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Children's Sensitivity to Prosody and Ostension in Answers to Wh-Questions

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1. Introduction

This paper examines the effects of two often overlooked factors in children's answers to wh-questions: the prosodic contour of the question and the complexity of the visual stimuli. There are two potential effects on the interpretation of a question in English: whether it is moved, and what kind of prosody it has. In English, the usual form of a wh-question has a wh-question moved to the front (1), in Spec CP. In such a case, the nuclear contour is usually falling:

(1) What did the woman buy?

In the case where the wh-question is stressed, the question has a rising nuclear contour:

(2) *What* did the woman buy?

In a third variety, the wh-word remains in situ, is stressed, and there is a rising nuclear contour:

(3) The woman bought *what?*

A 2010 corpus study of American English by Hedberg et al. examined prosody in adults' production of moved wh-questions and its relation to each question's pragmatic function in the discourse. They found that wh-questions have a falling nuclear contour 81% of the time, and a rising nuclear contour 18% of the time (Hedberg et al., 2010). Their results showed that falling questions are typically used to get more information about a topic, to introduce a subtopic, or to influence the discussion of the current topic. Rising questions, on the other hand, behave much more like wh-in-situ echo questions, and are used to ask for background information or to clarify information that was not heard. Are children

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sensitive to the echo reading that prosody can give to moved wh-questions? To our knowledge, there have been no prior studies which have examined when children are able to distinguish between and respond appropriately to rising and falling moved wh-questions. The ability to use prosodic information in interpretation of questions is also essential for children learning wh-in-situ languages, where typical wh-questions and echo questions often have the same surface structure.

There have been a number of studies which examine children's ability to successfully interpret prosodic information, though their findings are mixed. While some evidence has suggested that even infants are able to distinguish between sentences and questions based on prosody alone, (Frota et al., 2014), it is not clear whether this applies broadly to infants learning languages with wh-movement (Soderstrom et al., 2011) or if simply the ability to distinguish between sentence types is enough for children to fully grasp the distinction (Saindon et al., 2016). Saindon et. al. (2016) found that children ages 5-8 could successfully use prosodic cues to distinguish declarative questions ("Bob is funny?") from declarative sentences ("Bob is funny."), though 5- through 6-year-olds performed more poorly than older children and adults. A number of more recent studies have shown evidence that by ages 4-5 children can use prosody to interpret otherwise ambiguous sentences (de Carvalho, Dautriche & Christophe, 2016; de Carvalho, Lidz, et al., 2016). However, successful interpretation of prosodic information can still be quite difficult when faced with a lexical bias, as shown by Vogel & Raimy (2002). Vogel & Raimy found that children could not consistently use prosody to interpret otherwise ambiguous compound phrases until age 12. Overall, there is still much uncertainty about when children are able to successfully interpret utterances where prosody is the key to dispelling ambiguity.

While she did not account for prosody in her design, evidence from a study by Takahashi (1990) suggests that English speaking children do distinguish between typical echo questions (wh-in-situ) and typical wh-questions (moved wh-). An appropriate answer to an echo question such as (3) might repeat part of a previous utterance, for example in this discourse:

(4) A: "I think the woman bought fruit."
B: "The woman bought *what*?"
A: "Fruit."

However, an appropriate answer to a non-echo wh-question such as (1) provides new information,

(5) A: "I think the woman bought fruit."
B: "What did she buy?"
A: "Apples, maybe bananas, a watermelon."

Echo questions should elicit a different type of answer than non-echo, moved, wh-questions. Takahashi (1990) described the children's responses as "supercategory" and "subcategory" answers. In the stimuli they used, the phrases which the echo questions prompted repetition of were all broader categories, such as "animals "or "fruit," while the moved wh-questions required a list of specific items in the picture, such as "giraffes, horses and elephants," that is, an exhaustive list that had not been named in the previous discourse but was evident in the pictured story. Of the thirteen children tested (four 3-year-olds and nine 4-year-olds), four gave exactly the expected answers and two responded almost completely in line with the predictions. A further five children gave only repetition answers to echo questions, while their responses to non-echo questions were more mixed; and two gave only specific answers to both types of question. Most children seemed to have acquired the distinction between echo and non-echo wh-questions by age four, but it is unclear which aspect was important: was it prosody or movement?

