Communicable reasons: How children learn topoi through dialogue

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Abstract

Children's acquisition of language requires their learning of not just words/concepts and linguistic structure but how these interact in dialogue with knowledge about the world, our interlocutors, the shared environment and social norms. In this paper we explore how children acquire the rhetorical resources that they need in dialogue. These *topoi* are the underpinning warrants for incomplete (*enthymematic*) arguments in dialogue. We illustrate our account with examples from dialogues with children that demonstrate the topoi which they have learned – particularly in cases where these topoi are unexpected from the adult language user's perspective, and sketch a formal model using Type Theory with Records.

1 Introduction

As shown in (1), participating in any dialogic exchange requires a wealth of knowledge, not just about the linguistic items used, but about the world, our interlocutor(s), the shared environment and social norms. These factors are usually considered to be outside the remit of linguistics proper, consigned either to the pragmatics wastebasket (Bar-Hillel, 1971) or to sociolinguistics. 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, as noted by Labov (1972): "I have resisted the term sociolinguistics for many years, since it implies that there can be a successful linguistic theory or practice which is not social." (p13).

(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]

Here, in (1), it is evident to any competent language user that Lee is conveying that 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 that 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? In this paper we will explore how inference plays a role in building up the rhetorical resources required to be active participants in dialogue through interaction. We perceive the rhetorical resources available to a conversational participant as an open set of *topoi*. "Topos" is a term used by Aristotle to refer to a principle of reasoning warranting an argument in discourse.

The structure of the paper is as follows: First we will give some background to reasoning in dialogue, the role of interaction in language acquisition, and the building up of rhetorical resources. In Section 3 we will look at a number of examples from interactions between children and adults which demonstrate how children draw on and acquire rhetorical resources in interaction. In Section 4 we will suggest a way of modelling how the acquisition of rhetorical resources works and finally, in Section 5, we will discuss how the insights of this paper may be developed.

2 Background

2.1 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 in order to understand one another. 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 (2).[1] This could be underpinned by a more generally applicable topos such as the ones shown in (3) and (4).

$$(2) \quad \frac{\text{ill}(Lee)}{\text{stay\_home}(Lee)}$$

$$(3) \quad \frac{\text{ill}(x) \qquad \text{need\_rest}(x)}{\text{stay\_home}(x)}$$

$$(4) \quad \frac{\text{ill}(x) \qquad \text{contagious}(x)}{\text{stay\_home}(x)}$$

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).

2.2 Interaction in acquisition

Although traditional linguistics and much developmental psychology still assumes that there must

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[1] In this semi-formal notation, the premises are shown above the line and the conclusion below, as is standard. The wiggly line denotes a not strictly logical chain of reasoning. These are not intended to be complete formal representations, rather as a convenient and clear way of representing our intuitions about topoi and enthymemes. More complete formal representations are shown in section 4.

be an innate language learning facility due to the presumed 'poverty of the stimulus' of a child's linguistic input (Berwick et al., 2011), there is a large body of evidence that refutes this position, from both a computational (Clark and Lappin, 2010) and a more social perspective. This work (exemplified by Halliday, 1975, 1994 and Tomasello, 1992 a.o.) emphasises the nature of language as action, and makes explicit the role of interaction in language acquisition.

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').

Research on children in the early stages of verbal language acquisition also shows that children learn new words and concepts through interaction (Clark, 2015). The input from adults may be explicit or implicit. An example of explicit input would be an adult saying to a child "look at that, it's an elephant", while implicit input would be to just use the word "elephant" to refer to an object without introducing it. Brown and Hanlon (1970) show that child directed explicit disapprovals of grammar mistakes are very unusual. Rather, more recent research suggests that implicit input, such as corrective feedback, occurs more frequently and has a significant effect on language learning (Hiller and Fernández, 2016).

How children's language acquisition in interaction can be formalised has not been much explored, with one notable exception being the sketch using an information state update approach and dialogue gameboards (see section 4, below) developed in Ginzburg and Moradlou (2013). Additionally, Clark (2015) notes that a Type Theory with Records account offers a principled way to formalise how language use develops through interaction. Our formal sketch of topoi acquisition (section 4, below) using the same mechanisms fits in with such approaches.

