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Wh-Questions are understood before polar-questions: Evidence from English, German, and Chinese

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Abstract

In this paper we consider the order of emergence of comprehension of wh-questions and polar-questions. We argue that considerations of complexity and input favour the earlier emergence of polar questions; on the other hand, if one assumes that question understanding emerges as a consequence of interactive learning this favours (certain) wh-questions, as well as a small subclass of polar questions. We offer corpus evidence from the Providence corpus that (a certain class of) wh-questions are in fact understood earlier than the polar-questions. We test this observation using elicitation studies on German and Chinese speaking children. Our results confirm the finding from the corpus study and are in line with an interactive learning perspective for the emergence of understanding of questions.

Keywords: order of emergence; interrogative structures; understanding by children; wh-questions; polar-questions

Introduction

There has been much work since the 1970s on the order of emergence of various interrogative structures PRODUCED by children and how this is to be explained. There has been significantly less work on the emergence of understanding, (though see e.g., Casillas, Bobb & Clark, 2016; Ervin-Tripp, 1970; Tyack & Ingram, 1977; Veneziano, 1985).

In this paper we consider the order of emergence of comprehension of wh-questions and polar-questions. What are the factors that determine the order of emergence of understanding? Plausible factors to consider are the semantic and syntactic complexity of different kinds of questions and of the answers associated with such questions. As we discuss in our *Background* (literature review) section, considerations of complexity and input favour the earlier emergence of polar-questions; on the other hand, if one assumes that question understanding emerges as a consequence of interactive learning (Moradlou & Ginzburg, 2014), this favours (certain)

wh-questions, as well as a small subclass of polar-questions, primarily those used as requests.

After discussing previous work on the emergence of questions in production and comprehension in the *Background* section, we present corpus evidence from the Providence corpus (Demuth, Culbertson & Alter, 2006) in the *Corpus* Section. This suggests, with several important caveats, that wh-questions emerge earlier than (information oriented) polar-questions; one caveat is that this is a generalization that does not concern interrogative structures/construction types as such, but uses to which the interrogatives are put.¹

In this way it is analogous to proposition (the denotation of declarative uses, belief states etc). Hence, here we reserve interrogative for the structure/construction type. Another is that interrogatives that intrinsically involve sentential *answers* (such as why- or how-questions) are apparently understood later. We tested this finding using elicitation studies on German and Chinese speaking children described in Section *Methods*. As discussed in our *Results and Discussion* section, these elicitation studies confirm the finding from the corpus study. Some implications and further work are discussed in a concluding section.

Background

The syntax and semantics of questions and short answers

Although there has been much work in formal semantics on the meaning of interrogatives (for surveys see e.g., Ginzburg, 2010; Groenendijk & Stokhof, 1997; Wiśniewski, 2015), as Wiśniewski (2015, p.377) says ‘No commonly accepted theory of questions has been elaborated so far.’ The questions literature has not addressed the issue of how questions might be acquired, nor for any given theory the cognitive plausibility of the semantic entity that theory assumes as an interrogative denotation.

Nonetheless, on just about all existing theories, the entities denoted by wh-interrogatives are (in a sense we will elaborate on shortly) more complex entities than those denoted by polar-interrogatives. We exemplify this with respect to two such theories. In the partition theory (Groenendijk & Stokhof, 1997), a question is seen to be a partition of the set of possible worlds. Each block of the partition represents an exhaustive answer to the question. On this account, a polar-interrogative denotes a partition that has exactly two entities (corresponding to the question being resolved positively or negatively, respectively.) With a unary wh-interrogative, the size of the partition is less determinate; it depends on the number of possible candidate entities that could serve as fillers for the property in question – if that number is known to be n , then the size is 2^n .²

In the propositional function view of questions (Ginzburg, 2012; Ginzburg & Sag, 2000) on the other hand, a polar interrogative denotes a constant function, whose value is the queried proposition. A unary wh-interrogative denotes a function from possible candidate entities into the answers where they instantiate the property in question.

¹When care is warranted, among semanticists the word ‘question’ is nowadays usually taken to denote a semantic entity that is the content of an interrogative structure/construction type use or the content of certain erotetic cognitive states (e.g., wondering).

²Bos and Gabsdil (2000) argue that this exponential growth in the cardinality of the partition space makes it computationally intractable.

On both views, the polar-question is an entity whose makeup does not vary with the nature of the queried proposition, in contrast to the *wh*-question whose complexity is tied to the predicate and *wh*-word at issue.

From a syntactic point of view once again there is no clear argument that polar-interrogatives are more complex; if anything, the opposite holds. We mention two representative views. In Head-Driven Phrase Structure (HPSG) (Ginzburg & Sag, 2000; Sag, 2010) polar-interrogatives are analyzed as a subtype of the Subject-Auxiliary-Inversion (SAI) construction, a ternary branching construction headed by an auxiliary verb; (root) *wh*-interrogatives are analyzed as involving a filler-gap structure whose head-constituent is also a subtype of the Subject-Auxiliary-Inversion construction.³ While the details and conception in Government and Binding and Minimalist analyses are quite different (Chomsky, 1986, 1995) – for comparison between the frameworks' approaches see (Borsley & Müller, 2019; Müller, 2018) – a similar point can be made for these analyses. In GB theory polar interrogatives are analyzed as binary branching structures headed by the auxiliary viewed as the complementizer of an IP, whereas a *wh*-interrogative is viewed as structure in which the *wh*-word is moved into a SPEC of a CP, whose sister is a C' structure, identical to the structure posited for the polar interrogative.⁴ Although minimalism changes many aspects of the analysis, in terms of the basic structure, there is no significant difference between GB and minimalist analyses. Thus, both HPSG and GB and minimalist analyses have polar interrogative structures (or essentially isomorphic structures) as constituents of the structures they posit for *wh*-interrogatives.

What of the complexity of the form of the answers that children use initially to reply to questions, one word (or more generally non-sentential) short answers to *wh*-interrogatives and one word answers to polar questions?⁵ Here the answer given is also theory-specific, but theory involves two dimensions, syntax-semantics interface and the denotations assigned to the words and phrases involved.

From a semantic point of view *yes* has often been viewed as a function that returns as output a proposition derived from the question asked (Ginzburg, 2012; Groenendijk & Stokhof, 1984); *no* involves a somewhat more complicated function: for positive polar-questions, it returns the negation of the proposition derived from the question asked, whereas for negative polar-questions it affirms the proposition derived from the question asked. In both cases, one needs to operate on propositions – abstract entities of some kind. Answering a *wh*-question involves predication: the property associated with the question of the referent deriving from the answer. But in this case, at least for some types of *wh*-phrases, the predication involves concrete arguments: visible entities or locations.⁶

A syntactic perspective on this views both polar words and short answers as remnants of fully spelled out sentences. Merchant (2004) develops a view of short answers as involving fronting and deletion of the remaining material (see Jacobson

³In fact, this subtype *inv-decl-cl* differs from the subtype used to analyze polar-interrogatives *pol-int-cl* in that the former is specified as hosting a long distance dependency, whereas the latter does not host such a dependency. But this, if anything, makes the *inv-decl-cl* structure more complex syntactically than the polar-interrogative structure.