1.1. Exhaustivity

Even if children distinguish between typical wh-questions and echo questions by responding with specific or repetition answers respectively, they may not behave quite like adults. When answering typical moved wh-questions, children tend to give less exhaustive answers than adults do (Roeper et al., 2007). In a question like "Where is a bathroom around here?", a partially exhaustive, or *mention-some*, answer like "There's one down the hall." is perfectly acceptable. However, in a question like "Who is wearing a hat?" a complete answer would be an exhaustive list of everyone who is wearing a hat (John, Mary, Jill, Ben, …), and both a singleton answer, such as "John," and a plural answer, such as "John and Mary," would be unacceptable. Children however, seem to give singleton answers until about age 6. Roeper et al. (2007) also found that children go directly from giving singleton answers to completely exhaustive answers, without an in-between stage of giving plural answers.

For moved wh-questions in English, the wh-word typically occupies a position on the left periphery of the sentence, as the specifier of a complementizer phrase (spec-CP) (Roeper & de Villiers, 2011). However, there are many languages where wh-words are optionally (French) or obligatorily (Mandarin, Japanese) left in situ for non-echo wh-questions. For wh-in-situ languages, an early suggestion was that the movement occurred only at Logical Form (LF), a covert level of representation that influences semantic interpretation (Huang, 1992). However, more recent studies have suggested that for languages with wh-movement, wh-questions have two copies of a wh-item, which are what give moved wh-questions their interrogative meaning (de Villiers et al., 2018; Reis, 2012). These wh-items are not inherently pronounced: one wh-item occupies a scope position, the other a thematic position. Under this view, English and Mandarin would have the same structure, the difference is simply which wh-item

is pronounced. In English, this would be the item in the scope position, where the wh-word is pronounced in spec-CP, while the thematic position is not pronounced. For Mandarin, and other wh-in-situ languages, the wh-item in spec-CP is silent, while the one in the thematic position is pronounced. This is reinforced by the findings of de Villiers et al. (2018), which showed no evidence that having obligatory wh-in-situ as opposed to obligatory wh-movement influenced the acquisition path of exhaustivity of multiple wh-questions in Mandarin speaking children.

There is still much speculation about children's early representation of wh-questions. Roeper and de Villiers (2011) offered the potential explanation that children don't have a full spec-Head representation. Instead, only C is available. This could explain why children make mistakes like "*What he can juggle?" With only one position on the left periphery, only the wh-word or the auxiliary verb can be moved, not both.

Roeper et al. (2007) offer a semantic account for children's acquisition of exhaustivity, based particularly on their understanding of *specificity*. A noun phrase that is specific is one which relates to pre-established elements in the discourse. The authors suggest that children initially assume all wh-questions are specific, and therefore don't require an exhaustive answer. Under this account, children essentially interpret "Who has a hat?" as "Which one has a hat?" This is different from the adult mention-some reading, because adults give non-exhaustive answers in certain pragmatic contexts, while children do it universally. However, other researchers have proposed a pragmatic account, (Rooij 2004; Zimmermann 2007), which holds *relevance* to be the key factor in determining the degree of exhaustivity required in one's answer to a wh-question. If exhaustivity is determined by pragmatic factors rather than semantic factors, then *ostension* might also be a factor of interest for children's answers to wh-questions: that is, what are the properties of the reference field?

1.2. Ostension

The second focus of the current study concerns the role that the visual stimuli play in the degree of exhaustivity in children's answers to wh-questions. What role does ostension play? Kiss & Zétényi (2017) argued that experimental stimuli that contain only iconic symbols or drawings against a blank background are likely to lead the child to assume that all of the visual information included in the limited sketch must be *relevant* to what the experimenter is trying to communicate. Children's assumption of relevance affects their interpretation and response to the corresponding linguistic content. The authors also point out that children are more sensitive to ostensive signals than adults, as shown by the work of Csibra and Gergely (2009; 2011), giving us more reason to expect that ostension might affect their linguistic behavior.

