Communicable reasons: How children learn topoi through dialogue

Ellen Breitholtz and Christine Howes
Centre for Linguistic Theory and Studies in Probability
Department for Philosophy, Linguistics and Theory of Science
University of Gothenburg
ellen.breitholtz@ling.gu.se; christine.howes@gu.se

WatchDial 2020
July 19

What this talk is about

How children build up their rhetorical resources partly by generalising enthymematic arguments encountered in conversation.

Structure

- First we will give some background to reasoning in dialogue, the role of interaction in language acquisition, and the building up of rhetorical resources.
- Examples from interactions between children and adults which demonstrate how children draw on and acquire rhetorical resources in interaction.
- Finally, we will suggest a way of modelling how the acquisition of rhetorical resources works

Reasoning in Dialogue

Example 1

Dave: . . . you're gonna be home from football until four, you gonna have your dinner, want a bath.

Lee: Yeah, but I might not go to school tomorrow.

Dave: Why?

Lee: Cos of my cough.

Dave: How can you play football and not go to school then?

Lee: Cos I was going out in the fresh air, I'm alright when I'm out in the fresh air.

Dave: So why aren't you going to school then?

Lee: I'm in the class room all day dad. [BNC KBE 10554-10561]

- As shown in (1), participating in any dialogic exchange requires a wealth of knowledge,
  - linguistic items used
  - the world
  - interlocutor(s)
  - shared environment
  - social norms ...
- These factors are usually considered to be outside the remit of linguistics proper
- However, the distinctions between linguistics, pragmatics and social factors are hard to justify when we look at language as it is used in everyday interaction

- In (1), Lee is conveying
  - he is well enough to play football but not well enough to go to school because football takes place outdoors.
- Conversely, his father Dave infers
  - if Lee is well enough to play football then he is well enough to go to school.
- But how do we learn that being ill restricts certain activities; or the possible exceptions to this ‘rule’, such as where the activity occurs?

Reasoning in interaction

- Reasoning is essential in communication since interacting with others frequently involves making non-logical common-sense inferences linking context, background knowledge and beliefs to utterances in the dialogue
- Following Breitholtz and Cooper (2011); Breitholtz (2011, 2014a), we will use the Aristotelian term *enthymeme* in connection with such inferences.
- An enthymeme is an argument which appeals to what is in the listener's mind, i.e. an interlocutor must draw on background knowledge or contextual information to correctly interpret the argument.
- If a dialogue participant presents the argument P therefore Q, an interlocutor must supply a warrant that P is a valid reason for Q in order for the argument to be successful. These warrants are often referred to as *topoi* (Aristotle, 2007; Ducrot, 1988).

- In (1), the enthymeme from Dave's perspective can be depicted as (3).

Example 2

$$\frac{\text{ill}(\textit{Lee})}{\text{stay\_home}(\textit{Lee})}$$

- This enthymeme could be underpinned by a more generally applicable topos such as the ones shown in (3) and (4).

Example 3

$$\frac{\text{ill}(x) \quad \text{need\_rest}(x)}{\text{stay\_home}(x)}$$

Example 4

$$\frac{\text{ill}(x) \quad \text{contagious}(x)}{\text{stay\_home}(x)}$$

- When we interact we expect topoi to be common ground, or – if they are not – to be *accommodated* (adopted by dialogue participants Karttunen, 1974; Stalnaker, 1974) during the course of the interaction.
- In many contexts there might be several acceptable topoi, and misunderstandings and disagreement can arise if interlocutors assume different topoi (Jackson and Jacobs, 1980).

Interaction in acquisition

- A large body of work in computational- and sociolinguistic argues for a social perspective on language learning which makes explicit the role of interaction in language acquisition. (Clark and Lappin, 2010 Halliday, 1975, 1994 and Tomasello, 1992 a.o.).
- Specifically, research on child language acquisition underscores the importance of the social environment for the language learning child (Stephens and Matthews, 2014).
- Children are active in interactions with their caregivers long before they produce language and evidence suggests that it is this learning to interact (e.g. through gaze Gredebäck et al., 2010 and turn-taking Hilbrink et al., 2015; Casillas, 2014) which bootstraps language acquisition (Levinson's (2006) 'interaction engine').