⁴In this case, both structures used to analyze polar- and *wh*-interrogatives host a long distance dependency, the former from the aux to I, the latter from the *wh*-word to its "in situ" position.

⁵We are indebted to Edgar Onea (p.c.) for emphasizing to us the importance of this issue.

⁶And indeed, as discussed below, this does not apply to *why*- or *how*-questions, where the arguments are causes or manners.

(2016) for detailed critical comparison between this proposal and semantically-based proposals). Similarly, Holmberg (2015) proposes that *yes* and *no* associate with the specifier of focus phrase (FocP) in the left periphery of p-structure, linking up with a null element associated with the complement of the focus head: namely, a polarity phrase (PolP). As far as one can gather, there is no very obvious complexity difference between polar words and short answers – they both involve dislocation of the non-sentential utterance to the left periphery, generation of sentential material and its deletion.

To summarize:

1. Semantic theories of questions view polar-questions as generally simpler entities than wh-questions.
2. In terms of syntactic structure wh-interrogatives are viewed as structures one of whose constituents is a polar interrogative structure.
3. Semantically oriented theories of the meaning of short answers and polar words suggest that the latter are more complex in that they involve abstract propositional entities, whereas short answers with words like *where*, *what* and *who* involve predication of concrete entities
4. Syntactically-oriented theories of short answers and polar words do not offer a clear hypothesis with respect to their comparative complexity; both involve dislocation of the non-sentential utterance to the left periphery, generation of sentential material and its deletion.

The emergence of interrogatives

Children's production of questions.

Children's question asking behavior has long been a topic of interest (Davis, 1932; Smith, 1933). Smith (1933) reported that questions constituted 13% of children's utterances, and that the use of wh-words by children significantly declined with age (2 to 5 years) from 49 to 37 percent. The commonest wh-questions were *what*- and *where*-questions. Similarly, Ingram (1971) reports that in his corpus of 10 children aged 2.5 to 3 years, 19% of children's utterances were questions. Questions are frequent from early on in speech to young children; Newport, Gleitman, and Gleitman (1977), for example, report that 44% of child directed utterances are questions (15% wh-questions, 21% polar questions and 8% deictic questions). Cameron-Faulkner, Lieven, and Tomasello (2003) report these to be 31% of maternal utterances. These early questions often have multiple communicative functions, such as requests for information or requests for action (Shatz, 1978, 1979).

Even young children recognize the turn-allocating constraint on questions (Ervin-Tripp & Miller, 1977), possibly through prosodic processes (Geffen & Mintz, 2011), and sensitivity to word order (Geffen & Mintz, 2015). Indeed, Geffen and Mintz (2011) showed that infants as young as 7 months can differentiate between questions and statements. They investigate how this early ability arises, focusing mainly on prosodic cues, like pitch range, pitch peak and duration of the final syllable of each sentence. They showed that infants liked to listen to sentences of the same type (question or statement) as in the familiarization phase of the experiment, and that questions and statements were significantly different on the prosodic dimensions mentioned previously. However, the results do not exclude the possibility of other contributing factors such as word order. In a subsequent study Geffen and

Mintz (2015) showed that 12 months olds were able to distinguish between polar interrogatives and declaratives even when all prosodic cues were removed from the acoustic signals of such utterances.

Question acquisition has been extensively studied within Government and Binding and minimalism from the mid 1980s, to assess the extent of children's syntactic knowledge, with particular interest in structure and movement in *wh*-interrogatives in English (see for example, de Villiers, de Villiers & Roeper, 2011; Radford, 1994; Stromswold, 1995; Thornton, 1990).

Johnson (1983) showed that children's early questions consisted largely of formulaic *what is this* or *what is that* used in a limited set of routinized interactions.

She hypothesized that children first start out with a small number of formulaic uses and then extend these to a larger variety of contexts. The early formulaic utterances rely on frame types rather than the use of different *wh*-words.

Similarly, Dabrowska and Lieven (2005) studied children's early question constructions between the ages of 2 and 3, using a relatively dense corpus of spontaneous speech. They divided the corpus at each age into two parts, and attempted to derive children's syntactic questions in the test corpus from a larger main corpus, using only lexically specific units, and two operations, juxtaposition, and superimposition. This grammar could account for 90 percent of children's interrogatives in their test corpora. They analyzed the remaining 10 percent, and showed that these are no more complex than the successfully derived utterances, and that most are in fact near misses; they take this as evidence for children extrapolating from their existing linguistic knowledge rather than applying previously mastered rules. Their lexically specific grammar for children's interrogatives provides a concrete alternative to accounts requiring innate abstract rules for acquisition of interrogatives.

There appears to be a relatively robust order of acquisition for the production of *wh*-words in interrogatives reported for a variety of languages, in which *what* and *where* (and their cross-linguistic equivalents) are acquired before other *wh*-words (e.g., *why*, *how* and *when*) (in English for example see, Bloom, Merkin & Wooten, 1982; Brown & Hanlon, 1970; Smith, 1933, in Serbo-Croatian, Savlć 1975, and in Korean, Clancy, 1989). Bloom *et al.* (1982) proposed a complexity-based account. On this line, the first *wh*-questions to emerge are *wh*-identity questions – questions that ask for the identities of things or places. These are suggested to occur with *what* Bloom *et al.* term the 'relatively simple' *what* and *where*, and should occur primarily with the copula. Later on, the *wh*-words, which now also include *who*, are envisaged to start occurring with a greater variety of main verbs (e.g., *Where has he gone?*, *What are you doing?*). There have also been more recent alternative accounts of such phenomena in terms of input frequency (see Rowland, Pine, Lieven & Theakston, 2003; Theakston, Lieven, Pine & Rowland, 2001, and references therein).

Estigarribia (2010) studied the emergence of polar questions. He showed, based on a wide ranging study of corpora and in contrast to the focus on canonical, inverted polar structures in the literature, that "noncanonical" polar interrogative structures (such as *You about ready to eat? In the morning?*) are common in the input and emerge early in children's speech. Estigarribia argued that such structures, less complex structurally, facilitate the acquisition of canonical ones and formulated a model ('Right-to-left elaboration') which explicates this.

Children's comprehension of questions

There are fewer studies that investigated question *comprehension* in young children. Ervin-Tripp (1970) investigated the responses to questions in two separate groups of children, the first study is a longitudinal observation of 5 children from 1;9–2;5 for about a year. In this data-set she observed that *yes/no*, *what*, and *where* were the first questions to be understood. She found a similar order of acquisition in production of such questions, and noted a delay of several months between evidence for comprehension and the productive use of questions. She investigated question comprehension in a second study that was specifically designed to measure children's ability to answer different types of *wh*-questions. 30 different questions were asked using a picture book every month for a year, of 24 children (2;6–3;1). Error analysis of the responses led Ervin-Tripp to hypothesize four basic strategies for the child to process questions, based on child's cognitive development, and the verb in the question utterance: (1) If you recognize the question word, give a correct reply. (2) If there is a transitive verb, respond with the object of that verb. (3) If you are over three, and there is an animate subject and an intransitive verb, give a causal explanation. (4) For the remaining intransitives, give a locative or direction if it is missing.

