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18-month-olds Understand the Links Between Declaratives and Assertions, and Interrogatives and Questions

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1 Introduction

While speech act theorists have proposed a taxonomy containing many different kinds of speech acts (Austin, 1962; Searle, 1969), there are three speech acts that are crosslinguistically privileged in that all languages have a dedicated clause type that maps canonically to each of them (Sadock & Zwicky, 1985; König & Siemund, 2007):

(1) *Declarative clauses map canonically to assertions*
Zebra works at the school.

(2) *Interrogative clauses map canonically to questions*
Does Zebra work at the school?

(3) *Imperative clauses map canonically to requests*
Put Zebra in the school!

Children face several challenges in acquiring the mappings in (1)-(3). First, children cannot be born knowing the mappings between *particular* forms of clauses and their functions because the formal means of marking each clause type differ from language to language. For example, English forms polar questions like in (2) or the final line of (4) by subject-auxiliary inversion. In Mandarin, polar questions are formed by adding a particle *ma* to a sentence that is otherwise string identical to the corresponding declarative.

(4) Ellen zai jia ma? *Mandarin*
Ellen at home Q_{polar}
Is Ellen home?

Given that there is no crosslinguistically universal form for e.g. polar interrogatives, such forms cannot be known innately.

A second issue is that the canonical links in (1)-(3) do not always hold. For

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example, interrogatives can be used to make requests, as in (5), and declaratives can be used to ask questions, as in (6).

(5) *Interrogatives can map to requests*
Can you put Zebra in the school?

(6) *Declaratives can map to questions*
Zebra works at the school?

So in addition to learning the canonical mappings in (1)-(3), children must acquire noncanonical mappings, and are sure to encounter both in the input.

How do children figure out the (violable) mappings between speech acts and the particular language-specific forms of clauses in their language? In order to address this question, we first need to know *when* they acquire them, and as a result, how much of their grammatical, pragmatic, and social understanding is already in place during acquisition. For instance, while questions are canonically used to seek information, parents can't expect pre-linguistic children to give informative answers. So if children are acquiring the mappings before they can reliably answer questions, then many questions in the input are likely to be noninformation seeking, and therefore noncanonical, which may in turn affect hypothesizing about how they learn the mapping. To take another example, if children are acquiring the mapping before they have acquired wh-syntax, then this may affect proposals for how they handle wh-interrogatives in the input.

Thus, in this paper, we report results from a novel experiment that begins to address the *when* question. In section 2, we discuss relevant prior work, which leads us to identify 12 to 18 months as the likely age of acquisition. We report our study in section 3, and discuss some consequences and future work in section 4.

2 Prior studies

Pre-linguistic communicative abilities emerge throughout the first year of life. By 4 to 6 months old, infants selectively follow gazes if an attempt has been made to communicate with them via e.g. eye-contact, infant-directed greeting, or contingent responsivity (Gredebäck et al., 2008; Senju & Csibra, 2008). By around 12 months, infants use pointing to share information with adults (Liszkowski et al., 2007), and to extract information from them (Begus & Southgate, 2012; Kovács et al., 2014). Moreover, infants are able to track the knowledge and intentions of others from an early age (Woodward, 1998; Onishi & Baillargeon, 2005; Kovács et al., 2014; Martin et al., 2012). This may enable them to draw inferences about the purpose behind utterances, namely their speech act force. For example, by as early as 6 months, infants expect speech, but not coughing, to communicate information (Vouloumanos et al., 2012, 2014). In sum, this work suggests that the communicative abilities needed to acquire distinctions between speech acts and map them to clause types emerge in the first year of life.