Interaction in acquisition cont'd

- Research on children in the early stages of verbal language acquisition also shows that children learn new words and concepts through interaction Clark (2015).
- As with lexical concepts, which are learned through repeated encounters with words in interaction, topoi can be learned through repeated encounters with enthymematic arguments in dialogue.
- And, also analogously to the acquisition of concepts, this can be more or less explicit "You can't go to school today because you're poorly. You have to stay home and rest", compared to "I might not go to school tomorrow ... cos of my cough"

Building rhetorical resources

- In order to abstract principles of reasoning from co-occurring situations, a child must have a notion of *situation type*
- For a child to acquire the topos "If x is dropped, x falls to the ground", the child must abstract away from particular situations to establish that this generally holds
- Children may then use the topos in a situation that the child judges to be of the same type as that of the original situation, and the dialogical reasoning works seamlessly.

Example 5

4;1 year old Greta is playing with two dolls "Loria" and "Masha", January 2020

Greta: Loria's sleeping *[snoring noises]*

Mother: Loria's really noisy when she's sleeping. Has she got a cold?

Greta: Yes

(as L): I have got a cold so I can't go to school . . .

Later in the same game:

(as M): But why can't we go to school?

(as L): Because we've got a cold and we snore bad

- In (5) The enthymematic utterance "I have got a cold so I can't go to school" demonstrates that Greta has previously acquired an appropriate topos (perhaps the one shown in (3), above), which licenses the enthymeme.
- She also adds a new topos, (below in 6), that has been supplied enthymematically by her mother in the form of a question early on in the dialogue

Example 6

$$\frac{\mathrm{snores}(x)}{\mathrm{has\_cold}(x)}$$

Unexpected topoi

- However, as with children's well-documented overextention of lexical items Clark (2009); Gelman et al. (1998), in some cases the child overextends the domain to which the topos applies.
- These cases are particularly illustrative of how topoi are learned.
- we will look at some examples of how children apply topoi in interaction, which show how children generalise from small amounts of data to reason about novel situations.

Topos about death

Example 7

Child: *Lever din mormor?*
Lives your grandmother?
'Is your grandmother alive?'

Mother: *Nej, hon är död.*
No, she is dead.

Child: *[med anklagande ton] Puttade du henne?*
[with accusatory tone] Pushed you her?
'Did you push her?'

Mother commenting on twitter:
Ja, treåringen kan ha tittat LITE för
Yes, three-year-old$_{DET}$ can have watched little too
mycket på Lejonkungen.
much Lion-King$_{DET}$
'Yes, the three year old might have watched the Lion King a little too often.'

- The Child's understanding of death is generalised from their limited experience, which, according to the mother, comes exclusively from the film 'The Lion King'.
  - In this film, the main character father dies after he is pushed from a cliff edge by his brother.
- The child has correctly generalised the concept of death to other living things than lions
- However, the child has stored a 'death topos' with a causal relationship – if someone is dead then someone related pushed them (8).

Example 8

$$\frac{\mathrm{dead}(x) \quad \mathrm{related}(x, y)}{\mathrm{pushed}(x, y)}$$

- This topos is applied constructively by the child in the dialogue shown in (7).
- Learning that her mother's grandmother is dead, the child concludes that she must have been pushed and infers that it was her mother who did the pushing.

Topos about widows

- In a similar example from Breitholtz (2015), the child has extrapolated a topos (10) from their previous experience of the concept ‘widow’, which comes exclusively from fairy tales.

Example 9

Reading a bedtime story to 4 year old child

Mother: *Snövits mor dog kort efter födseln och en tid senare gifte hennes far, Kungen, om sig. Hans nya hustru var vacker men fåfäng och elak.*

Snow White’s mother died shortly after the birth, and after some time her father, the king, remarried. His new wife was beautiful but vain and wicked.