Tyack and Ingram (1977) found a similar pattern in production of questions, with *yes/no*, *what*, and *where* being most common, where questions declining with age, and other *wh*-questions becoming more frequent. They conducted an answer elicitation study of *where*-, *when*-, and *how*-questions in transitive and intransitive constructions, and *what*-questions in subject and object syntactic frames with transitive verbs. Their analysis of children's errors showed some support for Ervin-Tripp's strategy two. However, the semantic features of the verbs themselves seemed to play a role in how children answered the questions, as well. Based on these observations, they proposed revisions to Ervin-Tripp's answering strategies to emphasize semantic features of the verb and its location in the question utterance.

As mentioned earlier, one of the reasons for prevalence of questions in child directed speech is children's ability to discern their turn allocating properties which enable them to participate in conversation with their parents (Bloom, Rocissano & Hood, 1976). Due to their intrinsically dialogical nature, question-answer sequences are a natural candidate for studying parent/child interaction. Olsen-Fulero and Conforti (1983) investigated how variables such as each conversational partner's motivation, constraints on answers, difficulty and function of questions affect children's response rates. They also described the conversational structure of question-answer interaction. More recent studies like (Casillas *et al.*, 2016) and (Clark and Lindsay, 2016) have looked at the timing of children's responses to questions. Casillas *et al.* (2016) investigated factors contributing to response latencies in question-answer pairs between children and their caregiver, sampled from the Providence corpus (Demuth *et al.*, 2006) in six age points (1;8–3;5). They coded responses for *question type* (syntactic: *what*, *where*, *who*, or *yes/no*), *answer type*, *question complexity*, *answer complexity*, *givenness*, *routine familiarity*, if the question was information seeking or was meant to test children, if the response was confirming or disconfirming, and if the response was fricative-initial. Differences in response latencies were small for question types: polar-questions were answered the fastest, and *wh*-questions acquired earlier (*what* and *where*) had shorter latencies than *who*. They presented a mixed effect model with the previously mentioned factors, and found that answer type was a better predictor of latency than question type. In a second study they focused on polar-questions, sampling a new set of question-

answer pairs, to investigate how age affects response latencies for different answer types (minimal answers vs more complex answers). Children were faster at starting a simpler answer, they got faster at responding within a certain type of answer with age, and in the last age point response latencies for different answer types converged. They suggest that the underlying mechanism for these effects is processing demands of formulating an answer in conversational setting.

Moradlou and Ginzburg (2014) investigated children's answering behavior for wh-questions, in a study using the Rollins corpus, (Rollins, 2003). They classified question-answer interactions in three semantic/pragmatic classes of increasing complexity; with a view towards how these classes of interactive behaviors facilitate learning of question meanings, they called them *GAMES*. These games are hierarchical in that each more complex class generalizes the less complex game class:

1. Salient Object Identification games: a question is asked prompting for an appropriate descriptor of an object presented to the child:
 - (1) a. [Mother turns page to reveal page with mirror on it.]: who's that? who's hat? huh? can you see? rabbit.
 - b. [Mother walks Big Bird up] who's that? who's that? is that Big Bird?
2. Erotetically plausible question games: a question is asked in a situation where an obvious question arises:⁷

For instance, Someone V'ed raises the issue Who V'ed. When shown an object, the question will be: *Who/What is that?*; when an object disappears, the question will be: *Where is SO?*; seeing an animal – *What noise does it make?* seeing an object: *What things can it do?*; when observing a balloon being squeezed – *Will the balloon explode? etc.*⁸

 - (2) a. [Mother pulling hair from rattle]: Where is all this hair coming from?
 - b. [Mother removes big bird] Where did Big Bird go? [pulls big bird up into line of sight] peek a boo.
3. Situational Description games: a question is asked about properties of objects observable in the situation:
 - (3) a. [Mother looks at book]: What kind of colors do we have here? [puts book on tray] Look there's purple. That's Mot [= mommy's] favorite color. and pink. and blue.
 - b. [Child holding car] What's on this car? [grabs other side of car Chi has in hand and turns it over.] This car has a butterfly sticker on it.

The general idea underlying this paradigm is that the child already has questions in their cognitive system, just like they have propositions (beliefs about the world). Hence, to the extent that the answers can be understood by the child, then given sufficient exposure the child deduces an association between the pre-answer utterance and a question. Assuming that a relatively restricted set of questions is asked of children at

⁷This idea is inspired by work on *erotetic logic* – a logic which given certain assumptions allows one to deduce questions in addition to (the standard object of deduction) propositions (Wiśniewski, 2013, 2015). On this view a proposition *p* evokes/raises the question *q* iff (i) *p* entails that *q* is instantiated (there is an entity with the property *q*) and (ii) *p* does not entail a single simple answer *sa_q* of *q*. (Definition 28, p. 305, (Wiśniewski, 2015), slightly reformulated.).

⁸This is, hence, an example of an erotetically plausible *polar* question, in contrast to salient object identification games that are restricted to wh-questions.

this stage, this could lead to learning of these, though it does not directly explain the learning of interrogative constructions in their full generality.

Based on a random sample of 20 wh-questions of each file (31–48% of all wh-questions present in the files from early files of Naima in the Providence corpus, Demuth *et al.*, 2006), Moradlou and Ginzburg (2014) found no evidence that caregivers present children with the games discussed above SEQUENTIALLY (i.e., the frequency of the games did not change in favour of more complex ones over time.). However, they did find evidence that salient object identification and erotetically plausible questions are easier for the child to answer compared to situational description questions: the former get answered more often and might therefore be easier to learn.

A corpus study of question answering

Ginzburg and Moradlou (2013) made the observation that short answers to wh-questions constitute a substantial number of children's single word utterances and noted the relative absence of *yes* and *no* answers at this early stage. This is potentially an indication that children understand wh-questions earlier than polars. To investigate young children's ability to answer wh- and polar-questions, we annotated the child's responses to a sample of questions in three children in the Providence corpus (Demuth *et al.*, 2006).

A question was considered answered if the child provided a verbal or non-verbal response after the parent's question that was comprehensible to the parent and pertained to the question. A shrug, a nod, a head shake, or an action, for instance, are all examples of non verbal responses to polar-questions; *where* and *which* questions are often adequately answered non-verbally by pointing.

We analyzed data from three 1-year-old children. We annotated 30 +/- 3 minutes of each file and a total of 13 files. For Lily files 2, 4, 6, 8, and 10 (age 1;1.16 to 1;5.08), for Violet, files 1, 3, 5, 7, and 9 (age 1;2.00 to 1;6.03), and for Naima, files 2, 3, 4, 5, and 6 (age 1;0.14 to 1;2.07) were annotated.⁹ All three children answered significantly more wh-questions versus polars. This despite the fact that on the whole more polar questions were posed (Violet : 256 polar v. 212 wh; Naima: 292 polar v. 205 wh; Lily: 271 polar v. 291 wh). Table 1 summarizes the results. Furthermore, no verbal *yes* or *no* responses were found. The polar-questions answered in these samples were all request polars, exemplified in (4):

- (4) a. Mother: you want some rice? Child: (reaches out with bowl)
- b. Mother: you gonna kiss the horse? Child: (kisses horse)
- c. Mother: Can you close the box? Child: (closes box).