2.3 Building rhetorical resources

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" (1).

However, topoi may also be acquired through inference. In order to abstract principles of reasoning from co-occurring situations, a child must have a notion of situation type, that is it needs to be able to make the judgement that a situation of a particular type, such as when they let go of an object, is followed by a situation of another type, namely one where the object falls to the ground. In order 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 topos of gravity generally holds and can be used to make predictions about objects in general, not just about the specific situations about e.g. "my spoon" in which they have encountered it. 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. Often the child manages to apply a topos which is acceptable in the situation, and the dialogical reasoning works seamlessly. 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. In Section 3 we will look at some examples of how children apply topoi successfully and unsuccessfully in interaction with adults.

There are also specific dialogue strategies available for acquiring new knowledge, including topoi – such as asking questions (Chouinard et al., 2007). Bova (2011); Bova and Arcidiacono (2013) show that the main functions of why-questions asked by children in the home is argumentative and explanatory. Schlöder et al. (2016) suggest an analysis where why-questions are taken to be focused on eliciting acceptable reasons. Correspondingly, in order to be functional, responses to why-questions must be warranted by an acceptable principle of reasoning. On this account, the reason why illness is an acceptable answer to Dave's question "Why?" in (1) is that there are topoi regarding illness and rest (when you are sick you should rest in order to get better, as depicted in (3)) and illness and contagion (if you are ill you should not mix with others so as to not pass on the infection
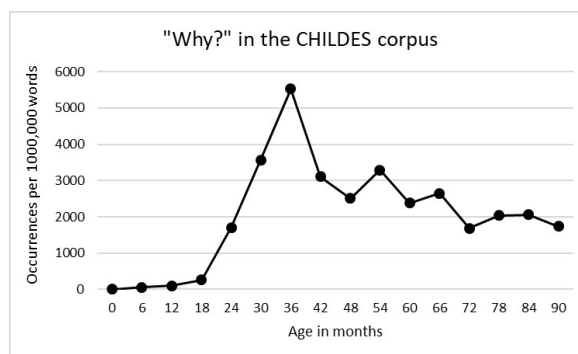

Figure 1: Frequency of 'why' in child language by age

(4)). These underpin Lee's utterance "Cos of my cough" in response to Dave's why-question regarding Dave's statement that he might not go to school tomorrow. Since why-questions specifically relate to pragmatic reasoning in dialogue, we can expect language users who are less familiar with the topoi that pertain to a given domain and are acceptable in a particular socio-cultural and situational context to ask more why-questions. A search of the CHILDES-corpus (MacWhinney, 2000) shows that children have a period around the age of 3 where the number of why-questions they ask peak (see figure 1, obtained using the ChildFreq tool Bååth 2010). This asking of why-questions is an efficient way for a child to expand their rhetorical resources through a recently acquired conversational strategy (Frazier et al., 2009).

3 Childrens' use of enthymemes

Young children are also clearly able to draw enthymematic connections in interaction, as shown in (5).

(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 Loria): I have got a cold so I can't go to school ...
Later in the same game:

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

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

In (5) Greta uses an enthymematic utterance "I have got a cold so I can't go to school" demonstrating that she has previously acquired an appropriate topos (perhaps the one shown in (3), above), which licenses the enthymeme. She also adds a new topos, depicted in (6), that has been supplied enthymematically by her mother in the form of a question early on in the dialogue and combines these two topoi in a play dialogue between the two dolls, thus demonstrating that she can apply the new topos appropriately.

(6) $$\frac{\text{snores}(x)}{\text{has\_cold}(x)}$$

New situations, such as the current coronavirus pandemic, lead to new topoi becoming available, or more specific instantiations of existing topoi. In the case of coronavirus, this offers a unique opportunity to investigate the emergence of new topoi which became part of the standard rhetorical resources of a very large number of people over a very short period of time. This is in contrast to the more usual situation where new topoi emerge in restricted domains, activities or groups.

