THE BACON not the bacon: How children and adults understand accented and
deaccented noun phrases

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Abstract

An eye-tracking experiment examines whether 4 and 5 year old children can use accenting information to guide their initial, on-line hypotheses about a noun's referent. Deaccented nouns tend to refer to given (previously mentioned) and accessible entities, while accented variants tend to refer to things that are less accessible or new. Accenting is informative for adults (Exp. 1), who show a bias toward given objects beginning 300 msec after the onset of deaccented nouns and pronouns, but later target identification for accented nouns with both given and new referents (cf. Dahan et al., 2002). 4 and 5 year old children (Exp. 2) show the same pattern, although their eye movements are slightly slower and they make more mistakes. These findings suggest that when a single object is given and accessible in the discourse, young children are able to rapidly integrate that accessibility with accenting information in incoming speech.
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Learning to understand language involves more than just words and grammatical rules. Children must learn to interpret words and sentences by connecting them with the preceding discourse and the larger context – and to do so very rapidly, as each word and sentence comes at them. This study investigates young children’s ability to generate on-line hypotheses about the referent of expressions like the bagel, and in particular whether they utilize the presence or absence of an accent to guide these hypotheses. Deaccented words tend to refer to information that is highly accessible in the discourse, while accented words tend to refer to less accessible information (e.g., Venditti & Hirschberg, 2003). If children are sensitive to this pattern, then they (like adults) should use accenting to guide them towards the appropriate referent, thus facilitating comprehension.

The use of accenting requires children to do three things: 1) learn the pragmatic specialization of accenting, i.e., the distribution of accenting with respect to referent accessibility; 2) learn to represent the discourse in an adult-like way, so that they perceive entities as accessible in the same way as their interlocutors; and 3) deploy their knowledge of accenting and discourse accessibility quickly enough to use it during real-time language comprehension. Evidence suggests that while adults are adept at all three of these things, less is known about preschoolers’ knowledge of accenting, and there is mixed evidence of their ability to represent and use discourse accessibility to constrain on-line reference comprehension.
Accenting and discourse status in adults

Spoken words can be pronounced with or without a *pitch accent*, which is a phonological feature that signals prominence, usually with pitch movement and a local pitch maximum or minimum; in English accents also correlate with longer durations and greater acoustic intensity (e.g., Ladd, 1996). Although the location of accents in an utterance is heavily determined by the focus structure of the sentence, it also correlates with discourse status. It is frequently claimed that accented words refer to things that are *new* to the discourse, whereas deaccented words are for *given* (previously mentioned) information (e.g., Brown, 1983; Chafe, 1987). However, recent evidence suggests that a more precise characterization is that accenting occurs with relatively inaccessible referents, both given and new, and deaccented forms are reserved for highly accessible referents (Hirschberg, 1993; Hirschberg & Pierrehumbert, 1986; for a review see Venditti & Hirschberg, 2003). Accessibility is often defined in terms of the discourse record, where adults tend to focus on things that have been recently mentioned in prominent syntactic or thematic positions, perceiving those things as accessible (e.g., Ariel, 1990; Arnold, 1998) This discourse accessibility guides accent placement, for example, deaccented variants tend to occur when the referent was mentioned in the previous clause in a parallel syntactic position to the current referring expression (Terken & Hirschberg, 1994).

The effect of discourse status on the acoustic properties of a word is not limited to accenting, per se. In Watson, Arnold, & Tanenhaus’s (2006) production experiment, most tokens were accented; nevertheless, words were acoustically attenuated when they referred to something in a parallel and syntactically prominent position, but were more
acoustically prominent when they referred to either new, or given but less accessible information. Similarly, acoustic attenuation tends to occur for words that were previously mentioned (Fowler & Housum, 1987; Bard et al., 2000; 2004), even when considering only accented nouns (Bard & Aylett, 1999).