Kiss & Zétényi (2017) were primarily concerned with demonstrating the effect of ostension on the phenomenon of "quantifier spreading." Young children consider the description "Every girl is riding a bicycle" to be false when paired with an image of three girls riding bicycles and one rider-less bicycle, as if they interpret the sentence to mean that every bicycle has a rider. Quantifier spreading has been found in many studies and in many different languages (Roeper et al., 2011; Philip, 2011; Freeman & Stedmon, 1986; Sekerina & Sauermann, 2015; O'Grady et al., 2010; Kang, 1999; etc.). However, the strength of the effect varies from study to study. The results of Kiss and Zétényi (2017) showed a reduced effect of quantifier spreading when the images the children saw were actual photographs, in comparison to the more typical cartoon-style sketches. They claim that the usual simplified images have an increased ostensive effect, in that the child considers everything in the image to be relevant. Therefore, they take the riderless bike to be relevant to the truth of the sentence. In contrast, in the photographs, there are additional accidental details, so the child is less likely to assume that every item in the image is relevant. Indeed, they found that photographs reduced the effect of quantifier spreading by about 50% (Kiss and Zétényi, 2017). Following the authors' reasoning, it is possible that the kind of visual stimuli could also affect the level of exhaustivity in children's answers to wh-questions. They did find an effect of the type of stimuli on the exhaustivity of preverbal focus in Hungarian sentences, but this has not yet been tested with responses to wh-questions.

1.3. Predictions

Based on the results found in Takahashi (1990), we expect that by age 4 children will be able to differentiate between in situ and moved wh-questions and respond appropriately to both types.

> Hypothesis 1: If children are able to distinguish in situ echo questions and moved wh-questions, we would expect them to give different answers to the two types of questions, where in situ questions would elicit repetition answers and moved wh-questions would elicit specific answers.

However, Takahashi did not take prosody into account in the design.

> Hypothesis 2: If children are sensitive to prosody in their interpretation of moved wh-questions, we expect them to give different answers for moved wh-questions with a rising intonation than for moved wh-questions with a falling intonation, with the former prompting repetition answers and the latter, specific.

Even if children give syntactically appropriate answers to the different types of wh-questions, their answer still may not match the answers that adults would give.

Roeper et al. (2007) found that children give singleton answers universally rather than in specific pragmatically acceptable contexts, until around age 6.

> Hypothesis 4: If exhaustivity is not triggered by pragmatic factors, we expect children will not give completely exhaustive answers until age 6.

If children's singleton answers are primarily due to semantic reasoning, as suggested by Roeper et al. (2007), as opposed to pragmatic reasoning, they also should not be as swayed by the visual stimuli. However, if exhaustivity is more a result of pragmatic factors, then we expect the type of visual stimuli to affect children's answers.

> Hypothesis 4: If the ostensive effect of the visual stimuli does influence children's responses to wh-questions, we expect that questions accompanied by photographs will elicit fewer completely exhaustive answers than questions accompanied by cartoon-style drawings.

2. Methods

The participating children were 21 three-year-olds (mean age: 3;5, SD (in months): 3.72, 8 female, 13 male), 16 four-year-olds (mean age: 4;6, SD: 3.00, 8 female, 8 male), 10 five-year-olds (mean age: 5;7, SD: 3.01, 5 female, 5 male), and 10 six-year-olds (mean age: 6;5, SD: 2.36, 5 female, 5 male) from four local daycare centers, a kindergarten, and a drop-in play group. Parents gave written consent, and all children gave verbal assent before participating. The adult participants were 21 undergraduates (all female). Adult participants received extra credit points in their college courses as compensation.

The stimuli consisted of two stories, each with eight accompanying videos and laminated pictures. The first story used photograph-style images (Figure 1), and the second used cartoon-style images (Figure 2). The videos showed a puppet, who would ask in situ and moved wh-questions about the story. The videos were played on an iPad, which was propped up on a stand. Pre-recorded videos were chosen over an actual puppet in order to keep the prosody of the questions consistent. In each story, half of the questions were in situ echo questions, and half were moved wh-questions. We chose not to randomize the order of the question types, since there were only eight items and two question types per story. Instead, we used a semi-random order, where questions of the same type never occurred more than twice in a row. The questions were presented in the same order for all participants.

