathit{Set}(\mathit{Ind}) \\ \text{compset} & : \mathit{Set}(\mathit{Ind}) \end{bmatrix} \\ \text{q-cond} : \text{Rel}(|\text{dgb-params.refset}|, |\text{dgb-params.compset}|) \end{bmatrix}
$$

iff $a = \iota x[x \in p([\downarrow P]) \wedge \text{Rel}(|\text{x.first}|, |\text{x.second}|) = 1 \wedge x \in \text{common-ground}(\text{spkr}, \text{addr})]$

- *indefinite*: refind is part of *q-params*.
  Example: *Can anybody find me somebody to love?* (Queen)

$$\mathrm{a}:\left[\mathrm{q\text{-}params}:\begin{bmatrix}\mathrm{maxset} & : \mathit{Set}(\mathit{Ind}) \\ \mathrm{c1} & : \overrightarrow{P}(\mathrm{maxset}) \\ \mathrm{refset} & : \mathit{Set}(\mathit{Ind}) \\ \mathrm{compset} & : \mathit{Set}(\mathit{Ind}) \\ \mathrm{refind} & : \mathit{Ind} \\ \mathrm{c2} & : \mathrm{in}(\mathrm{refind},\mathrm{refset})\end{bmatrix}\right],$$

iff $a \in p([\downarrow P]) \wedge \exists x[x \in a.\mathrm{first}] \wedge \ \mathrm{refind} \ = x$

- *singular reference*: refind is part of *dgb-params*. Example: *The current world chess champion is Magnus Carlsen.*

$$a : \left[\text{dgb-params} : \begin{bmatrix} \text{maxset} & : \mathit{Set}(\mathit{Ind}) \\ \text{c1} & : \overrightarrow{P}(\text{maxset}) \\ \text{refset} & : \mathit{Set}(\mathit{Ind}) \\ \text{compset} & : \mathit{Set}(\mathit{Ind}) \\ \text{refind} & : \mathit{Ind} \\ \text{c2} & : \text{in(refind,refset)} \end{bmatrix}\right],$$

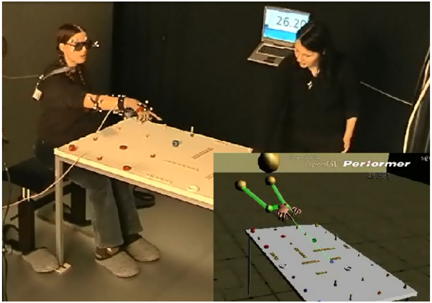
iff $a \in p([\downarrow P]) \wedge \iota x[x \in a.\text{first}] \wedge \text{refind} = x \wedge x \in \text{common-ground}(\text{spkr}, \text{addr})$

- Besides the 'classic' readings distinguished above, our referential/quantificational mechanism captures further, more finegrained, possibilities.
- For instance, detective Hercule Poirot (a figure of the crime stories of Agatha Christie) often finds himself in a situation where he knows the refset (i.e., the group of suspects, which is part of Poirot's dgb-params), but the actual culprit still has to be convicted, that is, the refind initially is part of q-params.
- The tension in such *Whodunit* crime novels consists in the detective transferring the refind from q-params to dgb-params.

- In *Spectre*, James Bond soon learns that Franz Oberhauser is a member of a criminal organisation (the eponymic secret society *Spectre*), but is still unaware of who else belongs to it.
- In this case, the refset (i.e., *Spectre* members) is part of Bond's q-params, while refind Oberhauser is already grounded in dgb-params.
- One can also conceive of cases where the compset is part of dgb-params, while the refset is part of q-params.
- This configuration is exemplified by John F. Kennedy's question 'If not us, who?'.
- These examples illustrate the range of, and the need for, a **cognitively oriented referentiality/non-referentiality mechanism**.

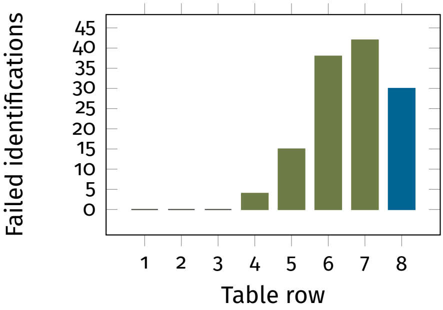
Look!