The above patterns mean that accenting and acoustic prominence could signal the listener about the discourse status of the referent – a deaccented and attenuated expression is likely to have a highly accessible referent, while an accented expression is likely to refer to something less accessible, or discourse new.¹ Thus, deaccented variants can direct the listener to look for the referent in the discourse model, whereas accented tokens suggest the construction of a new discourse representation. Accenting can furthermore help listeners surmount some of the challenges inherent in understanding language quickly. Speech occurs rapidly, and listeners need to process each word before the accumulating input exceeds memory capacity. Evidence suggests that indeed, adults interpret each word as it comes in, even considering possible interpretations before the entire word has been heard (e.g., Allopenna et al., 1998; Marslen-Wilson, 1987; Tanenhaus et al., 1995). However, this incremental interpretation creates rampant temporary ambiguity (e.g., Marslen-Wilson, 1973, 1975). For example, consider the following: *I made you some bacon. But be careful, the bacon is hot.* As the speaker begins the second *bacon*, the beginning (*ba-*) may be consistent with other objects in the situation, e.g. a bagel. Accenting can partially disambiguate this fragment; for example a

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¹ Accenting can guide comprehension regardless of whether it is produced as a signal to the listener, which is a matter of debate (see, e.g., Bard et al., 2000; Bard & Aylett, 2004; Gregory et al 2004; Watson et al., 2006).
deaccented *ba-* could guide listeners to attend to the bacon, which is highly accessible and therefore is the more likely referent.

There is substantial evidence that adults do use accenting and acoustic prominence to guide reference comprehension. Terken & Nooteboom (1987) reported faster comprehension for deaccented words with given referents, and for accented words with new referents. Similarly, listeners in Bock & Mazzella's (1983) study understood sentences faster when the new information was accented, and the given information was deaccented. In both of these studies, the preference for deaccented tokens occurred when the referent had been mentioned in a parallel syntactic position as the referring expression, for both subject and nonsubject positions. Listeners can also have more specific interpretations for different kinds of pitch accents, as has been found for German (Baumann & Hadelich, 2003; Baumann & Grice, 2004, in press.).

Moreover, adults can use accenting information extremely rapidly. Dahan, Chambers, & Tanenhaus (2002) monitored participants’ eye movements using a visual world paradigm task (Tanenhaus et al., 1995). In their experiment 1, participants saw displays similar to Figure 1, and followed instructions like *Put the candle/candy below the triangle. Now put the CANDLE/candle above the square.* The target instruction was the second one, in which the theme noun was either accented or deaccented. The referent had been either mentioned in the first instruction (given), or not (new).

Dahan et al.’s experiment capitalized on the fact that objects like bacon/bagel, called cohort competitors, have names that overlap at their onset, creating a temporary ambiguity (Marslen-Wilson, 1987), which causes listeners to fixate the cohort competitor at the onset of the target word on some proportion of the trials (e.g., Allopenna et al.,
Critically, the level of competition from the cohort depended on the accenting of the expression and the discourse status of the referent: If the competitor was given, participants looked at it more often when the expression was deaccented, and if the competitor was new, participants looked at it more often in the accented condition. This difference began to emerge around 300 msec after the onset of the referring expression, revealing that accenting affected the on-line interpretation of the referring expression. This study demonstrates adults’ sensitivity to the discourse specialization of accented and deaccented variants, their ability to calculate accessibility with respect to discourse givenness, and their ability to use accenting and accessibility to drive their real-time hypotheses about the referent of a noun phrase.

Reference comprehension in young children

The current study aims to understand whether children ages 4-5 can also make use of accenting during on-line reference comprehension. In the following sections, I consider existing evidence for children’s competence in the three areas that are necessary to support this ability: 1) knowledge of the pragmatic specialization of accenting, 2) adult-like representations of accessibility, and 3) on-line use of this information.