Annie:	*Ja*	*mamma*	–	*en*	*änka!*
	Yes	mum	–	a	widow!

Example 10

$$\frac{\text{beautiful}(x) \quad \text{vain}(x) \quad \text{wicked}(x)}{\text{widow}(x)}$$

- To anyone familiar with the conventional meaning of the word *widow*, it seems obvious that the child has got it wrong.
- However, this gives us an insight into how most of us usually get it right
  - Reasoning using *enthymemes* can be a means not only of lexical disambiguation (as suggested by Pustejovsky, 1998), but also a means of acquiring new concepts.

- While clearly linked to reasoning and interaction, it could be argued that these two examples of unexpected topoi are only about the lexical concepts that the child has acquired.
- However, there are also examples of children using unexpected topoi which cannot be reduced to a lexical concept, which also require explanation.
- For example, situations such as the current pandemic give rise to new topoi which may be overextended:

Example 11

Conversation with 4;3 year old Greta in March 2020 (coronavirus times)

Greta: What would happen if you drank the sea water?

Mother: It would make you poorly.

Greta: Really poorly?

Mother: Yes.

Greta: Old people would die. I don't know about us though.

Example 12

$$\underbrace{\text{is\_poorly}(x) \qquad \text{old}(x)}_{\text{die}(x)}$$

Possible input

- "The elderly and the unwell are more likely to die, if they contract coronavirus." (BBC news website)

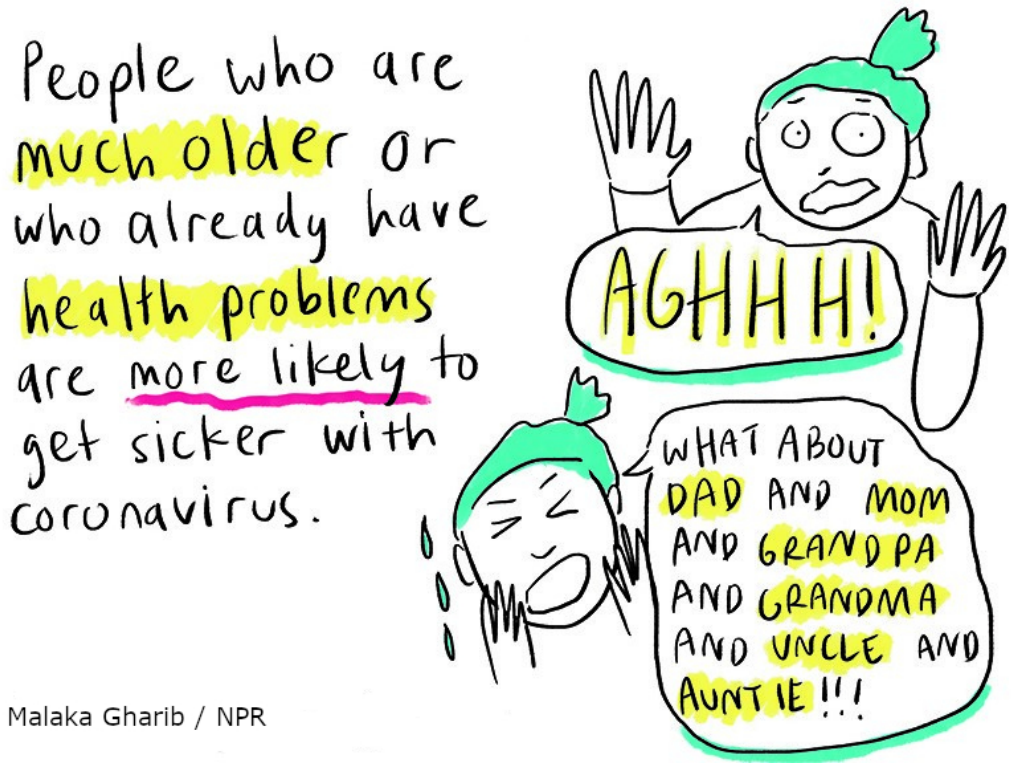

Figure: Underlying topos: Old people are more likely to get more ill with coronavirus

- the topos (13) that older people (and those with underlying medical conditions) are more likely to become more ill, or die if they contract coronavirus is now generally accepted
- This topos did not exist in 2019.

