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Seven-month-olds' Discrimination of Statements and Questions

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1. Introduction

Distinguishing between statements and questions is an important ability for language learners. In English and many other languages, questions generally involve syntactic structures and word order patterns that are different from statements. For example, in English, questions often begin with *wh-* words (e.g. who, what, where, etc.) and auxiliary verbs switch positions with subjects (compare *I see Jim* with *Who do I see?*). Distinguishing statements and questions is thus critical for learning the grammatical properties of the two sentence types. More broadly, the ability of learners to distinguish utterance types is required and assumed by many acquisition theories in which grammatical analyses are first carried out on canonical structures, such as simple transitive, declarative sentences (Pinker, 1984). Since questions and statements each account for a substantial portion of infant and child directed speech (44% and 30% respectively; Newport, 1977), learners' ability to differentiate utterance types in their input is critical for analyzing the majority of utterances in the appropriate way. Yet, although many language acquisition theories assume that learners can differentiate these sentence types in the early stages of syntax acquisition, there is little evidence of how and when they do so.

One potential source of sentence type information is prosodic information. In English and many other languages, there is evidence that adult listeners rely on pitch information as an important perceptual cue for distinguishing statements and questions. For example, although Russian has *wh-* words, sentences often do not include lexical or syntactic/grammatical indicators of sentence type (Makarova, 2007). Russian has relatively free word order and no auxiliary verbs (Rojina, 2004) so listeners rely on pitch peak alignment rather than lexical cues to perceive distinctions between statements and yes/no questions (Makarova, 2007; Svetozarova, 1998). Statements and exclamations have earlier peaks than questions. There is also an effect of pitch peak height, where questions have higher pitch peaks than statements. In languages like English (Cruttenden, 1986, Lieberman, 1967) and French (Vion & Colas, 2006), which do use lexical markings (e.g. auxiliary verbs) to distinguish sentence types, the final pitch contour is a critical region in the utterance for perceiving distinctions between questions and statements. Săfărŏvá and Swerts (2004)

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found that American English speakers were more likely to identify utterances as declarative questions if the utterances ended with a final rise. French listeners' accuracy in judging whether an utterance was a statement or question improved nearly 40% when final pitch information was included. In the absence of this final prosodic information, subjects defaulted to a statement judgment (Vion & Colas, 2006). In summary, there is cross-linguistic evidence that prosodic information is useful for discriminating utterance types, suggesting that infants could use prosody to differentiate questions and statements early on.

In further support of this possibility, there is evidence that infants are sensitive to prosodic information from birth. Newborns can distinguish their native language from other foreign languages (Mehler, Jusczyk, Lambertz, Halsted, Bertoncini, & Amiel-Tison, 1988; Moon, Cooper & Fifer, 1993) as well as distinguish languages from different rhythmic classes (Christophe & Morton, 1998; Nazzi, Bertoncini & Mehler, 1998). These results demonstrate infants' sensitivity to the prosodic properties of language from an early age. Therefore, it is reasonable to hypothesize that infants can use this sensitivity to prosody to distinguish between sentence types, especially given seven months exposure to their native language.

There is preliminary evidence that infants differentiate statements and questions at least as early as 7 months of age. Geffen (2010) examined sentence type discrimination with 7-month-olds, using a modified version of the Visual Habituation Paradigm (Houston, Horn, Qi, Ting, and Gao, 2007). Half the subjects were familiarized with statements, the other half with yes/no questions, then both groups were tested for a difference in looking time to familiarized vs. non-familiarized sentence types. Infants listened significantly longer to familiarized sentence types, suggesting that infants as young as seven months can distinguish between statements and yes/no questions. However, given that a familiarity preference in a habituation paradigm is unexpected, it is important to replicate the finding using a different method, which is an impetus for the current experiment.

Soderstrom, Ko and Nevzorova (2010, 2011) also found evidence suggesting that infants can distinguish statements and questions. However, their primary finding was with declarative questions, which do not pose the same learning problems with respect to grammar acquisition as do questions that exhibit non-canonical word orders. In addition, because declarative questions have identical word-order properties as statements, speakers may use prosody differently compared to their production of questions that alter word-order properties. It is thus important to confirm that the results generalize to other types of questions. Finally, the age range of subjects was quite broad (4.5 to 24 months), making it difficult to draw conclusions about the developmental trajectory of discrimination ability.

In summary, although early discrimination of statements and questions could greatly facilitate syntax acquisition, there are significant unanswered questions regarding infants' ability to distinguish statements and questions. In particular, it is unknown when the ability develops, and what information infants

use. This experiment is motivated by the hypothesis that, due to infants' early sensitivity to prosodic information, they will be able distinguish statements and questions early on based on prosodic information. We focus on yes/no questions here, because there is evidence that yes/no questions are more prosodically distinct from statements than are *wh*- questions, at least in adult directed speech (Hedberg, Sosa & Fadden, 2004). We note in advance that, in principle, differences in word order between statements and questions in our experiment could also provide a basis for discrimination—e.g., questions have do-support and aux-inversion. However, our 7-month-olds subjects are unlikely to represent incoming utterances in a way for this information to be useful—a point we take up in the discussion section. We therefore view this experiment as a first step in investigating when and how infants can begin to distinguish statements from questions.