Children’s knowledge of the pragmatic specialization of accenting. The only evidence of children’s sensitivity to the relationship between accenting and discourse status comes from production studies, which show that English-speaking preschoolers use accenting in adult-like ways in their own speech, preferring accented tokens for new referents, and deaccented ones for given referents (Wieman, 1976; Hornby & Hass, 1970;
MacWhinney & Bates, 1978). While these data are suggestive, they do not entail knowledge of pragmatic implications of accenting in the sense that is necessary to use accenting during comprehension. If children produce deaccented variants for accessible referents because of production-internal facilitation (cf claims by Bard et al., 2000), they may not know that other speakers use accenting systematically as well (for another example of production preceding comprehension developmentally, see Hurewitz, Brown-Schmidt, & Thorpe, 2000).

Children’s use of accessibility for on-line reference comprehension. The literature offers mixed evidence about whether preschoolers use adult-like representations of the discourse to guide their on-line interpretation of referring expressions. What evidence does exist comes from the comprehension of pronouns, which are like anaphoric noun phrases in that they depend on the discourse context for successful interpretation. And like deaccented noun phrases, pronouns tend to be assigned to referents that are highly accessible in the discourse context, and which match the features of the pronoun. For example, Arnold et al. (2000) presented adults with stories like Donald is bringing some mail to Minnie…. She’s carrying an umbrella…. Participants' eye movements were monitored while they viewed a picture of the story. In situations like this example, where the pronoun only matched one character’s gender, adults began looking at the referent of the pronoun around 200 msec after the pronoun's offset, indicating a rapid use of gender information to interpret the pronoun. In another condition, Minnie was replaced with Mickey, which required listeners to use information from the discourse context to infer which character is more prominent in the story, and assign the pronoun to that character. Adults looked at the target character just as quickly as in the gender-disambiguated case,
but only when it referred to the first-mentioned/subject character from the context sentence (Arnold et al., 2000). This "first-mentioned/subject bias" is a robust finding with adults (Gernsbacher, 1989; Gordon, Grosz, & Gilliom, 1993; Järvikivi et al., 2005; Kaiser & Trueswell, 2006; see Arnold, 1998, for a review).

Preschoolers, like adults, can rapidly identify a pronoun's referent on the basis of gender information. Arnold, Brown-Schmidt, & Trueswell (in press, experiment 2) monitored the eye movements of 4 and 5 year olds as they performed the same task as the adults in Arnold et al. (2000). When the pronoun was disambiguated by gender, children identified the referent just as quickly as adults. By contrast, they did not reliably use the first-mention bias to guide their on-line hypotheses about the referent. Results from an offline task with 3 to 5 year olds were consistent with the online results.

These results should not be taken as evidence that children are unaware of the relationship between pronouns and accessibility. Rather, it is evidence that preschoolers have not solidified their use of order of mention to infer whether the speaker is treating an entity as accessible in the discourse or not. In fact, research by Song and Fisher (2005) revealed that even 3-year-olds can successfully link a pronoun with the more accessible of two characters in a story. Their stories used multiple mechanisms to clearly establish one character as highly accessible, for example repeated mention, first mention, and pronominalization. However, their 3-year-olds did not use accessibility as rapidly as adults: the bias towards the accessible character did not usually occur until a full second after the pronoun.

Arnold et al. (in press) have argued that the above findings suggest that young children know that pronouns are used for accessible referents, but they do not have adult-
like representations of accessibility. Children need to learn that accessibility is a property of the joint discourse model, and not just their own egocentric focus of attention; they also need to learn how to use subtle, probabilistic cues like order-of-mention to infer which character is likely to be more central to the story (for further discussion, see Arnold et al., in press). In sum, children succeed when a single character matches the pronouns gender or is highly accessible in the discourse, but they are limited in their ability to make fine-grained distinctions in accessibility, as occurs with the contrast between first- and second-mentioned characters in an utterance.