Turning now to the formal side, infants distinguish declaratives from interrogatives by 12 months old, though these studies do not investigate what meanings they associate with these clauses (Geffen & Mintz, 2015, 2017; Frota et al., 2014; Soderstrom et al., 2011). By 18 to 20 months old, infants have an adult-like syntactic representation of wh-interrogatives (Gagliardi et al., 2016; Perkins, 2019). By age 2, children anticipate a change of speaker more after interrogatives than declaratives, while children between age 1 and 2 are marginally above chance (Casillas & Frank, 2017). However, as Casillas & Frank note, this doesn't mean that interrogatives are understood as questions. Children could have a superficial probabilistic association between interrogative form and change of speaker.

In sum, these prior results lead us to suspect that children may acquire the links between clause types and speech acts in the second year of life, likely between 12- and 18-months-old. Thus our study will target 18 months of age, with the plan to study younger children in the future.

3 Experiment

We developed a novel preferential looking study. The idea is to depict a context in which there are two characters, such that one character has some crucial information, while the other character lacks that information. At test, the characters have a conversation, but the visual scene does not reveal which character is speaking which sentences. We assume that people look at speakers more than addressees during speech (this assumption is supported by the results of Casillas & Frank 2017). So if participants understand the links between clause types and speech acts as well as the context, we predict they will look more at the informed character when hearing a declarative clause because assertions convey information, and more at the uninformed character when hearing an interrogative clause because questions ask for information.

3.1 Design and methods

Infants watch a video of two puppets. One puppet is behind a window (*window-puppet*) while the other is free to move about (*free-puppet*; see Figure 1). There are three phases: training, pre-test and test. During training, cookies are periodically delivered into a box in between the puppets via a mechanical arm. Free-puppet collects and eats the cookie, and both puppets celebrate by bouncing around and saying "Yay!" in unison. Sometimes the arm appears but does not leave the cookie. In this case, the puppets hang their heads and utter a disappointed sigh. This establishes that they are happy when the cookie is delivered, sad when it is not, that the two puppets have different voices (one male, one female, counterbalanced), though not which is which, and that only one puppet is able to get the cookie. The training phase shows four iterations of the mechanical arm's cookie delivery, and three iterations of non-delivery in pseudo-random order.

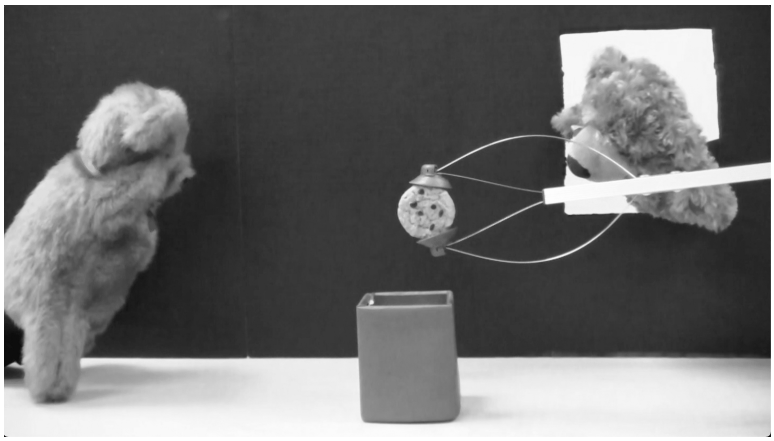

Figure 1: Grayscale still taken from video stimuli.

At pre-test, a phone rings and one of the puppets exits the scene before the cookie is delivered. The remaining puppet clearly witnesses the delivery. The first puppet only returns after the delivery arm has exited. This establishes an epistemic asymmetry between the puppets, making it appropriate for the puppet who witnessed the delivery to assert something about it, and for the puppet who answered the phone to ask a question about the delivery.

When the phone answering puppet returns, the test phase begins: The puppets face each other, and start gently and slightly moving up and down, simultaneously but not in unison. During this slight movement, participants either hear a series of declaratives ("There's a cookie in the box. There's a cookie. There is.") or a series of interrogatives ("Is there a cookie in the box? Is there a cookie? Is there?"). After the first series, a second series of utterances of the other clause type is heard. The puppets do not have moveable mouths, so there is no way to know who is speaking based on the visual scene. Free-puppet then collects and eats the cookie, and both celebrate. The whole video takes three minutes.