Even for young children, this may also lead to more specification of existing topoi as shown in (7). In this example, Greta is off nursery with a very slight cough which would not normally be sufficient to stay at home (so the topos in (3) does not apply). The official advice in Sweden at the time was: "If you feel ill with symptoms including a runny or blocked nose, cough, or fever you should avoid contact with other people. This also applies if you only feel a little bit unwell. Do not go to work or to school. It is very important not to risk passing the illness to anyone else."[2]

(7) *Greta (4;3) is off nursery with a minor cold playing with a doll "Lily", March 2020*

(as Lily): There's this illness going around that's
             why we're not going to dagis (=nursery)

In this case, the enthymeme used by Greta does not make reference to either herself or Lily being even slightly ill – it is rather the presence of the illness (coronavirus) in the community at large which is responsible for their staying at home.

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[2]Source: `https://www.folkhalsomyndigheten.se/the-public-health-agency-of-sweden/communicable-disease-control/covid-19/`

3.1 Unexpected topoi

As discussed in section 2.3, cases where children acquire rhetorical resources which do not completely correspond with those of an adult are particularly illustrative of how topoi are learned. These show how children generalise from small amounts of data to reason about novel situations, as in (8).

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

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

      Child: *[med anklagande ton]*
              [with accusatory tone]

              Puttade du   henne?
              Pushed   you   her?
              'Did you push her?'

Mother commenting on twitter:

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

In (8), the three year old 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 Simba's father dies after he is pushed from a cliff edge by his brother Scar. The child here has correctly generalised the concept of death to other living things than lions, but has stored a 'death topos' with a causal relationship, namely that if someone is dead then someone related pushed them (9).

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

This topos is applied constructively by the child in the dialogue shown in (8). When she learns that her mother's grandmother is dead, she concludes that she must have been pushed and infers that it was her mother who did the pushing.

In a similar example ((10) taken from Breitholtz 2015), the child has extrapolated a topos (11) from their previous experience of the concept 'widow', which comes exclusively from fairy tales.

(10) *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!

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

To anyone familiar with the conventional meaning of the word *widow*, it seems obvious that the child has got it wrong. However, as discussed in Breitholtz (2015), this gives us an insight into how most of us usually get it right, and suggests that 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, although we believe that this is because lexical concepts can also be conceived as underpinned by topoi (and therefore use the same processes – see also Rehder 2003), there are also examples of children using unexpected topoi which cannot be reduced to a lexical concept, which also require explanation.

Figure 2, taken from a graphic explanation of coronavirus aimed at children,[3] and the statement from the BBC news website shown in 12.[4] show that 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 a generally accepted topos, that obviously did not exist in 2019.

(12) The elderly and the unwell are more likely to die, if they contract coronavirus.

(13) $$\frac{\text{has\_corona}(x) \quad \text{old}(x)}{\text{die}(x)}$$

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[3]Source: https://www.npr.org/sections/goatsandsoda/2020/02/28/809580453/just-for-kids-a-comic-exploring-the-new-coronavirus

[4]Source: https://www.bbc.com/news/health-51674743, 24th March 2020

Malaka Gharib / NPR

Figure 2: Underlying topos: Old people are more likely to get more ill with coronavirus

Although a more general version that older people (and those with underlying medical conditions) are more likely to become more ill, or die if they contract other potentially fatal infectious diseases probably did exist for most adults prior to the coronavirus, Greta has not previously encountered such a topos. Nevertheless, based on her corona-specific new topos, she is able to apply a more general (in this case incorrect) version of this topos (15).

(14) *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.

(15) $$\frac{\text{is\_poorly}(x) \quad \text{old}(x)}{\text{die}(x)}$$

4 Updating enthymematic dialogues

The dialogue in (14) is an example where a child overextends the domain for when a particular topos applies. In this section we will sketch a formal account of such overextension.

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). The basic idea of this approach is that agents involved in interaction

need to coordinate, and we use gameboards to represent how the agents keep track of where they are in the creation of particular dialogue events (e.g. a project like finding out something or a move like asking, responding etc). 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. Being able to account for separate views of the state of the dialogue plays an essential role in coordination, especially with regards to miscommunication, where there is a mismatch between the participants' dialogue gameboards.