- ‘Look! [] All the dogs are barking.’
- According to direct reference views (Kaplan, 1989) such a sentence is true if the entity provided by the pointing gesture is part of the denotation of barking things [NB: Kaplan does not deal with pluralities, but intuitively clear enough]
- But what does ‘entity provided by the pointing gesture’ mean? ➔ let us ask experimental pragmatics studies

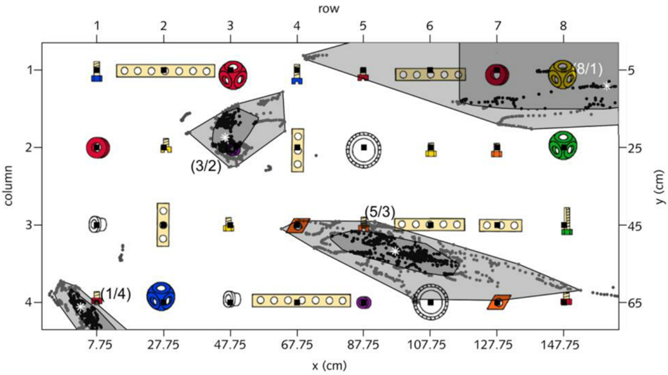


- *Experimental pragmatics* study (Kranstedt et al., 2006; Lücking, Pfeiffer and Rieser, 2015).
- Two runs: with speech and without speech.
- *Tracking of pointer*: simulate and 'measure' pointing.

Identification Failures



- For the addressee, the identifying force of pointings ceases in distal area.
- Note: decrease in row 8 due to 'gestural hyperbole'.



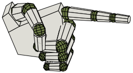
- Even in proximal area pointings do not hit their targets.

➔ Demonstrative reference rests on a *pre-semantic pragmatic inference*: *take the object that is closest to the idealized pointing beam.* (Lücking, Pfeiffer and Rieser, 2015).

From reference to attention (Lücking, 2022)

this

attentional index



spatial index

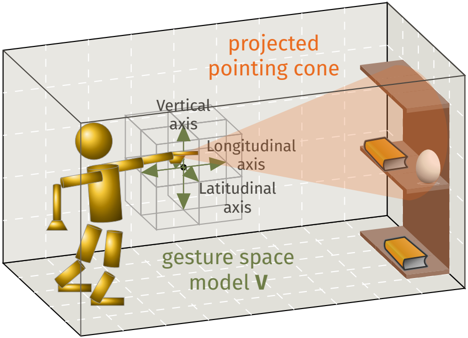
'search space'
(= set of situations, *Ground*)

∋

N

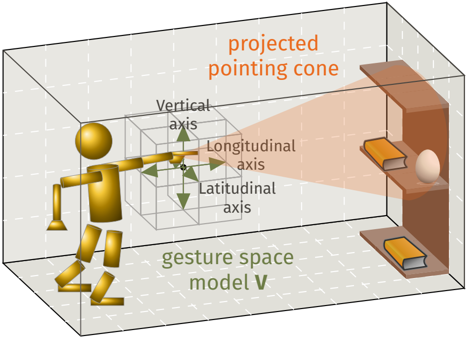
(true) description

index
(situational constituent, *Figure*)



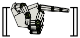
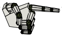
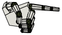
Spatial Semantics:

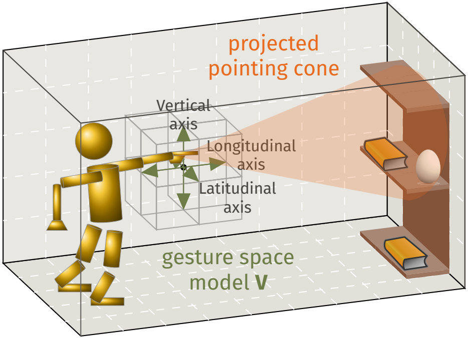
Demonstrations *constrain situation variables.*



Spatial Semantics:

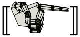
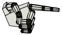
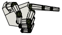
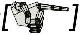
Demonstrations *constrain situation variables.*

- Pointing's *character* at u:
  $[\![$$]\!]^u = \lambda s.\ \text{region}(s) \cap \text{cone}($$)(u) \mapsto \text{relmax}$
  In short: $(s) \mapsto \max_i$



Spatial Semantics:

Demonstrations *constrain situation variables.*

- Pointing's *character* at u:
  $[\![$  $]\!]^u = \lambda s.\ \text{region}(s) \cap \text{cone}($  $)(u) \mapsto \text{relmax}$
  In short:  $(s) \mapsto \text{max}_i$
- *This[*  *] book is great*:
  $\lambda s.\iota x x$ is a book in s'&  $(s') \mapsto \text{max}_i$ is great in s.