Participants were separated into two groups, both of which received moved and in situ wh-questions, but the prosody of the moved wh-questions differed. Group A heard the moved wh-questions with more stress on the noun (What did the zookeeper give the BEARS?) and a falling intonation,

while Group B heard greater stress on the wh-word (WHAT did the zookeeper give the bears?) and a rising intonation. The prosody of the wh-in-situ questions was a rising intonation for both groups. Two sessions were run with each child. In the first session, the pictures were photograph-style (See Figure 1). In the second session the child heard a different story with the same types of questions and the same prosody as before, but this time accompanied by cartoon-style drawings instead.

Participants were told that, if they agreed, they would listen to a story, and a puppet, who was video chatting with us, would ask questions about the story. The experimenter explained that the puppet, Fuzzy, could not see the pictures, and could not hear the story very well, so he would ask some questions about it. The purpose of this explanation was to give a plausible reason for Fuzzy to ask both typical wh-questions and echo questions. Since Fuzzy couldn't see the pictures, he might ask questions that prompt the child to look at the pictures to answer (typical wh-questions), and since he couldn't hear well, he might ask questions that prompt the child to repeat part of what the experimenter said (echo questions). The experimenter first played a short video, where Fuzzy said hello and introduced himself. Then, the experimental trials began. Each trial consisted of the experimenter reading a segment of the story and showing a matching picture, then playing a video, wherein the puppet asked either an in situ echo question or a moved wh-question about what they heard. The accompanying picture showed the potential answer to the puppet's question. The child's responses were recorded and categorized as either completely exhaustive, partially exhaustive, or repetition answers.

(6) Experimenter's introduction:

> "So, the way my game works is that I have a little story that I'll read you, and I have some pictures that go with the story. My friend Fuzzy is here on Facetime, and he can't see the pictures, and he can't hear the story quite as well, so he's going to ask some questions about it. Your job is just to see if you can answer Fuzzy's questions and help him understand the story. Sound good?"

(7) Experimenter: "Over the weekend, Sam and his family went to visit a farm. While they were there, they saw lots of animals."

Puppet: “What did they SEE?” / “WHAT did they see?”

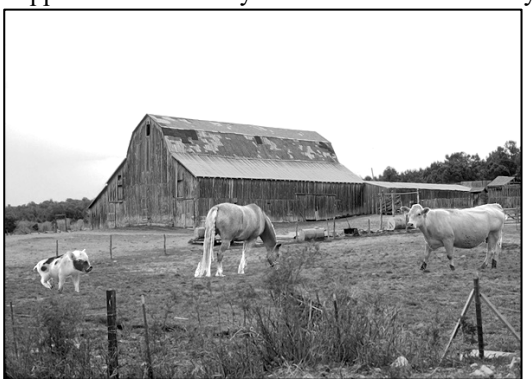

Figure 1: Photographic image.

(8) Experimenter: “She watched the zookeeper give the bears their lunch.”
Puppet: “He gave them what?”

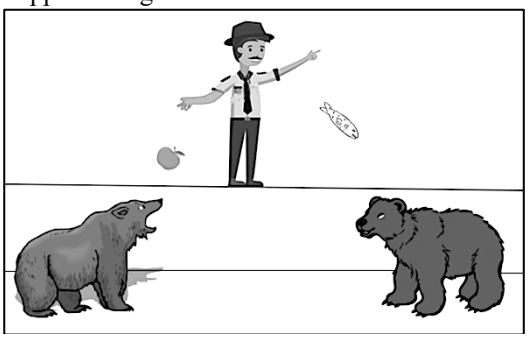

Figure 2: Schematic image.