4.1 Dialogue gameboards as types in TTR

Following Ginzburg (2012); Cooper and Ginzburg (2015); Cooper (in progress) 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 which potentially involve many ptypes and individuals, as well as other more general types, we use *record types*. A record type is a structure of pairs of labels and types, where labels may represent things like individuals, predicates and events.

$$(16) \quad \begin{bmatrix} \text{x:}Ind \\ \text{c}_{dog}\text{:dog(x)} \\ \text{c}_{run}\text{:run(x)} \end{bmatrix}$$

The object to which the label x points in (16) is of type *Ind*. There are two constraints on the type of situation – that this individual is a dog (c_{dog}:dog(x)) and that it runs (c_{run}:run(x)). In addition to record types we also want to be able to talk about situations that are witnesses of record types, actual situations that are of certain types. We represent such objects as *records*. A record is a structure where the labels are associated with *values* rather than types. In (17) we see a record representing one particular situation. This situation is of the type in (16) 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 (17) is a witness of the type of situation in (16). For an in-depth discussion and formal definitions, see Cooper (in progress).

$$(17) \quad \begin{bmatrix} \text{x} \quad \text{=fido} \\ \text{c}_{dog}\text{=}s_1 \\ \text{c}_{run}\text{=}s_2 \end{bmatrix}$$

In 18 we see an example of a (minimal) dialogue gameboard. 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.

$$(18) \quad \begin{bmatrix} \text{private:} \begin{bmatrix} \text{rhet\_resources:set(}Topos\text{)} \end{bmatrix} \\ \text{shared:} \begin{bmatrix} \text{eud:list(}Enthymeme\text{)} \end{bmatrix} \end{bmatrix}$$

4.2 Drinking seawater

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[5].

Intuitively this means that 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 (14) 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 (19).

$$(19) \quad \epsilon_1 = \lambda r: \begin{bmatrix} \text{x:}Ind \\ \text{c:person(x)} \\ \text{e:drink\_sea\_water(x)} \end{bmatrix} \cdot \\ \begin{bmatrix} \text{e:make\_poorly(}r.\text{e, }r.\text{x)} \end{bmatrix}$$

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[5]There are several reasons why we want to model enthymemes and topoi as the same kind of formal object. First, there is no principled difference between the specificity of enthymemes in general and topoi in general – what in one context is an enthymeme may in another context be a topos warranting another enthymeme. Secondly, it is problematic to model enthymemes and topoi as different kinds of formal objects parallel to types of situations as record types and situations as records. We are treating enthymemes and topoi as functions from records to record types (of type *Rec → RecType*). If we were to treat topoi as types of enthymemes we would need to introduces new types of types (subtypes of *RecType*) in order to make the distinctions we want. Alternatively, we could model an enthymeme as a function from a record to another record (of type *Rec → Rec*). This is problematic, however, since we want the enthymeme to represent a function from an actual (observed) situation to a type of situation to which there might or might not be a witness. For example, enthymemes can be used as instructions for action, that is, to create a situation of the type returned by the function by applying the enthymeme to the observed situation. In such cases there are no witness to the type returned by the function, unless the instructions are carried out.

The enthymeme conveyed by the child, on the other hand, says that if old people drink sea water, they will die, as seen in (20).

$$(20)\quad \epsilon_2 = \lambda r: \begin{bmatrix} \text{x:}\textit{Ind} \\ \text{c:person(x)} \\ c_1\text{:old(x)} \\ \text{e:drink\_sea\_water(x)} \end{bmatrix} . \\ \begin{bmatrix} \text{e:make\_die}(r.\text{e},r.\text{x}) \end{bmatrix}$$

The enthymeme produced by the child, ϵ_2, is not likely to be acceptable to most adults, and 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.