2. Method

2.1. Participants

Twelve typically developing English-learning infants (6.73-7.5 months, *M* =7.04 months) were recruited from county birth records, contacted first by letter, and then by phone or e-mail to schedule an appointment. Infants only participated at one time point. Subjects had no known hearing or cognitive impairments.

Parents were informed at the beginning of the experiment that participation is voluntary and they were free to withdraw from the experiment at any time.

2.2. Stimuli

Stimuli consisted of nine statements and nine questions. Familiarization consisted of seven exemplars of one type of sentence (e.g. statements) with the remaining two sentences of each type in the test phase. The test phase consisted of four blocks of new sentences. There were two types of test trials: familiar and novel trials. Familiar trials consisted of two new exemplars of the familiarization type. Novel trials consisted of two exemplars of the non-familiarization sentence type. Critically, all test trials contained sentences that did not appear in the familiarization phase. Stimuli were matched on number of syllables and duration. A full list of stimuli can be found in Table 1.

Stimuli were recorded by a female native English speaker in an infant-directed register, which exaggerates prosodic dimensions and is intrinsically appealing to infants (Fernald, 1984).

Table 1. Familiarization and test sentences for both groups.

	Statement Familiarization	Question Familiarization
Familiarization	We are having French toast for breakfast. We're going to the park today. The cat is playing with the ball. Your sweater is very pretty. Let's go outside and blow bubbles. We just bought a pair of new shoes. We saw elephants at the zoo.	Did you see a funny movie? Can we go to the beach today? Do you want some watermelon? Can I have a sugar cookie? Do you want to read a story? Do you want to go down the slide? Can I play with the cute brown puppy?
Test	We had turkey and grapes for lunch. The pirates hid the treasure chest. Can you bring me the teddy bear? Would you like a tuna sandwich?	

2.3. Design and Procedure

Infants were assessed with a version of Headturn Preference Procedure (HPP) (Kemler Nelson, Jusczyk, Mandel, Myers, Turk & Gerken, 1995) to evaluate their ability to distinguish between sentence types. Infants were randomly assigned to one of two familiarization groups, either statement or question familiarization with random presentation of familiar or novel trial first in the test phase.

Infants were seated in their parent's lap in a darkened, sound-attenuated room during the course of the experiment. Infants were initially facing forward and looking at a red flashing light with the opportunity to look at either of two yellow lights, one on either side of the room. The auditory stimuli were played through speakers positioned beneath the yellow lights. Trials ended when the child looked away from the light for longer than 2 seconds. The computer recorded infants looking time during each trial. The experiment took approximately 5-10 minutes.

When the child was settled and facing the red light, the red light was extinguished and the experiment began with familiarization. Infants were familiarized to seven examples of one sentence type (e.g. question) in 9 pseudo-random blocks, for a total duration of approximately 80 seconds; stimuli were presented through both loudspeakers. This was followed by a series of contingency trials, which used a tone to demonstrate that when the child looked at one of the side lights, a sound would play until they looked away for 2000 ms or until the entire stimulus had been played. The contingency phase was immediately followed by the test phase, which consisted of eight trials: four novel trials and four familiar trials. During the contingency and test trials stimuli

were presented through one loudspeaker at a time and the computer software selected the side to ensure that the first two trials consisted of one novel and one familiar trial and the other six trials were randomly presented such that the order of stimuli and order of location were independent of the infant's behavior. Standard protocols for counterbalancing and subject exclusion criteria were followed. Parents were told that if their child should become wiggly, the best time to readjust their child was when the red light was flashing, which indicated that no data was being collected.

3. Results

There was no difference in the pattern of listening times to familiar vs. novel trials across familiarization groups, so we collapsed the results. A repeated-measures ANOVA with 20% trimmed means comparing familiar to novel sentence types showed that infants listened significantly longer to familiar (M=14.16 s) vs. novel sentence types (M=10.15 s); $F(1,7)=8.0$, $p=0.025$). Thus, 7-month-old English-learners can indeed differentiate declaratives and interrogatives.

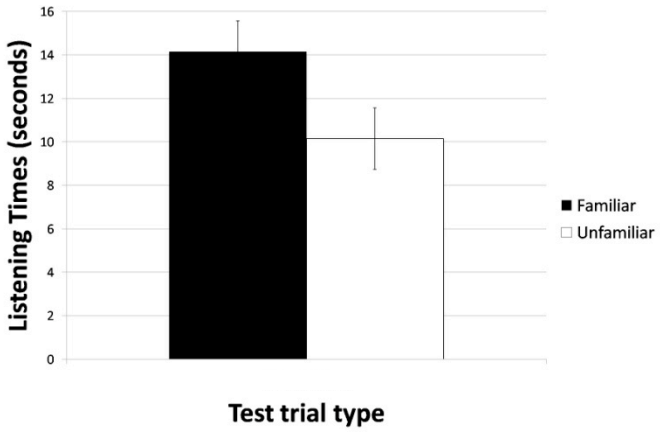

Figure 1. **Listening times to familiar versus unfamiliar sentences types. Error bars depict standard error calculated to take into account a within-subjects comparison.**