These results are consistent with the proposal that young children start out by paying attention to those sources of information that are most reliable for language comprehension, only later learning subtler patterns (Arnold, Brown-Schmidt, & Trueswell, 2006; Trueswell & Gleitmann, 2004). The gender cue is an example of an extremely reliable source of information; it nearly always matches the gender of the referent, and is frequently the only thing needed to pick out a unique referent from the discourse context. By contrast, order of mention is a probabilistic source of information. First-mention or subject position in a narrative context means that character is likely to be prominent in the discourse, and the referent of a pronoun -- but not always. But when a single character is identifiable as accessible through multiple probabilistic sources of information (as in Song & Fisher’s study), the result is a robust representation of accessibility that can be used to guide pronoun comprehension, even if children do not use the information as early as adults do.

*Predictions about children’s use of accenting*. On this view of reference comprehension in preschoolers, children would stand the best chance of utilizing
accenting if the discourse situation established a clear distinction in accessibility. The following study therefore examines accenting in a context where one candidate referent is given and highly accessible, and the other is new (unmentioned). Given referents are clearly more accessible than new ones, in that discourse participants can presume that previously mentioned information is known and accessible to all other discourse participants (Clark and Marshall, 1981). By contrast, there is less information about whether one’s interlocutors are focusing their attention on unmentioned objects, even if they are visible in the discourse context.

The robustness of the distinction between given and new is supported by research showing that toddlers are sensitive to this contrast for the purposes of word learning (Akhtar, Carpenter & Tomasello, 1996). Akhtar et al. had 24-month-old children participate in a novel word learning task, where the child initially played with three novel objects with the experimenter. Then that experimenter and the parent left the room, and the child played with a new novel object with another experimenter. Then the other adults returned and expressed excitement in the general direction of all the objects, e.g. "Look! I see a gazzer!" (Akhtar et al., 1996, page 641). Children successfully interpreted the experimenter’s excitement as evidence that the label referred to the new object, not the old ones, revealing a sensitivity to given vs. new information.

By using a context where accessibility is strongly manipulated, we can ask whether 4 and 5 year old children have learned the pragmatic specialization of accenting, and whether they can use it in real time. According to the above view on reference comprehension, the order in which children acquire processing skills is related to the amount of information available in the input, where stronger patterns, with more
substantial and reliable evidence, are learned earlier. (Arnold et al., 2006; Trueswell & Gleitman, 2004). This would predict an early use of accenting patterns for on-line comprehension if these patterns are robust in child-directed speech.

Indeed, there is substantial information available in the speech input to enable children to learn the pragmatic specialization of deaccented and accented expressions. Most content words have the possibility of bearing accents, which means that a deaccented pronunciation of a content word is informative. This means that children have amassed a large database of accented and deaccented words at a very young age. Furthermore, the adult pattern of using deaccented expressions for given and accessible referents is present in child-directed speech as well (Fisher and Tokura, 1995); more generally, speech to children tends to have attenuated pronunciations for words that are predictable from the discourse or physical context (Bard & Anderson, 1983, 1994). Furthermore, children’s own use of accenting (Wieman, 1976; Hornby & Hass, 1970; MacWhinney & Bates, 1978) supports the robustness of the distribution of accented and deaccented tokens with respect to the discourse status of their referents. If children do pay attention to these patterns, we should see a sensitivity to accenting during reference comprehension.

However, it is still unclear whether children are likely to use this information on-line. Evidence from pronoun comprehension shows that children interpret gender-disambiguated pronouns on-line, but there is mixed evidence for whether children can use accessibility to interpret pronouns (Arnold et al., 2006; Song & Fisher, 2005). What evidence exists for the use of accessibility does not occur until about 1000 ms after the pronoun (Song & Fisher, 2005); however, the children in this experiment were only 3
years old, leaving the possibility that 4 and 5 year olds may use accessibility more quickly during reference comprehension.

Table 1

Experiments 1 and 2 -- Example auditory instructions. Capitalization indicates accenting.