Caregivers tend to answer their own questions at a very high rate (Moradlou & Ginzburg, 2014; Veneziano, 1985). As indicated in Table 2, our corpus study found that the self-answering *rate* is somewhat higher for wh-questions compared to polars. However, given that polars are significantly more frequent, in terms of *raw numbers* of carer-answered questions encountered by the child, in two cases out of three (Naima and Violet) polars are as numerous or more than wh-questions.

⁹For Naima consecutive early files were selected to somewhat match the children in terms of their linguistic ability: all the children in these samples are still mostly producing single word utterances.

Table 1. Answering rates for Lily, Naima, and Violet of Providence corpus

type	% answering rate		
	Lily	Naima	Violet
polar	21	13.7	7
whq	39.8	25.8	25.5
All	31	18.7	15.4

Answering rates in percent

Table 2. Self answering rate for polars and wh-questions

	Naima		Lily		Violet	
	polar	wh	polar	wh	polar	wh
percent answered	22.8	30	21.9	64.8	31.1	45.8
number answered	23	13	14	57	28	27

Caregivers' self answering

Samples are from files 2,4, and 6 of Naima, 144 questions, 101 polars, 43 wh, 2,4, and 6 of Lily, 152 questions, 64 polars, 88 wh, files 1,3, and 5 of Violet, 149 questions, 90 polars, 59 wh

Experimental study

In the corpus study mentioned above it was observed that the ability to answer wh-questions emerges before the ability to answer polars.¹⁰

For certain classes of wh-questions, the answer involves reference to a concrete and sharable entity; this also applies to the requested object in request polars; for informational (non-request) polars, such potential reference is not available. Given this, the order of understanding is hypothesized to be correlated with questions whose answers are easier to understand. Additionally, it is possible that children answer polar-questions later, because the use of polar particles requires a representation of propositions. To better understand different factors in children's ability to answer different types of early questions, we conducted elicitation studies in the context of shared picture book reading.

The studies were conducted on German and Chinese speaking children in day-care centres in Germany and China. German, like English, is a language where the non-sentential strategy for responding to polar-questions involves using interjections

¹⁰As an anonymous reviewer for the *Journal of Child Language* has pointed out to us, this statement deserves a caveat. This is that, strictly speaking, what can be concluded from the corpus data are PROBABILITIES OF OBTAINING (ADEQUATE) RESPONSES, not ABILITY TO RESPOND as such. This given the variety of factors that can inhibit responses being given (shyness, mishearing etc). Nonetheless, we think that in the data discussed here, there is no clear reason that such factors would bias response provision in favour of one class of questions over another. Moreover, it seems to us that hypothesizing a causal relationship between probabilities of obtaining responses with ability to respond is reasonable, based as it is on a large sample from a corpus of naturalistic interactions. This in the absence of a clearly articulated alternative explanation of the correlation. Consequently, we will persist with the potentially over-interpreting terminology 'ability'.

(*ja* ‘yes’, *nein* ‘no’); it is also, like English, a language with a special purpose polar-question construction involving verb fronting, as exemplified in (5a)–though in contrast to English, such fronting is not limited to auxiliary verbs; as in English, *wh*-interrogatives typically involve a fronted *whP*, as illustrated in (5b); this can be answered sententially, as in (5c), or non-sententially, as in (5d); for more detail on German interrogatives in various frameworks see (Müller, 2018).

- (5) a. Ist das ein Ball? Ja./Nein.
is-3Psg that a-nom ball-masc yes/no
Is that a ball? Yes./No.
- b. Wo ist der Ball?
where is-3Psg the-masc-nom ball-masc-nom
Where is the ball?
- c. Der Ball ist zu Hause.
the-neut-nom ball-masc-nom is-3Psg at home-dat
The ball is at home.
- d. Zu Hause.

In Chinese there are several polar-question constructions (Zhu & Wu, 2011) – one strategy involves a string ‘V not V’, another uses ordinary declarative syntax with the particle *ma* at the end, as exemplified in (6a,b). The former is taken to be less biased and was exclusively used in our experiments. One crucial contrast with English and German concerns the non-sentential response strategy: this does not involve special purpose interjections, but repetition of the verb (for positive responses) or the negative prefixed verb (for negative responses), as exemplified in (6b). For *wh*-interrogatives, the *whP* is not dislocated, as in (6c). The sentential answer retains the same surface syntax, whereas, like English and German, a non-sentential answer is possible, as in (6d,e) respectively:

- (6) a. Zhè shì qiú ma? shì./bùshì.
that is ball q-part is/neg-is
Is that a ball? Yes./No.
- b. Zhè shì bùshì qiú? shì./bùshì
that is neg-is ball is/neg-is
Is that a ball? Yes./No.
- c. Qiú zài nǎlǐ?
ball in where
Where is the ball?
- d. Qiú zài jiālǐ.
ball in home
The ball is at home.
- e. jiālǐ.
home
(The ball is) at home.

Our aim in choosing German and Chinese was not contrastive as such, since these languages contrast in several ways (+/- special purpose polar interjections, +/-surface wh-fronting, and also +/- lexical tone). But rather to see if the corpus generalization from English survives in 1) a language that is similar in the relevant respects (German) and 2) one which differs crucially in the domain of polar interjections.

Methods

We designed a picture book using drawings of colorful objects and animals (ten pages, two pictures per page) chosen based on The MacArthur-Bates Communicative Development Inventory (CDI) scores for German (Szagun, Stumper & Schramm, 2009) in the age group of our study (18–30 months) and checked against Chinese CDI norms in (Tardif, Fletcher, Zhang, Liang, Zuo, and Cheng, 2008). The motivation of this study is that by limiting the range of questions we would get a better picture of what makes a question hard or easy to answer. Two such factors included in our experiment are: QUESTION TYPE (what feature of the object, the question is about), and presence or absence of wh-word.

We chose a set of three common question types : identity: *What is this?*, *Is this a cat?*, location/existence: *Where is the flower?*, *Is there a flower there?*, and animal sounds: *What does the cow say?*, *Does the cow say moo?*; the German and Chinese forms used are given in the appendix. Each of these question types is asked at some point in the experiment in three different conditions capturing presence or absence of a wh-word: wh, polar with correct answer *yes*, and polar with correct answer *no*. The aim here is to control for the contextual setup and truth bias of the questions. In natural parent/child conversation the (positive) proposition associated with polar question is often true; we added polar-questions which were answered correctly with a negative response to see if this would encourage the children to reply to polar-questions more often.