Example 13

$$\frac{\mathrm{has\_corona}(x) \qquad \mathrm{old}(x)}{\mathrm{die}(x)}$$

- A more general version – older people (and those with underlying medical conditions) are more likely to become more ill, or die if they contract diseases probably did exist for most adults prior to the coronavirus
- However, Greta has not previously encountered such a topos, but is, based on her corona-specific new topos, able to apply a more general (in this case incorrect) version of this topos.
- This is an example where a child overextends the domain for when a particular topos applies.

An account of overextension of topoi

- To account for the reasoning involved in the building up of rhetorical resources, we will use an information state update approach using dialogue gameboards cast in TTR, a type theory with records (Larsson, 2002; Ginzburg, 2012).
- Basic idea:
  - Agents involved in interaction need to coordinate
  - gameboards represent how they keep track of where they are in the creation of particular dialogue events
- Each agent has their own view of the state of the game, and thus we have separate gameboards for each of the participants in an interaction.
  - Enables us to account for coordination, especially with regards to miscommunication, where there is a mismatch between the participants' dialogue gameboards.

Dialogue gameboards as types in TTR

- Following Ginzburg (2012); Cooper and Ginzburg (2015); Cooper (ress) we model dialogue gameboards in TTR, a type theory with records (Cooper, 2005, 2012).
- The basis of TTR is our ability to perceive and classify the world, i.e. to perceive objects and situations in the world as being of *types* such as *Ind*, the type of entities such as humans, animals, things, and *ptypes*, consisting of a predicate and its arguments, for example *see(a,b)*, "*a* sees *b*".
- In order to represent complex situations we use *record types*.
  - A record type: a structure of pairs of labels and types, where labels may represent things like individuals, predicates and events.

Record types representing types of situations

Example 14

$$\begin{bmatrix} x{:}\mathit{Ind} \\ c_{dog}{:}\mathrm{dog}(x) \\ c_{run}{:}\mathrm{run}(x) \end{bmatrix}$$

- The object to which the label x points in (14) is of type *Ind*.
- Two constraints – the individual is a dog (c_{dog}:dog(x)) and it runs (c_{run}:run(x))

Records representing situations

- We also want to be able to talk about actual situations that are of certain types. We represent such objects as records.
- A record – a structure where the labels are associated with *values* rather than types.

Example 15

$$\begin{bmatrix} \mathsf{x} & = \mathsf{fido} \\ \mathsf{c}_{dog} & = s_1 \\ \mathsf{c}_{run} & = s_2 \end{bmatrix}$$

- In (16) we see a record representing one particular situation where Fido the dog runs.

- This situation is of the type in (14) if all the values are of the appropriate types (fido: *Ind*, s_1: dog(fido) and s_2: run(fido)).
- If these conditions are fulfilled, the record in (16) is a witness of the type of situation in (14).

Example 16

$$\begin{bmatrix} x & = \text{fido} \\ c_{dog} & = s_1 \\ c_{run} & = s_2 \end{bmatrix}$$

A (minimal) DGB

- The field ‘shared’ holds information that the agent takes to be shared, either as it has been explicitly referred to in the dialogue, or because the agent expects it to have been accommodated.
- The label ‘rhet_resources’ is associated with the set of topoi that the agent has access to.