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. In this case, the child has presumably encountered much input of the kind in figure 2 and news stories like the one in (12), which convey the enthymeme in (21).

$$(21)\quad \epsilon_{input} = \lambda r: \begin{bmatrix} \text{x:}\textit{Ind} \\ \text{y:}\textit{Ind} \\ \text{z:}\textit{Type} \\ \text{c:person(x)} \\ c_1\text{:person(y)} \\ c_2\text{:young(x)} \\ c_3\text{:old(y)} \\ c_4\text{:cause\_of\_harm(z)} \\ c_5\text{:corona(z)} \\ c_4\text{:(x)} \\ \text{e:make\_poorly(z,x)} \end{bmatrix} . \\ \begin{bmatrix} \text{e:make\_die}(r.\text{z}, r.\text{y}) \end{bmatrix}$$

The mother might already have access to a topos warranting ϵ_{input}. However, it would probably be based on various sources of input and not as general as the topos adopted by the child, but rather one where the domain of the topos is delimited to situations involving infectious diseases or similar, as seen below in (22).

$$(22)\quad \tau_{adult} = \lambda r: \begin{bmatrix} \text{x:}\textit{Ind} \\ \text{y:}\textit{Ind} \\ \text{z:}\textit{Type} \\ \text{c:person(x)} \\ c_1\text{:person(y)} \\ c_2\text{:young(x)} \\ c_3\text{:old(y)} \\ c_4\text{:cause\_of\_harm(z)} \\ c_4\text{:disease(x)} \\ \text{e:make\_poorly(z,x)} \end{bmatrix} . \\ \begin{bmatrix} \text{e:make\_die}(r.\text{z}, r.\text{y}) \end{bmatrix}$$

The child, on the other hand, having overextended ϵ_{input}, has adopted a topos like τ_{child} below in 23.

$$(23)\quad \tau_{child} = \lambda r: \begin{bmatrix} \text{x:}\textit{Ind} \\ \text{y:}\textit{Ind} \\ \text{z:}\textit{Type} \\ \text{c:person(x)} \\ c_1\text{:person(y)} \\ c_2\text{:young(x)} \\ c_3\text{:old(y)} \\ c_4\text{:cause\_of\_harm(z)} \\ \text{e:make\_poorly(z,x)} \end{bmatrix} . \\ \begin{bmatrix} \text{e:make\_die}(r.\text{z}, r.\text{y}) \end{bmatrix}$$

τ_{child} says that 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 conveyed in (20).

So, how are these topoi integrated into our rhetorical 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. However, in order to account for the adoption of generalised versions of enthymemes – which is a highly efficient strategy for building up rhetorical resources, although it sometimes leads to overextension – we must adjust the update rule to allow for accommodation of more general versions of encountered enthymemes.

$$f\_accommodate\_topos =$$

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

$$\lambda e: \neg \begin{bmatrix} \text{t:}\textit{Topos} \\ c_1\text{:in}(r.\text{private.rhet\_resources}(t)) \\ c_2\text{:spec}(t, \text{fst}(r.\text{shared.eud})) \end{bmatrix} \cdot$$

$$\begin{bmatrix} \text{private:} \begin{bmatrix} \text{rhet\_resources=[fst.}(r.\text{shared.eud})]\text{:set}(\textit{Topos}) \end{bmatrix} \end{bmatrix}$$

Figure 3: $f\_accommodate\_topos$

The update rule in Figure 3 says that if there is an enthymeme on the an agent's dialogue gameboard, for example ϵ_{input}, and it is not the case that there is a 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. By an enthymeme being a specification of a topos (or another enthymeme) we mean that if there is an enthymeme $\epsilon = \lambda r : T_1 \cdot T_2(r)$, and a topos $\tau = \lambda r : T_3 \cdot T_4(r)$, ϵ is a specification of τ iff $T_1 \sqsubseteq T_3$ and $\epsilon(r) \sqsubseteq$ of $\tau(r)$ for any r. So, this update rule would account for an agent encountering ϵ_{input} and simply adding that to their resources. However, the process leading to overextension of topoi cannot be accounted for through this update rule. Instead, we need an alternative rule like $f\_accommodate\_topos'$ in Figure 4, which is like $f\_accommodate\_topos$, except that the result of applying it is that the agent adopts a topos which is a *generalisation* of the enthymeme currently under discussion rather than the version conveyed in the actual discourse.

5 Conclusions and future work

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. We have provided a formal sketch for how this process operates, but of course at this stage it is just that – a sketch – and 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.