The choice of which questions are asked on what pages and the order in which they are asked on each page was made randomly with a number of constraints to disallow invalid orderings. We wrote a python program to find a random ordering where the following conditions are met (i.e., find a solution to a constraint satisfaction problem): disallow orderings where the answer to the first question, gives away the answer to the second question (e.g., *Is this a flower?* in *yes* condition, followed by *Where is the flower?*). Disallow orderings where there is a mismatch between the

QUESTION TYPE and the picture (e.g., *What does the apple say?*, wh and *yes* polar of the same question type do not appear on the same page.) Additionally every experimental item shows up at least once, and no item appears in more than one place. Figure 1 shows a page from our booklet as an example (see appendix for the complete booklet with questions in English, along with their German, and Chinese translations). Every experimental condition (question type \times +/-wh) was asked on two pages (four pictures). The booklet is composed of ten pages, 40 questions: 4 questions per experimental condition, and 4 fillers.

As mentioned above, the experiments were carried out in day-care centres in Germany and China (ages 1;2.22–3;1, mean 1;9.21 for German, and 1;5–2;9, mean 2;0.19 for Chinese). The experimenter looked at the pictures with each child and asked two questions about each picture after establishing joint attention. She gave feedback on child's responses and repeated the questions when needed.

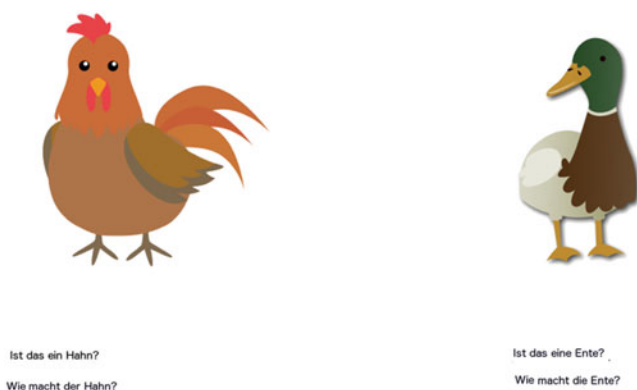


Figure 1. (l) Is this a hen? What does the hen say?
(r) Is this a duck? What does the duck say?

Results and discussion

Only the data from children who engaged with the task and produced at least one response, irrespective of correctness, were analyzed: 17 children (7 female) for German, 27 children (10 female) for Chinese.

In addition to coding the answers for being true or false, we coded for two other dimensions, TYPE CORRECTNESS, and PRAGMATIC CONGRUITY. An answer is type correct if it is of the same type as a true answer; a WHAT question is, for instance, asking for a label of an entity, whereas a WHERE question correspondingly seeks a location. An answer is pragmatically congruent if it could be considered an acceptable response in the conversational context. A point was given for matching each of these dimensions and a SCORE out of three was calculated. If the child did not respond to the question, that was given a score of zero. Answers can be verbal, non-verbal, or a combination of both. Examples for this coding are given in Table 3.¹¹

Table 4 gives an overview of each child's performance by including their mean score for wh-questions, the associated standard deviation, and the difference from the mean score for polar-questions (designated by $\Delta Wh-Pol$). These means are averages over trials, and Δ is between -3 and 3. For the German cohort, in all but three cases $\Delta Wh-Pol$ is positive and in these cases $\Delta Wh-Pol$ is small. For the Chinese cohort, three subjects scored 0 in both cases. For the rest, $\Delta Wh-Pol$ is positive for 15/24 of the children, while 9/24 had a negative $\Delta Wh-Pol$. However, in the latter case $\Delta Wh-Pol$ was generally very small and the scores on wh-questions quite high.

¹¹ An anonymous reviewer for *The Journal of Child Language* asks why verbatim repeats are not generally coded as pragmatically congruous answers (e.g., (i) E: *Is there a flower there?* C: *flower.*) We should emphasize that when such responses are provided along with a gesture (e.g., (ii) E: *Where is the flower?* C: *flower.*, the example is coded as pragmatically congruous. In the polar-question example (i), however, such responses can be used as *acknowledgments of understanding*, but would not be considered as communicating an answer in adult-adult interaction, from which the norms of response/answer felicity derive. And while it is true that in some languages, e.g., Chinese, responses to polar-questions involve verbatim repetition, this is restricted to repeating the verb. Of course, such cases are coded as answers in our scheme.

Table 3. Coding dimensions of responses provided by children

example	true	type correct	pragmatically congruent
E: what is this? (points to cat) C: cat	1	1	1
E: what is this? (points to cat) C: dog	0	1	1
E: is there a flower there? C: (shakes head) [there is a flower on the page]	0	1	1
E: what is this? (points to cat) C: miau	0	0	1
E: is there a flower there? C: there (points to flower)	0	0	1
E: is there a flower there? C: yes, no, yes, no [randomly]	0	1	0
E: is there a flower there? C: flower	0	0	0

If an answer is both true and type correct, it is also pragmatically congruent.

Moving to a detailed look at the aggregated scores, answers to polars got lower scores compared to wh-questions for both German and Chinese (see Figure 2). Figure 3 shows average scores for experimental conditions. Our experiments show that wh-questions are easier, even when answering was prompted using truth bias¹², and the context is relatively restricted compared to naturally occurring talk. Recall that we mentioned previously that Chinese might be hypothesized as encoding a bias helping polar-questions, given the fact that there are no special purpose affirmative/negative particles and that the non-sentential means for answering such questions are presented in the polar 'V not V' structure. Is this expectation fulfilled? On the one hand, the average scores for polar-questions are better in Chinese than in German, though the average differential between the scores for wh-questions and polar-questions is comparable (0.44 for German, 0.27 for Chinese). At the same time, the scores for wh-questions are also better in Chinese and the average age of the cohort in Chinese is 3 months more (2;0 v. 1;9); hence, it is somewhat difficult to affirm clearly with our data that the expectation for a polar-bias in Chinese is met.

We used linear regression to assess the role of each variable in predicting the answer scores. The model using both variables, +/- wh, and question type predicted the scores significantly better than models with only +/- wh or question type (nested model comparison using anova function in R). Tables 5a and 5b summarize the results. When considering each question type separately, differences between wh- and polar-questions were significant at $p < .05$ for question type location in both languages, and question type sound in Chinese. As we noted in our *Background* section, existing theories of questions generally view polar-questions as simpler entities than wh-questions; as for the answers, a syntactically-oriented view of ellipsis

¹²Post hoc analysis using Multiple Comparisons of Means (Tukey Contrasts) did not reveal a significant difference between yes- and no-polars, in either cohort.