<table>
<thead>
<tr>
<th>Instructions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nonanaphoric, Accented</td>
</tr>
<tr>
<td>Put the bacon on the star. Now put the BAGEL on the square.</td>
</tr>
<tr>
<td>Nonanaphoric, Deaccented</td>
</tr>
<tr>
<td>Put the bacon on the star. Now put the bagel on the square.</td>
</tr>
<tr>
<td>Anaphoric, Accented</td>
</tr>
<tr>
<td>Put the bacon on the star. Now put the BACON on the square.</td>
</tr>
<tr>
<td>Anaphoric, Deaccented</td>
</tr>
<tr>
<td>Put the bacon on the star. Now put the bacon on the square.</td>
</tr>
<tr>
<td>Anaphoric, Pronominal</td>
</tr>
<tr>
<td>Put the bacon on the star. Now put it on the square.</td>
</tr>
</tbody>
</table>

The following two experiments examined adults’ and children’s use of accenting during on-line reference comprehension, using the same experimental design as Dahan et al. (2002, experiment 1). Participants viewed a display with four objects, two of which were cohort competitors (e.g., bagel/bacon), and followed instructions like in Table 1. The context sentence (e.g., *Put the bacon on the star*) established a clear contrast in accessibility: the bacon is given, and as the only object manipulated, it becomes the most accessible object on the board. The bagel, by contrast, is unmentioned and therefore far
less accessible than the bacon. If accenting information guides children’s on-line comprehension, deaccented expressions should result in faster target looks in the anaphoric (given target) condition, and accented expressions should result in faster target looks in the nonanaphoric (new target) condition. As a control condition, we also examined the comprehension of pronominal instructions, Now put it…. Experiment 1 established adult performance in this task, and Experiment 2 investigated performance on the same task by 4 and 5 year old children.

Experiment 1: Adult controls

Method

Participants. 49 students at the University of North Carolina at Chapel Hill participated in exchange for course credit. Data from 13 were excluded: 7 because of technical problems, 5 because of problems calibrating the participant or too much track loss, and 1 participant had to leave before finishing the experiment. This left 36 participants in the analysis. All participants were native speakers of English.

Method and Materials. Participants were asked to wear a visor for the purposes of monitoring their eye movements. They viewed pictures on a computer screen, as in Figure 1. The pictures for all objects were drawn primarily from a colorized version of the Snodgrass & Vanderwart (1980) database of pictures (Rossion and Purtois, 2001); a few were from other clipart databases. Two of these objects were cohort competitors – objects whose names overlap during the initial segment, like bagel/bacon or candle/candy. The pictures always appeared on a grid, with the same four shapes in the corners on all trials. Participants followed recorded instructions to move objects onto the
shapes with the mouse. There were two instructions for each visual stimulus, e.g. *Put the bacon on the star. Now put the bacon on the square.*

**Figure 1.** Sample visual display for Experiment 1.

The object in the second instruction was the referring expression of interest, e.g. *bacon* in this example. The other cohort (e.g., the bagel) was the competitor. The first instruction established either the target as given (the anaphoric condition) or the competitor as given (the nonanaphoric condition); the other cohort object was not mentioned and therefore was new. The target referring expression occurred in three
conditions: accented, deaccented, and pronominal (Now put it…); the pronoun was always anaphoric. For an example of auditory stimuli, see Table 1.

In the accented condition, the target word carried a pitch accent and was acoustically prominent and relatively long (avg. 686 ms). In all accented conditions, the theme in the second instruction had a L+H* accent, followed by a L% boundary tone. The result was an extremely prominent sounding accent. In the deaccented condition, the target word carried no pitch accent and was acoustically attenuated, with a shorter duration (avg. 334 ms). The pronoun was also deaccented and acoustically attenuated, average duration 92 ms. Table 2 shows the average acoustic properties of the target words in each condition. Durations are measured from the onset of a word to the onset of the following word, including any pauses. It is important to note that accenting on any particular word is not independent from the prosodic characteristics of the rest of the utterance. As Table 3 shows, the durations of all preceding words (Now put the) were longer for the accented than the deaccented conditions.