Processing semantics of DemNPs

The dynamic semantics of DemNPs in dialog is governed by the retrieval question: ‘Where to find the referent?’ (Lücking, 2018)

Processing instructions for DemNPs

1. If there is a demonstration act, then the DemNP contributes to dgb-params and is witness-loaded in the focus of attention (*via* pointing cone).
2. If there is no demonstration, but a repetition of a constituent, the DemNP is interpreted anaphorically (also in dgb-params).
3. Otherwise, the DemNP contributes to q-params (but not to FoA/VisSit).

Lexical resource for pointing I

- The pointing device gives rise to a direction vector which indicates the direction into which the addressee of the pointing should turn its attention.
- $$\left[\begin{array}{l} \text{shape} : \texttt{pointing} \\ \text{dir=Vector(shape)} : \textit{Direction} \\ \text{dgb-params} : \left[\begin{array}{ll} \text{spkr} & : \textit{Ind} \\ \text{addr} & : \textit{Ind} \\ \text{utt-time} & : \textit{Time} \\ \text{c-utt} & : \text{addressing(spkr,addr,utt-time,shape)} \end{array}\right] \\ \text{content} = \text{DirectAttention(skpr,addr,turn(addr.}e_{\text{gaze}}\text{,dir))} : \textit{IllocProp} \end{array}\right]$$
- triggers: Visual situation update (cf. Lect. 1)

Lexical resource for pointing II

- Visual situation update

$$\left[\begin{array}{l} \text{tcs}=\left[\begin{array}{l}\text{dgb : DGBType}\\ \text{private : Private}\end{array}\right] : \text{TCS} \\ \text{B = dgb.addr : IND} \\ \text{B.pre :} \quad \left[\begin{array}{lcl}\text{d} & : & \text{Direction}\\ \text{LatestMove = DirectAttention(spkr,addr,o)} & : & \text{IllocProp}\end{array}\right] \\ \text{B.effects :} \quad \left[\text{VisSit.InAttention = d : Direction}\right] \end{array}\right]$$

- Interaction with exophoric demonstrative *this*:

- $$\left[\begin{array}{l} \text{phon}{=}\textit{this} : \textit{Phon} \\ \text{dgb-params} : \left[\begin{array}{lll} \text{spkr} & : & \textit{Ind} \\ \text{addr} & : & \textit{Ind} \\ \text{utt-time} & : & \textit{Time} \\ \text{c-utt} & : & \text{addressing(spkr,addr,utt-time,phon)} \\ \text{o} & : & \textit{Ind} \\ \text{vis-sit} & = & \left[\text{InAttention} : \textit{Dir}\right] : \textit{RecType} \end{array}\right] \\ \text{cont}{=}\text{in(o,VisSit.InAttention)} : \textit{RecType} \end{array}\right]$$
- In sum: cognitively oriented, interactive modeling of spatial Figure–Ground model of deictic reference.

(Lücking & Ginzburg in prep.)

In some parts of *Conversation Analysis* (CA) attention seems to be derived from reference:

- ‘[. . .] a speaker introduces a new object by pointing at it and establishes the joint attention of the co-participants towards it’ (Mondada, 2014, p. 95)
- ‘In perhaps its barest form, referring consists of literally pointing to something in order for two people to share attention on that thing [. . .]’ (Enfield, 2013, p. 433)

From attention to reference?

- We conjecture that the mechanism for deictic reference is to be deduced from shared attention—not the other way round.
- Establishing pragmatic reference—that is filling the value of *InAttention* within the addressee's VisSit—is brought about by combining the ventral and dorsal processing streams (Connor and Knierim, 2017) such that an object becomes the unit of attention from a focused perceptual scene/direction (Scholl, 2001).
- Computationally, deictic reference is modeled in terms of a spatial semantics; procedurally, it employs two pathways of visual processing.

Upshot

A proper understanding of quantification and (deictic) reference need a cooperation of theoretical linguistics/dialogue semantics and cognitive science.

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