Table 4. Mean scores attained by each child for wh-questions and the differential from means for polars; German (l), Chinese (r), ordered by size of wh–polar differential

German			Chinese		
wh-mean	SD	$\Delta wh - (yes + no)/2$	wh-mean	SD	$\Delta wh - (yes + no)/2$
2.50	1.17	1.92	2.58	0.90	1.83
1.75	1.54	1.58	2.75	0.62	1.54
2.00	1.48	1.29	1.58	1.38	1.25
1.33	1.50	1.21	2.67	0.89	0.81
1.00	1.48	0.92	0.75	1.36	0.75
1.67	1.37	0.79	0.75	1.36	0.71
1.42	1.44	0.59	2.67	0.89	0.63
0.25	0.87	0.37	0.83	1.27	0.62
0.50	1.17	0.29	2.75	0.87	0.58
0.25	0.87	0.21	0.58	1.00	0.41
0.25	0.87	0.21	2.42	0.67	0.34
0.75	1.36	0.18	1.42	1.51	0.34
1.58	1.51	0.16	2.08	1.31	0.33
0.33	0.89	0.00	1.00	1.48	0.33
1.75	1.36	−0.08	0.17	0.58	0.17
0.75	1.36	−0.25	2.67	0.89	−0.08
1.08	1.44	−0.63	1.83	1.40	−0.09
			1.25	1.54	−0.17
			2.50	0.90	−0.21
			2.08	1.38	−0.25
			2.42	0.79	−0.33
			1.25	1.54	−0.42
			0.00	0.00	−0.62
			1.00	1.48	−0.96

resolution does not seem to offer clear grounds for differentiation, whereas semantically-oriented views associate propositional operators with polar words, whereas predicates of concrete associate visually accessible individuals with short answers.

The study described in the *Methods* section was motivated by our corpus study discussed earlier that suggested earlier ability to answer wh-questions as compared with polar-questions. As expected from our corpus study, polars were significantly harder for the children to answer compared to wh-questions. We found the answerability of question types to be in the following order for both languages: location > identity > sound – post hoc pairwise comparisons revealed significant

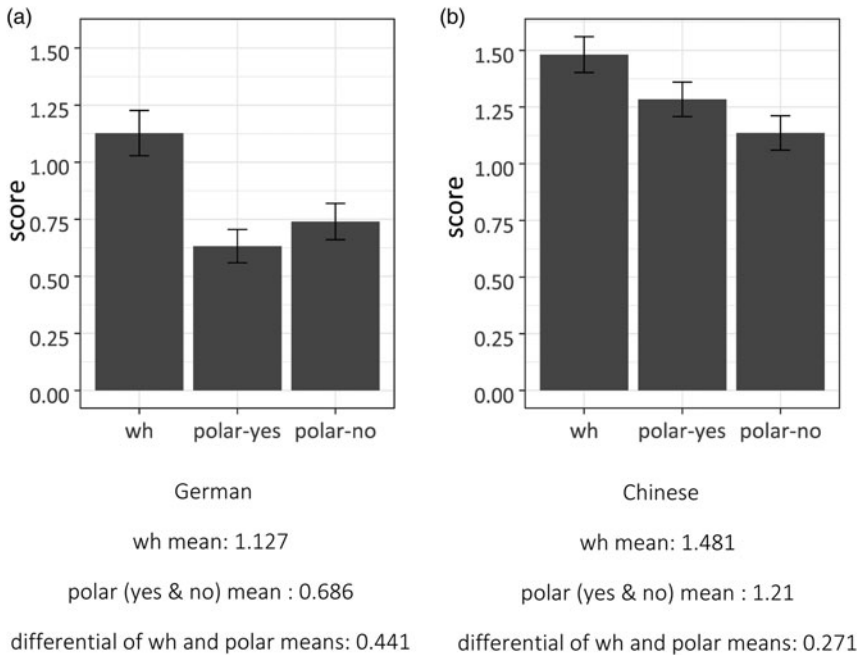


Figure 2. Average scores for wh vs polar-yes and polar-no

differences between questions types in both cohorts at at least $p < .005$ except for sound versus identity in Chinese with $p = 0.057$, also see Figure 4.

We postulate that the complexity of the answer is the driving force for the observed disparity in answerability of wh-questions and polars in two ways. Pointing to an object, for instance, is both easier for a young child to perform (Children are faster at responding with gestures than answering verbally (Clark & Lindsey, 2015)), and more PERCEPTUALLY GROUNDED than labeling it verbally. Pointing to a location in response to a *where* question adequately answers it; even a location/existence yes polar (e.g., *Is there a banana there?*) is indirectly answered by pointing to the object in question. Answers to location questions are in this sense easy to produce (see Figure 4)¹³.

The second component of answer complexity, concreteness and perceptual grounding of the answer, is important in terms of learning interrogative meanings from question-answer interactions. This is different from the notion of answer complexity ('answer types') described by Casillas *et al.* (2016), where complexity, and subsequently the timing of an answer, arises from the effort needed for planning a particular answer by

¹³An anonymous reviewer for the *Journal of Child Language* points out that gestural responses exist for polars as well: namely, nodding and head-shaking. The difference, however, is that such responses are conventionalized and not perceptually grounded – cf. cultures such as Bulgaria where affirmation and negation are expressed by head shaking and nodding respectively (Andrén, 2014). Indeed, as Andrén points out, the earliest head shakes are associated with refusals – so not purely information oriented, but by and large occur SIMULTANEOUSLY with speech.

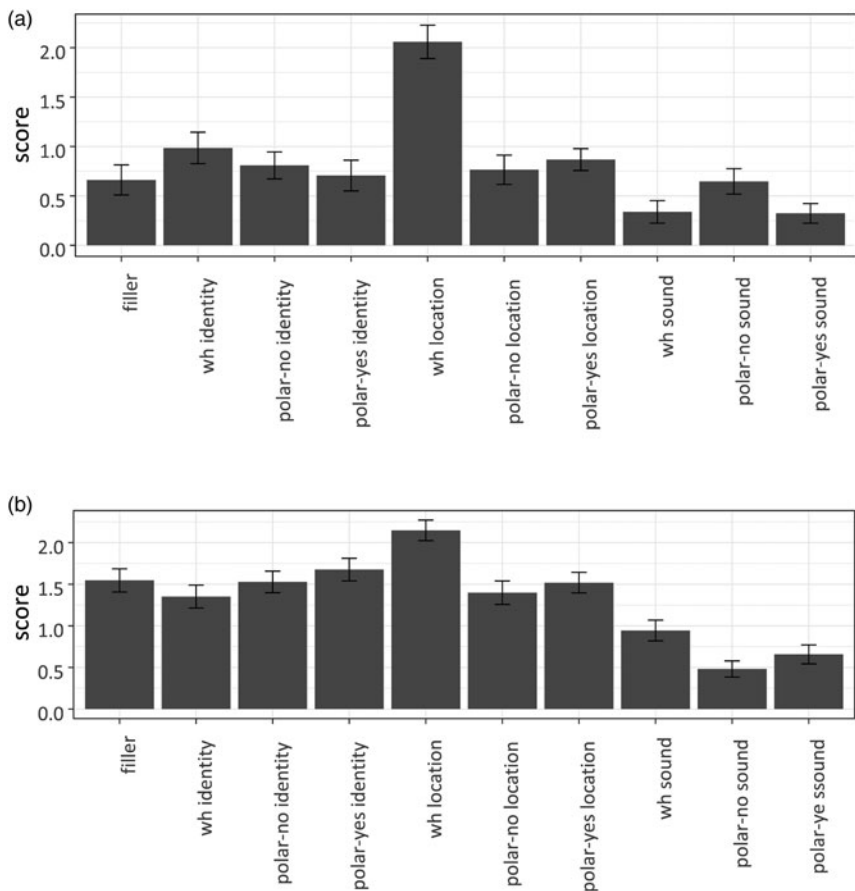


Figure 3. Average scores for experimental conditions

children. This explains in part, we think, why our results are different from the ones reported by Casillas *et al.* (2016), which we discussed in the *Background* section. In addition, there are other factors distinguishing the studies: (a) Age: Casillas *et al.* started sampling at around 1;8, our oldest samples are of age 1;6 in our corpus study. (b) Sampling: Casillas *et al.* sampled only from successful question–answer interactions. (c) Repetition as affirmation: Casillas *et al.* accepted verbatim repetitions of words from a polar-interrogative as affirmative answers, whereas we do not. (d) Non-informational polar-questions: polars in the corpus compiled by Casillas *et al.* are mostly offers, invitations, clarifications, and requests. This is not the case for our experiments. (e) Phonological effect: Casillas *et al.* found a main effect of fricative-initial answers; these happen more often in answers to wh-questions which might explain the longer latencies for answers to wh- compared to polar-questions.