The independent variable is which clause type appears in the first series of utterances (interrogative vs. declarative). This manipulation is run between subjects. We counterbalance which puppet disappears from view at pre-test (window-puppet vs. free-puppet). The dependent variable is looking time: participants' gazes are coded frame by frame during the series of utterances. Gaze is coded for looks to each puppet, to the cookie box, and off screen. Before training, there is a brief calibration, in which participants see three spinning pinwheels on the screen, one at a time, in the same position on the screen as the two puppets and the cookie box. This helps the coder identify, for each participant, what it looks like when they look at one of the coding targets. The purpose of having three utterances of the same clause type in a row (e.g. three declaratives in a row) is to provide more

Table 1: Descriptions and durations of phases of a trial

Trial Phase	Description	Time
Training	4 trials: Cookie is delivered; free-puppet collects and eats cookie; puppets say "Yay!" 3 trials: Cookie is not delivered; puppets sigh	160s
Pre-test	Phone rings; one puppet exits; the remaining puppet witnesses cookie delivery; missing puppet returns	15s
Test	Puppets face each other, start moving up and down	1s
	First speaker utters 3 sentences	5s
	Second speaker utters 3 sentences	5s
Post-test	Free-puppet collects and eats the cookie; puppets say "Yay!"	20s

time for participants to comprehend what is happening and find the speaker, as well as to increase the number of codeable frames.

3.2 Predictions

The only way to know who is speaking at test is to combine information from the context with knowledge of the links between the forms and functions of the clauses uttered. If a participant understands that interrogatives are canonically used to ask questions, then upon hearing "Is there a cookie in the box?", such a participant should expect the puppet who did not witness the delivery to be the speaker. If a participant understands that declaratives are canonically used to assert, then upon hearing a declarative like "There's a cookie in the box," such a participant should expect the puppet who did witness the delivery to be the speaker. Finally, given the assumption that people look more at speakers during speech, we predict participants who have acquired the canonical links between clause types and speech acts, and who understand the context, to look more at the uninformed puppet during interrogatives, and look more at the informed puppet during declaratives.

Beyond these predictions, we have two other expectations: First, we expect participants to be looking at the uninformed puppet at the beginning of coding, regardless of condition. That is because the uninformed puppet has just returned from being off screen, and so will attract participants' attention. Thus, in the interrogative condition, participants' gazes should stay on the uninformed puppet, while in the declarative condition, the gaze should switch to the informed puppet. Second, given the result in Casillas & Frank 2017 that children saccade away from speakers just before or after the ends of their utterances, we expect some saccading

at the end of each of the three sentences in the series.

3.3 Participants

So far, we have collected data from 27 eighteen-month-olds (17;14 to 19;21, mean=18;16; target n=48). Three more were excluded, one due to being distracted during pre-test, the other two due to the video recording quality being too poor to code. 15 of the 27 participants are in the interrogative condition, 12 in the declarative condition. Participants are recorded via Zoom.

3.4 Results

Figure 2 displays the timecourse of looks by condition for the first series of three utterances. The x axis is time (milleseconds), and there are 25 frames per second. The y axis is mean looks to the uninformed puppet in each frame from the start of test (mean = # of participants looking at the uninformed puppet at that frame divided by the # of participants looking at either puppet at that frame; looks at the cookie box or off screen were excluded). The vertical dotted lines indicate the onset of each of the first speaker's three utterances. Coding begins two seconds before the onset of the first utterance, just as the uninformed puppet is returning to the screen.