3. Results

3.1. Answer type (Specific vs. Repetition)

The children’s responses were first coded as either specific answers (“carrots,” “carrots and tomatoes,” “carrots, tomatoes, and green beans”) or repetition answers (“vegetables”). Specific answers included singleton, plural, and completely exhaustive answers, as long as they referred to the subcategory. In cases where participants gave both a specific answer and a repetition answer (“Vegetables—some carrots.”) the data were coded as specific. Any other answers that did not fall into one of these categories (“He helped in the garden.”) were treated as missing data.

Participants were divided into two age groups: younger (3- and 4-year-olds) and older (5- and 6-year-olds). A repeated measures ANOVA was performed to analyze the effects of the independent variables of movement (fronted versus in situ wh-), ostension (schematic versus complex images),

prosody group (rising versus falling nuclear contour of moved wh-questions), and age group (3- and 4-year-olds versus 5- and 6-year-olds) on the proportion of specific answers children gave.

We found significant effects of movement, F(1, 46) = 22.28, p < .001, ηp2 = .326, and prosody, F(1, 46) = 65.7, p < .001, ηp2 = .588, as well as a significant interaction effect of movement and prosody, F(1, 46) = 15.3, p < .001, ηp2 = .249. The effect of movement confirms that children gave a higher proportion of specific answers after moved wh-questions than in situ echo questions. Children who received falling intonation moved wh-questions also gave specific answers more frequently than those who received rising intonation wh-questions. The interaction effect suggests that the difference between children's answers to moved wh-questions and in situ echo questions was greater in the group that received moved wh-questions with falling intonation than in the group that received moved wh-questions with rising intonation. As expected, the highest proportion of specific answers was found after moved wh-questions with a falling intonation.

Ostension alone did not have a significant effect, though it showed a trend, $F(1, 46) = 2.98$, $p = .091$, $\eta_p^2 = .061$. However, there was a significant interaction effect of prosody and ostension, $F(1, 46) = 5.56$, $p = .023$, $\eta_p^2 = .108$. This shows that the difference between children's answers when presented with complex images as opposed to schematic images was greater in the group that received moved wh-questions with falling intonation. Overall, children who received moved wh-questions with falling intonation gave a higher proportion of specific answers when the questions were accompanied by schematic images as opposed to complex images.

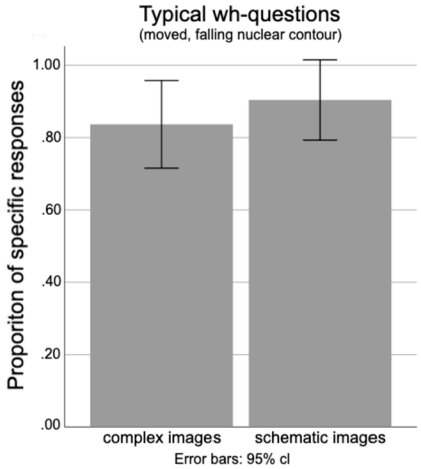

Figure 3: Proportion of specific responses to moved wh-questions with a falling intonation by image type.

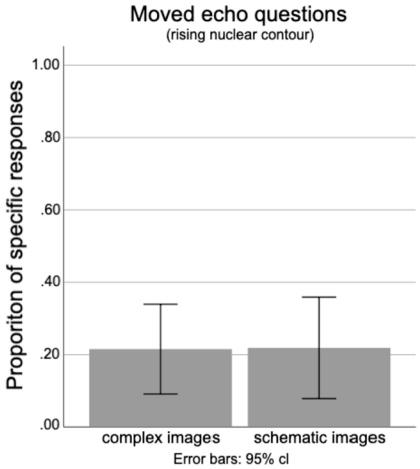

Figure 4: Proportion of specific responses to moved wh-questions with a rising intonation by image type.

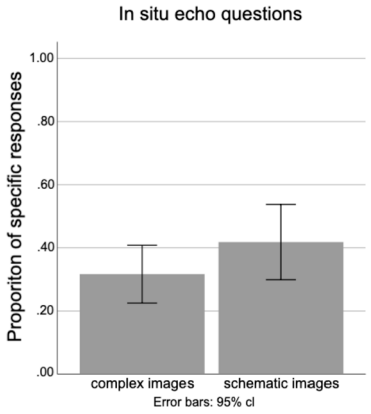

Figure 5: Proportion of specific responses to in situ wh-question by image type (both prosody groups).