Example 17

$$\begin{bmatrix} \text{private}: \begin{bmatrix} \text{rhet\_resources}:\text{set}(\textit{Topos}) \end{bmatrix} \\ \text{shared}: \begin{bmatrix} \text{eud}:\text{list}(\textit{Enthymeme}) \end{bmatrix} \end{bmatrix}$$

Enthymemes & topoi in TTR

- Following Breitholtz and Cooper (2011); Breitholtz (2014b,a); Ginzburg et al. (2015); Breitholtz et al. (2017) we model topoi and enthymemes as functions from records to record types
  - Intuitively: If we have a situation of a particular type, we can predict a certain type of situation.
- For example, the enthymeme conveyed by the mother in (11) says that if someone drinks sea water, it will make them poorly, that is, if you perceive a situation where someone drinks sea water, you can predict that it will make them poorly, as seen in (18).

The mother's enthymeme

Example 18

$$\epsilon_1 = \lambda r{:}\ \begin{bmatrix} \mathsf{x}{:}\mathit{Ind} \\ \mathsf{c}{:}\mathsf{person}(\mathsf{x}) \\ \mathsf{e}{:}\mathsf{drink\_sea\_water}(\mathsf{x}) \end{bmatrix} \cdot \begin{bmatrix} \mathsf{e}{:}\mathsf{make\_poorly}(r.\mathsf{e},\ r.\mathsf{x}) \end{bmatrix}$$

Greta's enthymeme

- "if old people drink sea water, they will die"

Example 19

$$\epsilon_2 = \lambda r: \begin{bmatrix} \mathsf{x}:\mathit{Ind} \\ \mathsf{c}:\mathsf{person}(\mathsf{x}) \\ \mathsf{c}_1:\mathsf{old}(\mathsf{x}) \\ \mathsf{e}:\mathsf{drink\_sea\_water}(\mathsf{x}) \end{bmatrix} . \begin{bmatrix} \mathsf{e}:\mathsf{make\_die}(r.\mathsf{e}, r.\mathsf{x}) \end{bmatrix}$$

- ϵ_2 is not likely to be acceptable to most adults
- it is unlikely that the child has received input saying explicitly that old people would die from drinking sea water.
- Still, there must be some topos warranting it. So how did the child acquire this topos? We argue that is is through overextension and accommodation.

Unfamiliar enthymemes

- Sometimes we encounter enthymemes which we cannot make sense of, either since the topos is unfamiliar or because we fail to recognise the enthymeme as a specification of a particular topos which is already in our resources.
- The unfamiliar enthymeme could then be tentatively incorporated into the rhetorical resources of the language user.
- When the agent encounters similar enthymemes, they may eventually extend the domain of these related enthymemes and construe a topos that warrants all of them.
- However, children's tendency to overextension Barrett (1978) combined with our general ability of accommodation cause children to sometimes integrate topoi in their resources that are not necessarily warranted by the input.

Input enthymeme

- "If we have a situation of the type where young people get poorly from the corona virus, we can predict a type of situation where old people die from the corona virus "

Example 20

$$\epsilon_{input} = \lambda r: \begin{bmatrix} \mathrm{x}{:}\mathit{Ind} \\ \mathrm{y}{:}\mathit{Ind} \\ \mathrm{z}{:}\mathit{Type} \\ \mathrm{c}{:}\mathrm{person}(\mathrm{x}) \\ c_1{:}\mathrm{person}(\mathrm{y}) \\ \mathrm{c}_2{:}\mathrm{young}(\mathrm{x}) \\ \mathrm{c}_3{:}\mathrm{old}(\mathrm{y}) \\ \mathrm{c}_4{:}\mathrm{cause\_of\_harm}(\mathrm{z}) \\ \mathrm{c}_5{:}\mathrm{corona}(\mathrm{z}) \\ \mathrm{c}_4{:}(\mathrm{x}) \\ \mathrm{e}{:}\mathrm{make\_poorly}(\mathrm{z},\mathrm{x}) \end{bmatrix} \cdot \begin{bmatrix} \mathrm{e}{:}\mathrm{make\_die}(r.\mathrm{z},\ r.\mathrm{y}) \end{bmatrix}$$

The mother's topos, τ_{adult}

- The mother might already have access to a topos warranting ϵ_{input}.
- based on various sources of input and not as general as the topos adopted by the child, but one where the domain of the topos is delimited to situations involving infectious diseases or similar, as seen below in (21).