We believe that our approach – providing a formal analysis of a limited number of genuine examples is complementary to rigorous empirical analysis (experimental and corpus studies) and that 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. This is particularly apparent in a situation like the current coronavirus pandemic, in which new topoi have quickly become shared across populations, and are now taken largely for granted.

One question that arises is how to delimit the adopting of topoi which are generalisations of encountered enthymemes. For example, it seems quite acceptable that someone who has no previous experience of cats on encountering a particular purring cat construes a topos saying that cats purr. However, it is not obvious that we would like a theory that allows 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.

On our view it is clear that the use of topoi is not, like much else in language, all-or-nothing, but must be couched probabilistically. This is true for both when a particular topoi is applied or accommodated in a dialogue, and for the content of the topoi themselves (as in (12), (13) where the conclusion should not be that old people will definitely die if they contract coronavirus, just that they are more likely to than younger people). Interestingly, our examples suggest that young children may not extract such nuanced information – though whether they are able to do so is of course an empirical question. Thus, one of our current research goals is to introduce a probabilistic component into our model, for example extend the probabilistic account of TTR (Cooper et al., 2015) to topoi.

As a basis for this, we would need considerably more data than what we have presented in this paper. However, quantitative corpus studies of enthymemes and topoi are problematic since they are not easy to find automatically, and manual searches that would produce enough data for quantitative studies are not feasible. One option that might be worth pursuing in this context is enthymeme mining (Razuvayevskaya and Teufel, 2017; Maraev et al., 2020).

6 The last word

(24) Greta: Coronavirus I want you to go away soon. I'm bored of it. Are you, too?

$$f\_accommodate\_topos' =$$

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

$$\lambda e: \neg \begin{bmatrix} \text{t:}\textit{Topos} \\ c_1:\text{in}(r.\text{private.rhet\_resources(t))} \\ c_2:\text{spec(t, fst}(r.\text{shared.eud)}) \end{bmatrix} .$$

$$\begin{bmatrix} \text{private:} \begin{bmatrix} \text{rhet\_resources=[gen(fst.}(r.\text{shared.eud))]:set}(\textit{Topos}) \end{bmatrix} \end{bmatrix}$$

Figure 4: $f\_accommodate\_topos'$

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References

George A. Kennedy Aristotle. 2007. *On Rhetoric, a theory of civic discourse*. Oxford University Press.

Rasmus Bååth. 2010. Childfreq: An online tool to explore word frequencies in child language. *Lucs Minor*, 16:1–6.

Yehoshua Bar-Hillel. 1971. Out of the pragmatic wastebasket. *Linguistic inquiry*, 2(3):401–407.

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

Robert C. Berwick, Paul Pietroski, Beracah Yankama, and Noam Chomsky. 2011. Poverty of the stimulus revisited. *Cognitive Science*, 35(7):1207–1242.

Antonio Bova. 2011. Functions of "why" questions asked by children in family conversations. *Procedia – Social and Behavioral Sciences*, 30:776–782.

Antonio Bova and Francesco Arcidiacono. 2013. Investigating children's why-questions: A study comparing argumentative and explanatory function. *Discourse Studies*, 15(6):713–734.

Ellen Breitholtz. 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*.

Ellen Breitholtz. 2014a. *Enthymemes in Dialogue: A micro-rhetorical approach*. Ph.D. thesis, University of Gothenburg.

Ellen Breitholtz. 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.

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

Ellen Breitholtz and Robin Cooper. 2011. Enthymemes as rhetorical resources. In *SemDial 2011 - Proceedings of the 15th Workshop on the Semantics and Pragmatics of Dialogue (LosAngelogue)*, pages 149–157.

Ellen Breitholtz, Christine Howes, and Robin Cooper. 2017. Incrementality all the way up. In *Proceedings of the Computing Natural Language Inference Workshop*.

Roger Brown and C. Hanlon. 1970. Derivational complexity and order of acquisition in child speech. In J.R. Hayes, editor, *Cognition and the development of language*. Wiley, New York.

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

Michelle M. Chouinard, Paul L. Harris, and Michael P. Maratsos. 2007. Children's questions: A mechanism for cognitive development. *Monographs of the Society for Research in Child Development*, pages i–129.

