Communicative acts in parent—child conversations

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Abstract

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From their first utterances, children are not just producing language but *using* it to communicate. A child who can produce only one-word utterances can nonetheless convey several communicative intentions: using variations in pitch, she can use the word *mama* to identify a person, question possession of an object, or to call for someone's presence (Dore, 1975). From 14 to 30 months of age, children quickly branch out from communicative acts like *requesting*, *protesting*, and *marking an event* to *agreeing to an action*, *stating intent*, and asking and answering a variety of questions (Snow, Pan, Imbens-Bailey, & Herman, 1996). These close studies of children's conversations, using rich observations to infer their likely intended meaning in context, show that much of the action of language acquisition happens at the level of what children *mean* to say. [. . .]

Describing children's communicative acts at a larger scale, however, is a challenging task. Without nuanced, context-sensitive human coding, communicative acts can be hard to identify. Words are amenable to identification, storage, and tabulation using common computational tools; perhaps due to their ease of use, models of language development have often approached language development at the level of words (i.e., vocabulary learning). The goals and intentions underlying those words are less amenable to such manipulation. In this paper, we put forth one approach to modeling the children's communicative acts, working backwards from the words they produce: we model communicative acts as the latent sources from which words emerge, and characterize children's engagement in these acts across development.

[. . .]

Studying children's communicative acts using a computational model also allows us to extract communicative patterns across many children with less a priori specification of what those patterns are. Traditionally, studies of communicative acts among children have brought frameworks from adult communication, such as Speech Act theory (Austin, 1962; Searle & Searle, 1969) and Conversation Analysis (Sacks, Schegloff, & Jefferson, 1974), to bear on children's conversations. While concepts like 'directive', 'expressive', 'accusation' and 'justification' can be useful to characterize children's conversations, young children may not have the same communicative needs as adults—these may not be relevant distinctions in children's communication. An advantage of characterizing patterns of language use over large swaths of data is that we do not need to specify the types of communicative acts a priori. [. . .]

Here, we characterize children's growing repertoire of communicative acts using a Hidden Topic Markov Model. This model observes utterances produced by parents and children and attempts to infer common underlying processes—topics—that produced them. [. . .]

We first show that without top-down specification, this model extracts several communicative acts analogous to those observed in close case studies of children's communication. We then show that use of these acts has a developmental trajectory in line with findings from close studies of children's communication. [. . .]

Corpus

We use transcripts of conversations from the Child Language Data Exchange System (CHILDES), a database of child conversation corpora (MacWhinney, 2000). These corpora predominantly record spontaneous conversations between children and their family members, often in the home. We used transcripts from the North American English collection of CHILDES among children 6 months to 60 months old, and filtered these transcripts to include only utterances spoken by the target child or their parents. Overall, our training data included 4,043 transcripts from 411 children.

Model

We use a Hidden Topic Markov Model (Gruber, Weiss, & Rosen-Zvi, 2007) to extract communicative modes from parent—child conversations. Topic models represent documents as mixtures of topics, and topics as mixtures of words. For instance, a simple topic model trained on news articles may extract a topic whose distinctive words are "fire", "flood", and "aid" and another whose distinctive words are "speech", "legislation", and "administration". Based on its distribution of words, an article about politicians' provision of disaster relief may be correctly inferred to feature these two topics, among others. Intuitively, the goal of a topic model is to recover the underlying sources—topics—from which the words in a document spring.

mental states	labeling	counting	evaluation	proposed actions	non-present events	??	requests	knowledge questions	lo
i	a	two	not	you	to	of	some	you	th
you	that	one	it's	it	we	they	you	what	in
what	what's	dis	good	me	go	we	want	are	th
know	is	three	i'm	to	and	have	i	do	pu
don't	this	four	you're	can	you	like	more	look	he
it	that's	de	a	want	going	the	have	see	it
do	what	dat	that's	okay	did	i	eat	with	go
that	the	five	very	i	when	and	milk	at	on
did	look	duh	be	up	at	them	juice	play	ri
think	who's	six	he	get	school	are	your	those	th

Table 1: The most distinctive words in each topic. Distinctiveness is measured by the difference between a word's likelihood in the given topic and its average likelihood across all topics.