Example 21

$$\tau_{adult} = \lambda r: \begin{bmatrix} x{:}Ind \\ y{:}Ind \\ z{:}Type \\ c{:}person(x) \\ c_1{:}person(y) \\ c_2{:}young(x) \\ c_3{:}old(y) \\ c_4{:}cause\_of\_harm(z) \\ c_4{:}disease(x) \\ e{:}make\_poorly(z,x) \end{bmatrix} . \begin{bmatrix} e{:}make\_die(r.z,\ r.y) \end{bmatrix}$$

Greta's topos, τ_{child}

The child, on the other hand, having overextended ϵ_{input}, has adopted a topos like τ_{child} below in 22.

Example 22

$$\tau_{child} = \lambda r{:}\ \begin{bmatrix} \mathsf{x}{:}\mathit{Ind} \\ \mathsf{y}{:}\mathit{Ind} \\ \mathsf{z}{:}\mathit{Type} \\ \mathsf{c}{:}\mathsf{person}(\mathsf{x}) \\ \mathsf{c}_1{:}\mathsf{person}(\mathsf{y}) \\ \mathsf{c}_2{:}\mathsf{young}(\mathsf{x}) \\ \mathsf{c}_3{:}\mathsf{old}(\mathsf{y}) \\ \mathsf{c}_4{:}\mathsf{cause\_of\_harm}(\mathsf{z}) \\ \mathsf{e}{:}\mathsf{make\_poorly}(\mathsf{z},\mathsf{x}) \end{bmatrix} \cdot \begin{bmatrix} \mathsf{e}{:}\mathsf{make\_die}(r.\mathsf{z},\ r.\mathsf{y}) \end{bmatrix}$$

Greta's topos, τ_{child}

- "If there is a situation where a young person is affected by some cause of harm which makes them poorly, and there is an old person who is affected by the same cause, we are licensed to predict a type of situation where the old person dies.
- Such topos would warrant Greta's enthymeme ϵ_2

How are topoi integrated into our resources?

- For standard adult topos acquisition, the update rule we want to use is one that says that if there is no accessible topos in the agent's rhetorical resources, they are allowed to add the encountered enthymeme to their resources, thus making it a tentative topos.

$$
\begin{array}{c}
f\_accommodate\_topos = \\
\lambda r{:}\begin{bmatrix}\text{private}{:}\left[\text{rhet\_resources}{:}\text{set}(\mathit{Topos})\right]\\ \text{shared}{:}\left[\text{eud}{:}\text{list}(\mathit{Enthymeme})\right]\end{bmatrix}\cdot \\
\lambda e{:}\ \neg\begin{bmatrix}\text{t}{:}\mathit{Topos}\\ \text{c}_1{:}\text{in}(r.\text{private.rhet\_resources}(\text{t}))\\ \text{c}_2{:}\text{spec}(\text{t},\ \text{fst}(r.\text{shared.eud}))\end{bmatrix}\cdot \\
\left[\text{private}{:}\left[\text{rhet\_resources}{=}[\text{fst}.(r.\text{shared.eud})]{:}\text{set}(\mathit{Topos})\right]\right]
\end{array}
$$

Figure: *f_accommodate_topos*

How are topoi integrated into our resources?

- The standard rule for topos accommodation
  - there is an enthymeme on the an agent's dialogue gameboard and there is no topos in the agent's rhetorical resources in relation to which ϵ_{input} is a specification (spec), then the agent is licensed to add the enthymeme to their rhetorical resources.
- For example: A dialogue participant encounters the enthymeme "Because of the corona virus pandemic, we can't travel" adds the topos "when there is a corona virus pandemic we can't travel" to his rhetorical resources.