Alexander Clark and Shalom Lappin. 2010. *Linguistic Nativism and the Poverty of the Stimulus*. John Wiley & Sons.

Eve V. Clark. 2009. *First language acquisition*. Cambridge University Press.

Eve V. Clark. 2015. Semantics and language acquisition. In Shalom Lappin and Chris Fox, editors, *The Handbook of Contemporary Semantic Theory*, pages 714 – 733. Wiley-Blackwell.

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

Robin Cooper. 2012. Type theory and semantics in flux. In Ruth Kempson, Nicholas Asher, and Tim Fernando, editors, *Handbook of the Philosophy of Science*. Elsevier BV.

Robin Cooper. in progress. *Type theory and language - From perception to linguistic communication.*

Robin Cooper, Simon Dobnik, Staffan Larsson, and Shalom Lappin. 2015. Probabilistic type theory and natural language semantics. *Linguistic issues in language technology*, 10(4):1–45.

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

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

Brandy N. Frazier, Susan A. Gelman, and Henry M. Wellman. 2009. Preschoolers' search for explanatory information within adult–child conversation. *Child development*, 80(6):1592–1611.

Susan A. Gelman, William Croft, Panfang Fu, Timothy Clausner, and Gail Gottfried. 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.

Jonathan Ginzburg. 2012. *The Interactive Stance: Meaning for Conversation.* Oxford University Press.

Jonathan Ginzburg, Ellen Breitholtz, Robin Cooper, Julian Hough, and Ye Tian. 2015. Understanding laughter. In *Proceedings of the 20th Amsterdam Colloquium.*

Jonathan Ginzburg and Sara Moradlou. 2013. The earliest utterances in dialogue: towards a formal theory of parent/child talk in interaction. In *Proceedings of the 17th Workshop on the Semantics and Pragmatics of Dialogue - Full Papers*, Amsterdam, The Netherlands. SEMDIAL.

Gustaf Gredebäck, Linn Fikke, and Annika Melinder. 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.

Michael Alexander Kirkwood Halliday. 1975. Learning how to mean. In *Foundations of language development*, pages 239–265. Elsevier.

Michael Alexander Kirkwood Halliday. 1994. The place of dialogue in children's construction of meaning. In R.B. Ruddel, M. Rapp Ruddell, and Singer H., editors, *Theoretical models and processes of reading*. International Reading Association, Newark, DE.

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

Sarah Hiller and Raquel Fernández. 2016. A data-driven investigation of corrective feedback on subject omission errors in first language acquisition. In *Proceedings of The 20th SIGNLL Conference on Computational Natural Language Learning*, pages 105–114.

Sally Jackson and Scott Jacobs. 1980. Structure of conversational argument: Pragmatic bases for the enthymeme. *Quarterly Journal of Speech*, 66(3):251–265.

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

William Labov. 1972. *Sociolinguistic patterns*. 4. University of Pennsylvania Press.

Staffan Larsson. 2002. *Issue Based Dialogue Management*. Ph.D. thesis, University of Gothenburg.

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

Brian MacWhinney. 2000. The childes project: Tools for analyzing talk: Volume i: Transcription format and programs, volume ii: The database.

Vladislav Maraev, Ellen Breitholtz, and Christine Howes. 2020. How do you make an AI get the joke? Here's what I found on the web. In *First AISB Symposium on Conversational AI (SoCAI).*

James Pustejovsky. 1998. *The Generative Lexicon*. MIT Press.

Olesya Razuvayevskaya and Simone Teufel. 2017. Finding enthymemes in real-world texts: A feasibility study. *Argument & Computation*, 8(2):113–129.

Bob Rehder. 2003. Categorization as causal reasoning. *Cognitive Science*, 27(5):709–748.

Julian Schlöder, Ellen Breitholtz, and Raquel Fernández. 2016. Why? In *Proceedings of JerSem*, pages 5–14.

Robert Stalnaker. 1974. Pragmatic presuppositions. In Milton K. Munitz and Peter Unger, editors, *Semantics and Philosophy*. New York University Press.

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

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