The Hidden Topic Markov Model (HTMM) differs from a simple topic model in that it takes into account the sequential utterance structure of a document, not just its static distribution of words. The HTMM assumes that words within an utterance are of the same topic, and that sequential utterances may be more likely to be of the same topic. It represents topic transitions between utterances in a coarse-grained way: either switch or stay. Gruber et al. (2007) develop this model and use it to segment machine learning conference papers, showing that the model can distinguish instances of the word "support" in mathematical contexts (describing support vectors) from those in the context of acknowledgements.

We trained the HTMM on all the utterances in our corpus. Some markers for unintelligible or non-word speech were removed; when this resulted in empty utterances, a 'non-word utterance' token was included to preserve the temporal structure of the dialogue. Typically, function words are removed from corpora before training topic models to aid detection of thematic content. Here, we aim to classify communicative modes underlying utterances rather than thematic topics. We expect function words to be diagnostic of these modes, so include them in our training data.

Topic models require pre-specification of the number of topics. To determine the right number of topics, we trained the model several times with different numbers of topics—5 to 30 topics, in intervals of 5—with Dirichlet parameters of $alpha = 1/k$, where k is the number of topics, and $beta = 0.01$. Each model produces a sequence of the most likely topic assigned to each utterance. Our selection metric was the proportion of other-topic transitions in this sequence: since we aim to characterize the temporal structure of topic transitions, we want to choose a model that has lots of transitions between topics rather than long stretches of utterances all assigned to the same topic. However, increasing the number of topics will almost necessarily increase the number of other-topic transitions, and may make the results harder to interpret as topics proliferate; therefore, we must balance the proportion of other-topic transitions against number of topics. Plotting the proportion of other-topic transitions across number of topics, we judged 15 topics as an inflection point after which increasing the number of topics had diminishing effect on other-topic transitions, and therefore chose the 15-topic model.

After training, the model produces a set of topics with associated probability distributions over words. One can conceive of these topics as bags of words, in which some words will be highly likely to be produced and others will be unlikely to be produced. We extract the most distinctive words from each topic by taking the difference between the likelihood of each word in a given topic and its average likelihood across all topics (Table 1). Using this probability distribution of words within topics, the model also produces a probability distribution over topics for each utterance in the corpus. Note that this assignment of topic probabilities happens at the utterance level, but temporal structure between utterances is not taken into account. Since we aim to characterize communicative acts and not thematic content or conversational topics, the label 'topic' for these types can be misleading; from here on, we will refer to these types as communicative acts rather than topics.

In the first part of this paper, we will show that the model captures some aspects of communicative acts and explore the static distribution of these utterance types. In the second part, we will examine trajectories of topic use across development among parents and children. In the third part, we will examine the temporal dynamics of topic use within discourse.

Topics and their static structure

The most distinctive words of each communicative act in the model, as measured by difference between a word's probability within a type of act and its average probability across all act types, are shown in Table 1. Based on these most distinctive words and looking at utterances in each act type, we labeled each act type to make findings easier to convey. Keep in mind, however, that these act type assignments are probabilistic, and that the labels of these kinds are subjective; these types are not ironclad. The communicative act types are as follows: mental states and testimony, labeling and directing attention, counting, evaluations and praise, proposed actions, non-present events, explanations ??, requests and provision, knowledge questions, location, social routines, backchannels

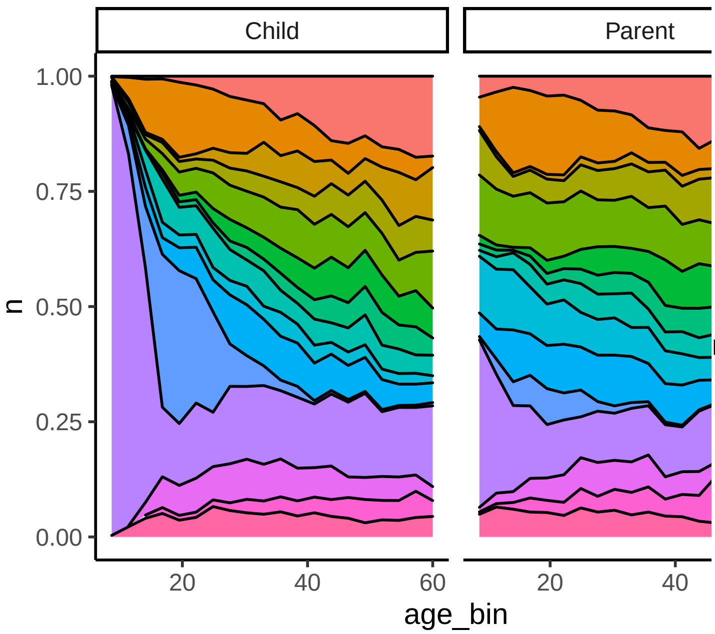

Figure 1: Plot showing the distribution of topics produced by children and parents across development.