How are topoi integrated into our resources? cont'd

- In order to account for the adoption of generalised versions of enthymemes we must adjust the update rule to allow for accommodation of more general versions of encountered enthymemes.

$$f\_accommodate\_topos' = \lambda r{:}\begin{bmatrix}\text{private}{:}\left[\text{rhet\_resources}{:}\text{set}(\mathit{Topos})\right]\\ \text{shared}{:}\left[\text{eud}{:}\text{list}(\mathit{Enthymeme})\right]\end{bmatrix}.\ \lambda e{:}\ \neg\begin{bmatrix}\text{t}{:}\mathit{Topos}\\ \text{c}_1{:}\text{in}(r.\text{private.rhet\_resources}(\text{t}))\\ \text{c}_2{:}\text{spec}(\text{t},\ \text{fst}(r.\text{shared.eud}))\end{bmatrix}.$$

$$\left[\text{private}{:}\left[\text{rhet\_resources}{=}[\text{gen}(\text{fst}.(r.\text{shared.eud}))]{:}\text{set}(\mathit{Topos})\right]\right]$$

$$f\_accommodate\_topos'$$

How are topoi integrated into our resources? cont'd

- The standard rule for accommodating topoi can account for an agent encountering ϵ_{input} and simply adding that to their resources.
- However, the process leading to overextension of topoi requires an update rule allowing us to adopt a generalisation of an encountered enthymeme to our resources.
- For example: A dialogue participant encounters the enthymeme "Because of the corona virus pandemic, we can't travel" adds the topos "when there is a pandemic we can't travel" to his rhetorical resources.
- a highly efficient strategy for building up rhetorical resources, although it sometimes leads to overextension

Conclusions

- In this paper we have seen how examples of errors in children's acquisition of topoi show how they generalise from exposure to repeated enthymematic arguments in dialogue.
- Our formal account for how this process operates, is at this stagea sketch – many of the details need fleshing out if our intuitions are to be able to provide a full model of how children build up their rhetorical resources.
- A formal analysis of a limited number of genuine examples is complementary to rigorous empirical analysis (experimental and corpus studies)
- Looking at uses of language in interactions with children also offers insights into adult language use and the dynamic nature of all of our rhetorical resources.

Future work

- How do we delimit the adopting of topoi which are generalisations of encountered enthymemes?
  - For example, ok to construe a topos saying that cats purr based on an encounter with a particular purring cat, but not obviously ok to allow any generalisation, for instance to all four legged animals.
  - However, as we have seen, children do indeed make these kinds of overextensions, and we would like to be able to account for that.
- It seems clear that the use of topoi is not, like much else in language, all-or-nothing, but must be couched probabilistically.
  - How likely is a particular topos to be evoked in a given situation?
  - To what degree does the content of the topos hold?
- Introduce a probabilistic component into our model (for which we need more data...)

Aristotle, G. A. K. (2007). *On Rhetoric, a theory of civic discourse*. Oxford University Press.

Barrett, M. D. (1978). Lexical development and overextension in child language. *Journal of child language*, 5(2):205–219.

Breitholtz, E. (2011). Enthymemes under Discussion: Towards a micro-rhetorical approach to dialogue modelling. In *Proceedings of SPR-11 ILCLI International Workshop on Semantics, Pragmatics, and Rhetoric*.

Breitholtz, E. (2014a). *Enthymemes in Dialogue: A micro-rhetorical approach*. PhD thesis, University of Gothenburg.

Breitholtz, E. (2014b). Reasoning with topoi - towards a rhetorical approach to non-monotonicity. In *Proceedings of the 50th anniversery convention of the AISB*, pages 190–198. AISB.

Breitholtz, E. (2015). Are widows always wicked? learning concepts through enthymematic reasoning. In *Type Theory and Lexical Semantics: ESSLLI 2015*.

Breitholtz, E. and Cooper, R. (2011). Enthymemes as rhetorical resources. In *SemDial 2011 - Proceedings of the 15th Workshop*

on the Semantics and Pragmatics of Dialogue (LosAngelogue), pages 149–157.