To explore whether infants in our study could have used prosodic information to discriminate sentence types, we measured pitch range, pitch peak and duration of the final syllable of each sentence. Mean pitch range for interrogatives (243.60 Hz) and declaratives (156.89 Hz) was significantly different ($t(15)=2.24$, $p=0.041$). Mean pitch peak for the last syllable of questions (467 Hz, SD= 54 Hz) was significantly different than for statements (280 Hz, SD=113 Hz; $t(11)=4.49$, $p<0.001$).The difference in mean duration for interrogatives (0.29 s) and declaratives (0.44 s) was marginally significant ($t(15)=-1.76$, p=0.099).

4. Discussion

Infants preferred to listen to test sentences that were the same type as the sentences they heard during familiarization. This confirms one part of our hypothesis: that infants would discriminate between the sentences that were statements and those that were questions. However, our experiment is not conclusive on the question of *how* they were able to make the discrimination. What kind of information might they have used?

While our acoustic analyses are consistent with the hypothesis that infants used prosodic cues, it is also possible that word order patterns themselves were informative. As discussed earlier, yes/no questions exhibit aux-inversion, and in some cases do-support. In principle, infants could have been using the presence or absence of auxiliary-initial sentences in order to make the discrimination.

There are several reasons why we think this is unlikely as a general mechanism for infants of this age. First, this type of distributional information presupposes having lexical categories *auxiliary* (or, in the case of *wh*- questions, *wh*-word). As of yet, we have no evidence that these functional categories are, part of young infants' representations of utterances. Moreover, there is evidence that infants' lexical categories are more acoustically-based early on, a fact that would tend to group auxiliaries and *wh*- words with other closed-class words such as determiners, and perhaps even pronouns (Shi, Werker & Morgan,1999). Such a broad functor category (or functor/pronoun category) would not be informative for utterance type discrimination. On the other hand, infants might use individual auxiliaries (or *wh*- words) in utterance-initial position as a cue that the utterance should be treated differently from others. However, this kind of approach would lead to overly fine-grained and grammatically irrelevant distinctions. For example, while an utterance-initial *do* could be used to distinguish yes/no questions from statements, and trigger a hypothesis that they have different underlying structures, a mechanism that did so might also create distinctions between utterances that start with, say, *the* vs. *you*. So, t*he boy saw the girl* would be marked as a different kind of utterance from y*ou saw the girl*, despite their shared transitive, declarative structure. Moreover, some questions have declarative word order: *You want a cup?* Thus, it is doubtful that these distributional patterns alone would be sufficient as an initial source of sentence type information for infant language learners. On the other hand, as we have discussed, there are reasons to hypothesize that infants might make initial utterance type distinctions based on prosody.

That said, in our particular experiment, it is possible that infants discriminated statement and question trials based on properties of initial words. This is because one of the question test items began with the same word (*can*) as several sentences in the question familiarization set (and not in the statement one), and the initial words in statement trials were shared by many familiarization statements. It is, thus, conceivable that infants were simply responding to the familiar initial word in our experiment. We are addressing this

issue in a follow-up experiment by removing this confound. However, if infants' responses were due to the familiarity of the initial word, one might have expected stronger discrimination in the statement familiarization group, as there was a much stronger basis for familiarity on that dimension for that group. We found no evidence that the familiarity preference varied by group, which suggests to us that we will replicate these findings when the initial-word confound is removed.

To further investigate the source of infants' sentence discrimination, future work will evaluate whether infants can distinguish statements and questions when lexical information is removed, leaving only pitch and rhythm information. Taking this a step farther, we will also evaluate how much information is necessary for infants to be able to make distinctions between sentence types. Infants will be presented with resynthesized sentences where speech related information (e.g. formants) will be replaced with the original prosodic pattern carried only by a sine wave that fluctuates in pitch.

Another direction for future work is evaluating the role of word order patterns in making sentence type distinctions. As mentioned earlier, many questions have distinct word order properties such as auxiliary inversion and *wh*-fronting. While there is little evidence that 7-month-olds attend to sequential word order information, there is considerable evidence that 12-month-olds do. By 12 months, infants use lexical distributional patterns to categorize novel words (Mintz, 2006) as well as to distinguish novel grammatical and ungrammatical utterances (Gomez & Gerken, 1999). Therefore, unlike 7-month-olds, 12-month-olds may be able to categorize utterances based on lexical distributional information. Future work will evaluate the role of word order in making sentence type distinctions in 12-month-old infants, asking whether 12-month-olds can use word order alone to distinguish statements and questions.

In summary, the current study provides preliminary evidence that infants as young as 7-months can make sentence-level discriminations that could significantly help them in learning the structure of their language. Future research is needed to determine whether infants based this discrimination on sentence-level prosodic contours, or sentence-initial words, which also differed across sentence types, or some other factor.

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