An interactive learning view in line with Moradlou and Ginzburg (2014) – in which interrogative meanings are learned from situated question and answer pairs, both offered by caregiver themselves – would explain the seemingly earlier arrival of short answers to wh-questions compared to verbal yes and no responses. Could this

Table 5. Best fitting models

(a) German	Estimate	Std. Error	t value	Pr(> t)
(Intercept)	2.06	0.14	14.97	0.000
'yes' polar	-1.19	0.19	-6.13	0.000
'no' polar	-1.29	0.19	-6.66	0.000
q_type identity	-1.07	0.19	-5.52	0.000
q_type sound	-1.72	0.19	-8.85	0.000
'yes' polar : q_type identity	0.91	0.27	3.32	0.001
'no' polar : q_type identity	1.12	0.27	4.06	0.000
'yes' polar : q_type sound	1.18	0.27	4.28	0.000
'no' polar : q_type sound	1.60	0.27	5.83	0.000

score ~ +/-wh (whq, yes polar, no polar) * question type (location, identity, sound).
Reference levels are +/-wh = whq and question type = location

(b) Chinese	Estimate	Std. Error	t value	Pr(> t)
(Intercept)	2.15	0.13	17.07	0.000
'yes' polar	-0.63	0.18	-3.54	0.000
'no' polar	-0.75	0.18	-4.21	0.000
q_type identity	-0.80	0.18	-4.47	0.000
q_type sound	-1.20	0.18	-6.76	0.000
'yes' polar : q_type identity	0.95	0.25	3.79	0.000
'no' polar : q_type identity	0.93	0.25	3.68	0.000
'yes' polar : q_type sound	0.34	0.25	1.36	0.174
'no' polar : q_type sound	0.29	0.25	1.14	0.254

score ~ +/-wh (whq, yes polar, no polar) * question type (location, identity, sound).
Reference levels are +/-wh = whq and question type = location

difference be (more simply?) explained in terms of routinization?¹⁴ The idea would be that wh-questions occur typically as part of, for instance, book reading or feeding routines, whereas polar-questions do not (or far less so). We cannot rule out such an explanation, which would require a careful and extensive coding of all question occurrences in such terms and a rigorous definition of 'routine'; moreover, in any case, such an explanation is not inconsistent with an emphasis on the role of interactive learning. There are two considerations, nonetheless, that suggest that

¹⁴We thank an anonymous reviewer for the *Journal of Child Language* for raising this possibility.

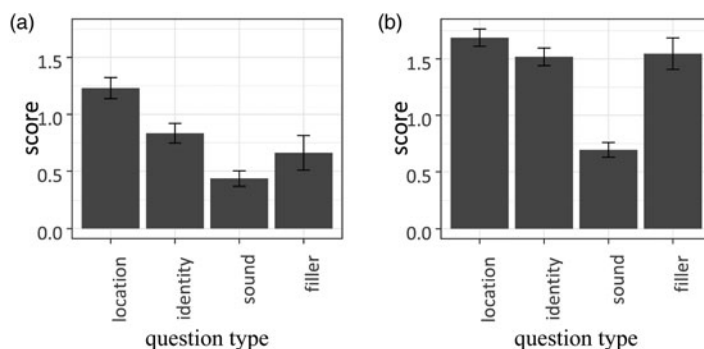


Figure 4. Average scores for question types

routinization does not provide a full account. First, one finds in the data no dearth of wh-questions posed and answered by the carer in what seem to be “non-routine” situations, whereas conversely one finds polar-questions in routine situations such as book reading and feeding:

- (7) a. (Free play) *MOT: where’s the spoon Daddy? *FAT: where I don’t know where is the spoon *FAT: where’s the spoon? *MOT: is the spoon in the basement *MOT: where’s the spoon? *FAT: there it is. *FAT: there’s the spoon. (Naima, 1;02.07)
- b. (Free play) *MOT: and what else is in here *MOT: what’re [: what are] you doing? *MOT: woah. *MOT: are you building a tower with that Cuisinart (Naima 1;01.11)
- c. (looking through a picture album) *MOT: is that a picture of xxx? *MOT: xxx? *CHI: yyy. *MOT: xxx. *MOT: yes that is xxx. (Naima 1;0.14)
- d. (While eating) *MOT: d’you [: do you] want a little bit more yogurt *MOT:no (Naima 1;0.14)

A second consideration is that, in our elicitation experiments, the questions where the scores were lowest were onomatopoeia (“animal sound”) questions. These are perhaps the clearest example of questions used in a routine, when parent and child interaction are looking at pictures of animals. Moreover, animal sounds are more forgiving and open to interpretation than labels for objects, for example. Finding an explanation for the relative difficulty such questions pose and, more generally, for the differentials across question types, to the extent the scores we obtained scale up, is an interesting question for future research.

It is important to note that even the best fitting model explains the variation in answerability only partially (Adjusted R-squared: 0.14, and 0.12). Since we only had permission to record audio and take notes during the experiment, we were unable to precisely account for other factors such as attention, on a second by second basis. This is somewhat remedied by the fact that for each condition, we have four data points from each child.

Conclusions and further work

In this paper, we offer evidence about the order of emergence of UNDERSTANDING in questions. Following the theoretical literature on questions, we assume that understanding a question is correlated with the ability to PROVIDE AN ANSWER to a question (posed by an adult). At a minimum, the evidence we provide can simply be viewed as relating to the emergence of the ability to answer questions appropriately.

We have tested the hypothesis that arises from work by Moradlou and Ginzburg (2014) on the English speaking Providence corpus from CHILDES (Demuth *et al.*, 2006): namely, that on the whole (a class of) wh-questions emerges earlier as answerable than polar-questions. This hypothesis is supported on the basis of elicitation studies on German and Chinese speaking children. *A priori*, Chinese provides some additional bias in favour of polar-questions, as non-sentential positive and negative answers involve repetition of words from the polar-interrogative ('...V not-V ...'), not special purpose particles like *yes/ja/no/nein*. However, as we have seen, our results do not show a clear difference on this score between German and Chinese.