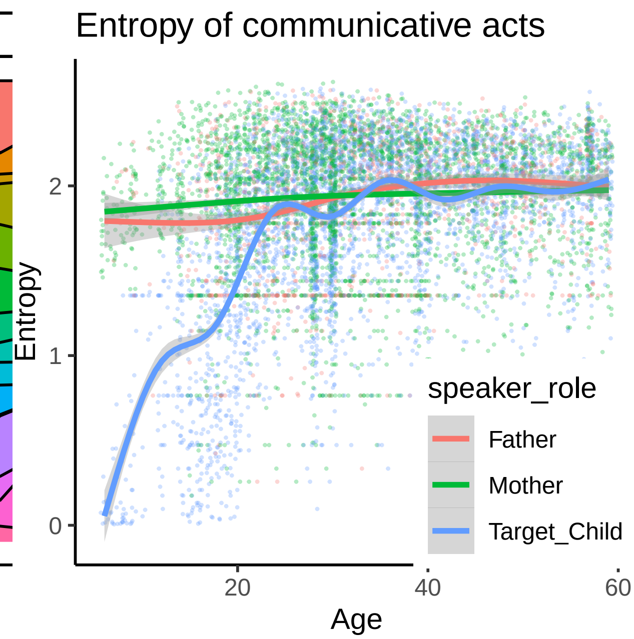

Figure 2: Entropy of topics produced by children, mothers and fathers over development.

and interjections, description, storytelling, and body routines.

One way to characterize the diversity of communicative acts a person engages in is to measure the entropy of their communicative acts. Overall, parents' communicative acts have higher entropy than children's. Children's communicative act entropy increases drastically over development between 6 and around 24 months, and remains relatively stable across the rest of our age range, as shown in 2. Our communicative acts are therefore capturing some capacity that becomes more adult-like across development. [more description / perhaps some stats] [this paragraph could be moved to part 2.]

Beyond becoming more complex across development, the ability to engage in a variety of communicative acts might reasonably be expected to correlate with other measures of language ability. Indeed, Snow et al. (1996) find that the number of speech act types children use correlates highly with the number of word types they use, but does not consistently correlate with mean length of utterance (MLU). We replicate these findings here: children's number of communicative act types produced correlate with their word types produced (*stats*) and does not consistently correlate with MLU (*stats*).

Use of communicative acts over development

Children's use of communicative acts changes drastically as they grow. Early on, children's utterances are predominantly backchannels, interjections, and affirmations or negations (e.g., "yeah", "no", "uh huh"). By around 20 months of age, social routines such as greetings and naming family members (e.g., "hi", "bye", "mommy") displace backchannels to become a substantial part of children's repertoire. Around the same age, an increasing proportion of children's utterances direct attention to or label things in the environment (e.g., "what's that?", "there's a. . . "). Parents also frequently use these labeling utterances when their children are around 15-30 months old; after around 30 months, these utterance diminish in both parent and child speech.

From 6 to 60 months, both parents and children consistently increase the proportion of their statements about mental states and testimony (e.g., "know", "think", "said"). This is consistent with prior work showing an increase in mental state talk over the 3- to 5-year-old age range, correlated with theory of mind task performance [insert cite Hughes & Dunn, 1998; de Villiers 2000]. It may also reflect growing mastery of the complex syntax required to produce embedded constructions about mental states (e.g., "She thinks it will rain.")

Notably, children at the lowest end of our age range start with at least some representation of several communicative act types, and expand on their repertoire rapidly. They also reach adult-like levels of diversity in communicative act production quickly, by around 36 months—long before they reach comparably adult-like levels of vocabulary production [add entropy of acts vs vocab plot?].