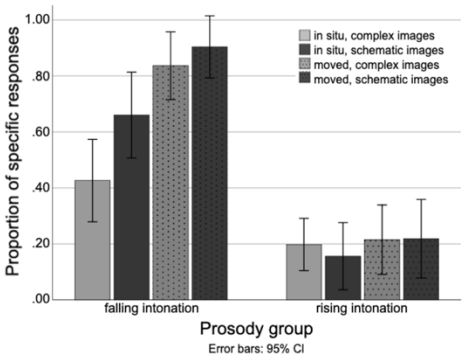

Figure 6: Proportion of specific responses by question type, image type, and prosody group.

3.2. Degree of Exhaustivity

For the next analysis, we were only interested in the degree of exhaustivity in children's answers that were specific. This time, the data were coded as either partially exhaustive ("carrots," "carrots and tomatoes") or completely exhaustive ("carrots, tomatoes, and green beans"). Partially exhaustive answers included singleton and plural answers. Responses that included a repetition answer and a specific answer were coded according to the degree of exhaustivity in the specific part of their answer. For example, "Vegetables—some carrots," would have been counted as partially exhaustive. Repetition answers and miscellaneous unexpected answers were treated as missing data. Since children in the group with rising intonation moved wh-questions gave very few specific answers, we only analyzed the data of the group with falling intonation moved wh-questions. Children were again divided into two age groups. A repeated measures ANOVA was performed with independent variables movement, ostension, and age group, the dependent variable being the proportion of completely exhaustive answers.

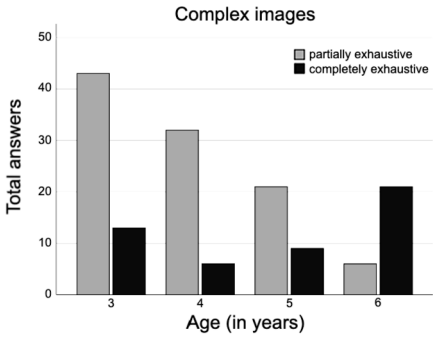

Figure 7: Total number of completely and partially exhaustive responses to questions paired with complex images by age (in years).

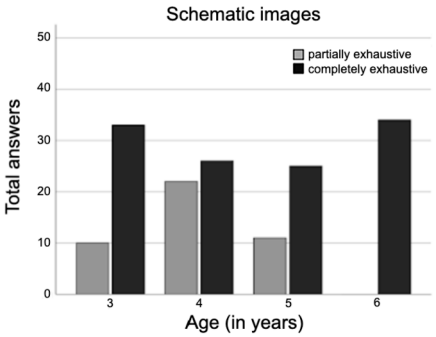

Figure 8: Total number of completely and partially exhaustive responses to questions paired with schematic images by age (in years).

There was a significant effect of ostension, $F(1, 15) = 20.1$, $p < .001$, $\eta_p^2 = .572$, suggesting that the complexity of the visual stimuli influenced the degree of exhaustivity in children's answers. Children in the group with falling intonation moved wh-questions gave a higher proportion of completely exhaustive answers when the questions were accompanied by schematic images rather than complex images. There was a nearly significant effect of age group, $F(1, 15) = 3.33$, $p = .088$, $\eta_p^2 = .182$.

In order to more closely examine the effect of age, and to see whether collapsing the age groups was hiding a developmental trend in the data, the same analysis was performed with the children divided by age in years rather than the broader age groupings. We again found a significant effect of ostension, $F(1, 13) = 23.5$, $p < .001$, $\eta_p^2 = .643$, and this time, age did have a significant effect, $F(3, 13) = 5.43$, $p = .012$, $\eta_p^2 = .556$. Post Hoc tests revealed the greatest difference in the proportion of completely exhaustive answers was between 4-year-olds and 6-year-olds, $M = .675$, $SD = .170$, $p = .007$.