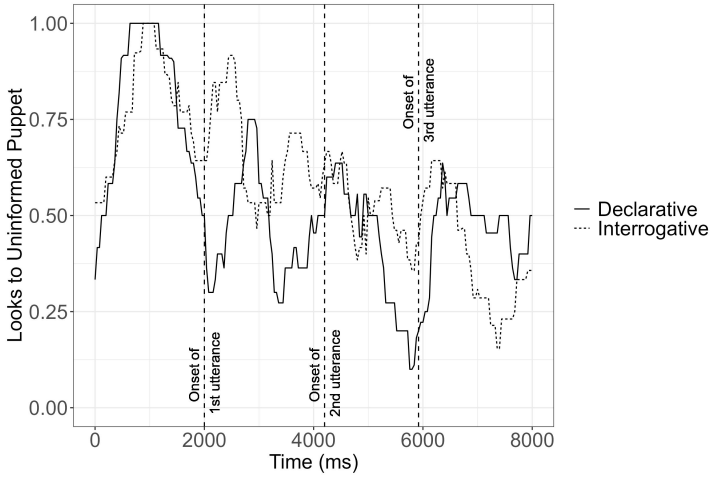

Figure 2: Timecourse of looks to the uninformed puppet by condition.

Visual inspection shows that participants in both conditions started out looking more at the uninformed puppet, as expected. Then, looking behavior diverges at the onset of the first utterance as expected: Participants in the interrogative condition are more likely to focus their gaze on the uninformed puppet, while

participants in the declarative condition are more likely to shift their gaze away from the uninformed puppet and toward the informed puppet. Moreover, there is some saccading over the course of the first utterance.

The results become less clear in the second and third utterance windows. If participants accurately understand the context, as is suggested by looking behavior during the first utterance, then it's possible that they find the second and third utterances, which repeat the message of the first, odd, and that they instead expect the puppets to resolve the situation as they have before, with free-puppet collecting the cookie. If this is correct, it may be that the repetitions are unnecessary, and that the first utterance is a large enough window in which to observe an effect after all.

Figure 3 zooms in on the first utterance, displaying the looking behavior by condition as bar plots collapsed across all of the frames between the onset of the first utterance and the onset of the second utterance.

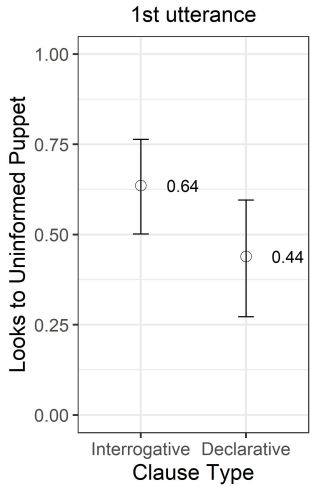

Figure 3: Mean looks to the uninformed puppet by condition during the first utterance with 95% confidence intervals.

A two sample t-test on the two means in Figure 3 reveals that the difference between the two groups is not quite significant ($t = 1.9$, $p = .075$). A complete evaluation of the difference between the groups awaits completion of the sample (21 more participants).

Finally, Figure 4 displays the timecourse of looks to the cookie box (looks to cookie box divided by looks to cookie box plus looks to either puppet) by condition.

The main thing to note here is that box looks increase during the second utterance in both conditions. Perhaps this is because once the first utterance is com-

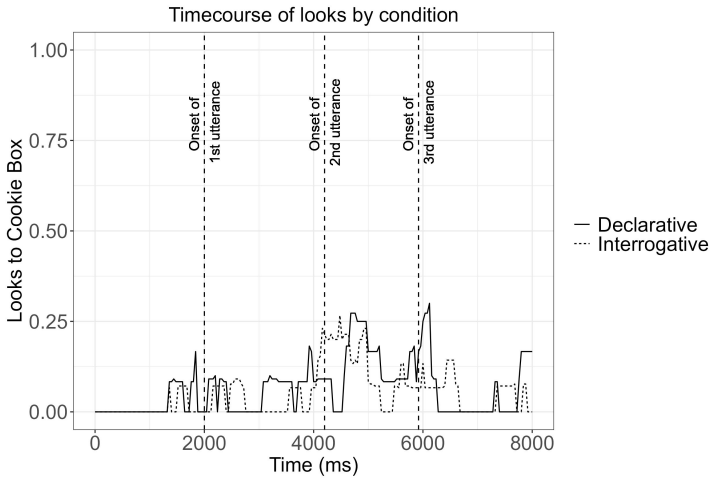

Figure 4: Timecourse of looks to the cookie box by condition.