Parents' and children's communicative usage patterns echo one another somewhat [. . .] [Potential alignment at young ages etc . . .]

act_type	gloss_23	speaker_23	gloss_39	speaker_39	gloss_53
5	put back	Target_Child	i'm going to turn off the tape recorder	Father	hey can i take this to
12	oh thank_you	Father	no no	Target_Child	yeah
4	that is so nice	Father	why not	Father	that's neat
5	thank_you for putting that back	Father	cause turn it on so i could reach	Target_Child	daddy you could ope

Table 2: Four examples of the same communicative act sequence (5, 12, 4, 5) in conversations from different children at different ages. Though they involve different topical content, they follow a similar communicative pattern: a suggestion or request regarding action and location; an affirmative or negative response; an evaluative statement or question; and another suggestion regarding action and location.

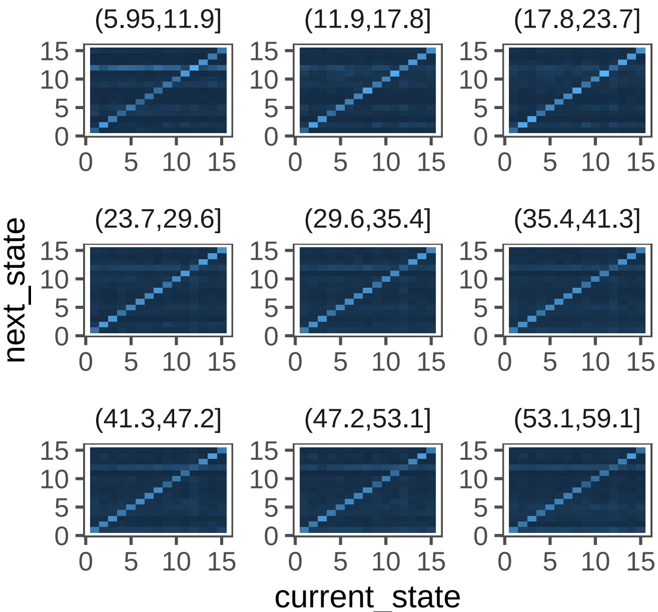

Figure 3: Heatmaps showing transition probabilities between communicative acts, by child age range.

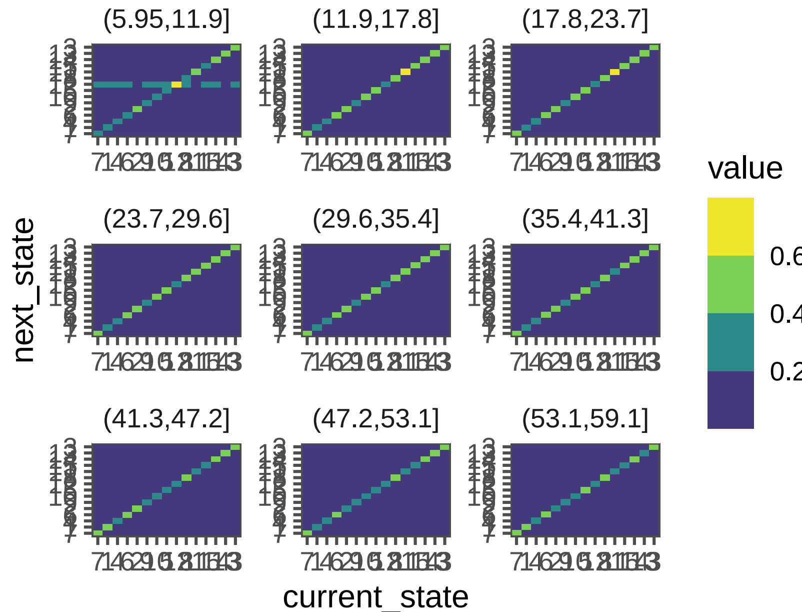

Figure 4: Heatmaps showing transition probabilities between communicative acts, by child age range.

Part 3: Dynamics of communicative acts in conversation

Discussion

In this paper, we present one approach to characterizing children's communicative acts on a large scale. In doing so, we gain the ability to examine the communication of more children in more contexts and across a wider age range than afforded by hand coding, and are able to examine patterns of usage that only become clear across such a wide range of data. We also lose nuance in the conversational context and nonverbal aspects of communication. Children can achieve communicative goals even before they can use language to do so: they can use gestures and vocalizations both to request a desired object and to call a person's attention to something in the environment (Bates, Camaioni, & Volterra, 1975). Pointing alone can serve multiple functions, such as making action requests, informing, or asking for information [cite Liszkowski papers and Kovács papers]. Studies of children's one-word utterances demonstrate that they can use the same word to fulfill multiple communicative goals (Dore, 1975), which are lumped together in our approach.

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