4. Discussion

We found that children gave a higher proportion of specific answers after moved wh-questions than after in situ echo questions, suggesting that they are able to distinguish between in situ echo questions and moved wh-questions. This is in line with the findings of Takahashi (1990).

Past studies showed mixed evidence as to whether or not children are sensitive to prosody in their interpretation of potentially ambiguous utterances. We found that children are sensitive to prosody in their interpretation of moved wh-questions. The interaction effect of movement and prosody indicates that the difference between children's answers to moved and echo wh-questions was greater for the group which received falling intonation moved wh-questions than for the group which received rising intonation moved wh-questions. These

findings are in accordance with those of Saindon et al. (2016), de Carvalho, Dautriche & Christophe, (2016) and de Carvalho, Lidz, et al. (2016).

Age had a significant effect on the degree of exhaustivity in children's answers to echo questions and wh-questions with a falling intonation. Like in Roeper et al. (2007), we found that children don't consistently give completely exhaustive answers to wh-questions until around age 6. This could be explained by the proposal made by Roeper et al. (2007), that children interpret typical wh-questions as specific.

There was an interaction effect of movement and prosody, as well as complete lack of significant effects of ostension for the group that received rising intonation moved wh-questions. This means that the ostensive effect of the stimuli did not cause children to give *inappropriately* specific answers to moved wh-questions when the semantics and prosody required a repetition answer. However, ostension, as well as movement, were both significant for the group that received moved wh-questions with a falling intonation. The effect of movement is expected, since the moved wh-questions with a falling intonation should elicit different answers than the in situ echo questions. The effect of ostension is a bit more difficult to explain. We did not expect ostension to influence whether children gave specific answers as opposed to repetition answers. Instead, we expected ostension to influence the proportion of completely and partially exhaustive answers.

It is likely that a carry-over effect of the prosody caused children who received moved wh-questions with a falling intonation to give a higher proportion of specific answers after in situ echo questions than children in the other group. In falling intonation moved wh-questions, the wh-word moves to spec-CP, while in rising intonation moved wh-questions, the wh-word can be thought to move to FocP (Artstein, 2002). In the group that received moved wh-questions with a rising intonation, there was no movement to spec-CP in either the in situ or moved questions. Instead, focus played a key role in the underlying structure and the prosody of both types of in situ echo questions and moved wh-questions with a rising intonation. However, in the group that received moved wh-questions with a falling intonation, it was only the in situ echo questions where focus played a role, as opposed to the moved wh-questions, where the underlying structure has movement to spec-CP. Due to this contrast, perhaps the specific interpretation of the moved wh-questions influenced the children's responses to in situ wh-questions. The carry-over effect may have then been exaggerated by the ostensive effect of the visual stimuli, but it is unlikely that ostension on its own caused this effect.

Ostension did affect the degree of exhaustivity in children's answers. However, it did not cause children to give overly exhaustive answers in cases where the prosody and semantics of the questions required a repetition answer. This suggests that the role of the ostensive effect of the visual stimuli was largely one of performance. It is likely that in some of the cases where children gave partially exhaustive answers, they actually attempted to give completely exhaustive answers, but this attempt was thwarted by the

complexity of the stimuli. The proportion of partially exhaustive answers decreased with age, suggesting that as children get older, they are more able to pick out the relevant information from complex images, and the ostensive effect of the visual stimuli has less of an influence.

5. Conclusion

We began this project with the question of whether children are sensitive to the echo reading that prosody and focus can give to moved wh-questions, and whether different visual stimuli influence the level of exhaustivity in their answers. We propose that the wh-word in moved questions with a rising intonation moves to FocP, while in questions with a falling intonation, the wh-word moves to spec-CP. This helps to explain why moved wh-questions with a rising intonation and in situ echo questions, which are also governed by focus, both require repetition answers. Children aged 3 to 4 are already sensitive to the differences.

Many of the ideas around the relationships between prosody, focus, and exhaustivity are still very speculative. More research is necessary to better understand what causes certain questions to require a completely exhaustive answer, and why children don't seem to consistently give completely exhaustive answers until age 6.

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