pleted, participants expect the puppet to get the cookie, or they want to affirm the question/confirm the assertion.

4 Concluding discussion

The results of this experiment so far suggest that 18-month-olds look more at the uninformed puppet during interrogatives than declaratives. If this result is borne out, we think a crucial step in the explanation of the result is that 18-month-olds have acquired the canonical links between interrogatives and questions, and declaratives and assertions. Then, if participants understand the context, they should expect the informed puppet to assert and the uninformed puppet to ask. Thus, assuming people look more at speakers during speech, when a participant hears a declarative, they should look more at the informed puppet, and when a participant hears an interrogative, they should look more at the uninformed puppet, as observed in the results.

In future work, we plan to run several follow-up studies. First, we plan to collect data from 12-month-old participants, as a means to establish a lower bound on the ability to differentiate the conditions in this experiment. We also plan to run follow-up versions with different conditions. The current study varies two formal linguistic features across conditions: syntax (subject-auxiliary inversion vs. no inversion) and prosody (rising polar question contour vs. falling assertion contour).[1] So it is unclear whether participants are sensitive to both of these fea-

[1] In the Tones and Break Indices (ToBI) system for annotating prosodic intonation, the contours are L* H-H% and H* L-L% respectively (Veilleux et al., 2006).

tures, or just one or the other. We would like to tease these apart, first by holding declarative syntax constant, and varying only the intonational contour. This will reveal whether prosody combined with lexical information is enough to produce an effect. If not, it suggests that participants may have relied primarily on syntax in the experiment described above. If so, then it shows children are sensitive to prosody. In another study, we plan to hold prosody constant and manipulate syntax only by contrasting wh-interrogatives against falling declaratives. If children succeed at this, it suggests that they are sensitive to syntax in the absence of prosodic differences. Finally, we plan to factor out both lexical and syntactic information entirely, while still having intonational cues. We will do this by testing monolingual English-acquiring children's sensitivity to stimuli from French, which has similar prosodic contours to English. This study will be run with very young children, 6-month-olds, because we expect older children would be surprised by the unfamiliar lexical content, which may swamp any potential effect. This last study would therefore reveal whether or not very young children are able to rely on intonational contour as a signal to speech act, even when they don't understand the lexical or syntactic content of the utterance.

Returning to the question of how children acquire the canonical links between clause types and speech acts, we offer some initial remarks. We think the child acquires these mappings by tracking different kinds of formal and pragmatic information that they should have access to between 12 and 18 months of age. On the formal side, they are tracking information about syntax and prosody, e.g. the relative positions of subject and verb, whether there is a bare verb, functional items that may be particles, rising prosody, etc. On the pragmatic side, the child tracks information about speaker intentions, e.g. what the speaker wants and what the speaker knows. We refer to this as the pragmatic-syntactic bootstrapping hypothesis:

(7) *Pragmatic-syntactic bootstrapping*
To uncover canonical links between clause types and speech acts, children track regularities in both form and speaker intentions, in mutually informing ways.

We think this process is likely aided by an expectation on the part of the child that there will be three main clause types linked to three main speech acts, given that these canonical mappings are a crosslinguistic universal. The child's goal is then to figure out what specific forms those three clause types take in their language, and which speech acts they canonically map to. For further investigations into how children acquire clause type-speech act mappings, and how they track aspects of form and function in particular, see Yang (2022).

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