From a theoretical point of view, the earlier emergence of wh-question answerability suggests that neither the syntactic nor the semantic complexity of INTERROGATIVES/QUESTIONS are explanatory factors, as on most semantic theories of questions, polar-questions are in a fairly clear way less complex entities than wh-questions; nor is there any clear additional complexity for the former in terms of their syntactic structure. Similarly, as far as the input goes, polar-questions are at least as frequent and often more frequent than wh-questions. Moreover, even though there is evidence that wh-questions are answered at a somewhat higher rate than polar-questions by the child's carers, in terms of raw question-answer pairs encountered, polar-questions seem to be no less frequent (though our data on this score is not conclusive). Relatedly, it is not straightforward to REDUCE these results to a "routine"/"non-routine" dichotomy, to the extent that such a distinction can be drawn in a principled way: there seem to be no dearth of wh-questions being posed and answered by carers in spontaneous interaction and, conversely, there are polars in "routinized" interaction. Moreover, the worst scores obtained in our elicitation experiments occur for the most prototypically routinized: namely, onomatopoeia ("animal sound") questions.

What does seem to be a factor is the EASE IN UNDERSTANDING an answer to a given type of question. This ties in with an earlier proposal by Moradlou and Ginzburg (2014) that question answerability emerges via a sequence of gradually more complex interactions between carer and child. On this view certain wh-questions emerge earlier because the answer that can be provided to such questions in "training sessions" between carer and child is easier to ground perceptually than the abstract entities expressed by propositional answers required for polar-questions.

We should clarify two points here with respect to these results. First, clearly they do not imply that the entire class of wh-questions emerges before polar-questions; to take one example, *why*- and *how*- questions that intrinsically involve sentential ANSWERS.¹⁵

¹⁵In fact, *why*, *when*, and *how* questions are very infrequent in early child directed speech in our data – in the first 9 files of Naima of the Providence corpus, containing 1771 questions of any type, we found only 13 such questions that were addressed to Naima: 4 *how*, 4 *why*, 3 *how many*, 2 *how come* questions (to suggest an action to the child, e.g. *How come you are not riding your bike?*). This presumably reflects the parents' judgement that such questions have little chance of being understood at this stage.

This is consistent with our explanation concerning the importance of understanding the answer. Second, the generalisation does not concern decontextualized classes of constructions: we have pointed out that polars used as requests get answered at an early stage, comparable to the first wh-questions. And more generally, there is some variability in the answerability of the various subclasses of wh-questions and polar-questions investigated here. Thus, what we have shown is that a class of wh-question meanings gets better established in interaction before information oriented polar-questions; this does not imply any general claims about structure as such.

Naturally enough, the conclusions we draw here are tentative and in need of further experimental replication in languages other than German and Chinese and for those languages as well with larger samples. They also suggest the need for a computational account of the interactive learning model sketched by Moradlou and Ginzburg (2014), one which can also test rigorously the role of routinization in the learning process.

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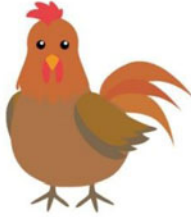
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Appendix Picture book used in the experiments

page 1: (polar-yes identity, wh sound)



Is this a hen?
Ist das ein Hahn? 这是不是鸡

What does the hen say?
Wie macht der Hahn? 鸡怎么叫



Is this a duck?
Ist das eine Ente? 这是不是鸭子

What does the duck say?
Wie macht die Ente? 鸭子怎么叫

page 2: (polar-yes identity, wh sound)



Is this a sheep?
Ist das ein Schaf? 这是不是羊

What does the sheep say?
Wie macht das Schaf? 羊怎么叫



Is this a pig?
Ist das ein Schwein? 这是不是猪

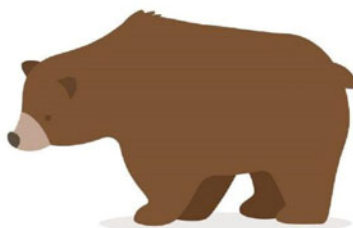
What does the pig say?
Wie macht das Schwein? 猪怎么叫

page 3: (wh location, polar-no sound)



Where is the owl?
Wo ist die Eule? 猫头鹰在哪里

Does the owl go moo?
Macht die Eule Muh? 猫头鹰的叫声是不是
(imitate cow sound)



Where is the bear?
Wo ist der Bär? 猫头鹰在哪里

Does the bear go moo?
Macht der Bär muh? 猫头鹰的叫声是不是
(imitate cow sound)

page 4: (polar-no identity, filler)



Is that a ball?
Ist das ein Ball? 这是不是球?

Do you have a Teddybear at home? (filler)
Hast du einen Teddybär zu Hause?
你家里有球吗?



Is that a shoe?
Ist das ein Schuh? 这是不是鞋?

Do you like reading? (filler)
Liest du gerne? 你喜欢看书吗?

page 5: (wh identity, polar-yes sound)



What is this?
Was ist das? 这是什么?

Does the bird say tweet tweet?
Macht der Vogel piep piep? 鸟的叫声是不是
(imitate bird sounds)



What is this?
Was ist das? 这是什么?

Does the bee say buzz buzz?
Macht die Biene summ summ? 蜜蜂的叫声是不是
(imitate bee sounds)

page 6: (wh location, polar-no sound)



Where is the cow?
Wo ist die Kuh? 牛在哪里?

Does the cow go hoo hoo?
Macht die Kuh uhu? 牛的叫声是不是
(imitate owl sounds)



Where is the horse?
Wo ist das Pferd? 马在哪里?

Does the horse go hoo hoo?
Macht das Pferd uhu? 马的叫声是不是
(imitate owl sounds)

page 7: (polar-no location , polar-yes location)



Is there a tree there (on the page)?
Ist da ein Baum? 这里有没有树?

Is there a banana?
Ist da eine Banane? 这里有没有香蕉?

Is there a flower?
Ist da eine Blume? 这里有没有花?

Is there an apple?
Ist da ein Apfel? 这里有没有苹果?

page 7: (polar-no location , polar-yes location)



Is this a teddy-bear?
Ist das ein Teddybär? 这是不是泰迪熊?

Is this a book?
Ist das ein Buch? 这是不是书?

Do you have a ball at home?
Hast du einen Ball zu Hause?

Where are your shoes?
Wo sind deine Schuhe? 你的鞋在哪里?

你家里有没有泰迪熊?

page 9: (wh identity, polar-yes sound)



What is this?
Was ist das? 这是什么?

Does the cat say meow?
Macht die Katze miau? 猫叫声是不是
(imitate cat sound)



What is this?
Was ist das? 这是什么?

Does the dog say woof woof?
Macht der Hund wuff wuff? 狗叫声是不是
(imitate dog sound)

page 10: (polar-no location, polar-yes location)



Is there a banana?
Ist da eine Banane? 这里有没有香蕉?

Is there an apple?
Ist da ein Apfel? 这里有没有苹果?



Is there a flower?
Ist da eine Blume? 这里有没有花?

Is there a tree?
Ist da ein Baum?
这里有没有树?

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