Breitholtz, E., Howes, C., and Cooper, R. (2017). Incrementality all the way up. In *Proceedings of the Computing Natural Language Inference Workshop*.

Casillas, M. (2014). Turn-taking. In Matthews, D., editor, *Pragmatic development in first language acquisition*, pages 53–70. John Benjamins Amsterdam, The Netherlands.

Clark, A. and Lappin, S. (2010). *Linguistic Nativism and the Poverty of the Stimulus*. John Wiley & Sons.

Clark, E. V. (2009). *First language acquisition*. Cambridge University Press.

Clark, E. V. (2015). Semantics and language acquisition. In Lappin, S. and Fox, C., editors, *The Handbook of Contemporary Semantic Theory*, pages 714 – 733. Wiley-Blackwell.

Cooper, R. (2005). Records and record types in semantic theory. *Journal of Logic and Computation*, 12:99–112.

Cooper, R. (2012). Type theory and semantics in flux. In Kempson, R., Asher, N., and Fernando, T., editors, *Handbook of the Philosophy of Science*. Elsevier BV.

Cooper, R. (in progress). *Type theory and language - From perception to linguistic communication*.

Cooper, R. and Ginzburg, J. (2015). Type theory with records for natural language semantics. *Handbook of Contemporary Semantic Theory, The*, pages 375–407.

Ducrot, O. (1988). Topoï et formes topique. *Bulletin d'études de la linguistique française*, 22:1–14.

Gelman, S. A., Croft, W., Fu, P., Clausner, T., and Gottfried, G. (1998). Why is a pomegranate an apple? the role of shape, taxonomic relatedness, and prior lexical knowledge in children's overextensions of apple and dog. *Journal of Child language*, 25(2):267–291.

Ginzburg, J. (2012). *The Interactive Stance: Meaning for Conversation*. Oxford University Press.

Ginzburg, J., Breitholtz, E., Cooper, R., Hough, J., and Tian, Y. (2015). Understanding laughter. In *Proceedings of the 20th Amsterdam Colloquium*.

Gredebäck, G., Fikke, L., and Melinder, A. (2010). The development of joint visual attention: a longitudinal study of gaze following during interactions with mothers and strangers. *Developmental science*, 13(6):839–848.

Halliday, M. A. K. (1975). Learning how to mean. In *Foundations of language development*, pages 239–265. Elsevier.

Halliday, M. A. K. (1994). The place of dialogue in children's construction of meaning. In Ruddel, R., Rapp Ruddell, M., and H., S., editors, *Theoretical models and processes of reading*. International Reading Association, Newark, DE.

Hilbrink, E. E., Gattis, M., and Levinson, S. C. (2015). Early developmental changes in the timing of turn-taking: a longitudinal study of mother–infant interaction. *Frontiers in psychology*, 6:1492.

Jackson, S. and Jacobs, S. (1980). Structure of conversational

argument: Pragmatic bases for the enthymeme. *Quarterly Journal of Speech*, 66(3):251–265.

Karttunen, L. (1974). Presupposition and linguistic context. *Theoretical linguistics*, 1(1-3):181–194.

Larsson, S. (2002). *Issue Based Dialogue Management*. PhD thesis, University of Gothenburg.

Levinson, S. C. (2006). On the human "interaction engine'. In Enfield, N. J. and C., L. S., editors, *Roots of Human Sociality: Culture, Cognition and Interaction*. The Wenner-Gren Foundation, Oxford.

Pustejovsky, J. (1998). *The Generative Lexicon*. MIT Press.

Stalnaker, R. (1974). Pragmatic presuppositions. In Munitz, M. K. and Unger, P., editors, *Semantics and Philosophy*. New York University Press.

Stephens, G. and Matthews, D. (2014). The communicative infant from 0-18 months: The social-cognitive foundations of pragmatic development. In Matthews, D., editor, *Pragmatic development in first language acquisition*, pages 13–36. John Benjamins Publishing Company.

Tomasello, M. (1992). The social bases of language acquisition. *Social development*, 1(1):67–87.