Table 2

<table>
<thead>
<tr>
<th></th>
<th>Accent</th>
<th>No accent</th>
<th>Pronoun</th>
</tr>
</thead>
<tbody>
<tr>
<td>Target word duration</td>
<td>686 ms</td>
<td>334 ms</td>
<td>92 ms</td>
</tr>
<tr>
<td>Following pause</td>
<td>187 ms</td>
<td>13 ms</td>
<td>0 ms</td>
</tr>
<tr>
<td>Maximum pitch</td>
<td>286 Hz.</td>
<td>192 Hz.</td>
<td>186</td>
</tr>
<tr>
<td>Minimum pitch</td>
<td>121 Hz.</td>
<td>160 Hz.</td>
<td>166</td>
</tr>
</tbody>
</table>
Table 3

Experiment 1 - Average duration for the initial words in each condition

<table>
<thead>
<tr>
<th></th>
<th>Accent</th>
<th>No accent</th>
<th>Pronoun</th>
</tr>
</thead>
<tbody>
<tr>
<td>Now duration</td>
<td>368</td>
<td>315</td>
<td>305</td>
</tr>
<tr>
<td>Put duration</td>
<td>170</td>
<td>130</td>
<td>113</td>
</tr>
<tr>
<td>The duration</td>
<td>125</td>
<td>87</td>
<td>--</td>
</tr>
</tbody>
</table>

This experiment also included an additional manipulation of the prosody on the word *Now*. In half the items *Now* carried a large pitch accent, and in half the items it was deaccented. This variable did not affect the results substantially, and therefore will not be discussed further. The experiment with children (Experiment 2) only used the accented *Now* conditions, so only those items will be presented here.

Thus, the basic experimental design was 2 (anaphoric vs. nonanaphoric) x 2 (accented vs. deaccented target), plus a pronominal/anaphoric condition. These 5 conditions occurred either with an accented *Now* or an deaccented *Now*, for a total for 10 conditions. The critical items were combined with 12 fillers into 10 lists. As an additional control, there was a second set of 10 lists in which the cohort items that were assigned to target and competitor were swapped; e.g. the example in Table 1 became *Put the bagel on the circle. Now put the bacon on the square*. Before each list there were two practice items, in one the target expression was accented, in the other it was deaccented; both referred to a different object than was mentioned in the first instruction.

All 12 filler items also included a pair of cohorts. These were never mentioned in the context instruction, and were mentioned in six fillers as the theme of the second
instruction. The fillers thus served to reduce the expectation that one of the two cohorts would be mentioned in the first instruction, as well as the expectation that if one cohort was mentioned, the other would be too. Out of the 12 fillers and 2 practice items, the target noun was anaphoric in 4 items and nonanaphoric in 10; 7 target expressions were accented, and 7 were deaccented.

On critical items, the target and competitor objects occurred equally in all four positions in the display. On all items, the target and competitor were placed either diagonally or vertically from each other on the initial display. The experiment was designed so that the first instruction would always result in the object being moved to the shape immediately next to it, because of methodological constraints on coding direction of eye gaze in Experiment 2. However, due to a programming error, all the objects on the bottom half of the screen were moved to the bottom shape on the opposite half of the screen. This did not affect our ability to identify eye movements for this experiment.

Procedure and Apparatus

We monitored participants' eye movements with an Eyelink II head mounted eyetracker. After the task was explained, the visor with cameras was arranged on the participant's head, and calibrated. Participants completed two practice items, were given a chance to ask questions, and then went on to do the experimental task.

The visual and auditory stimuli were presented on a PC computer running the ExBuilder software (Longhurst, 2006). Each trial was preceded by a screen with a dot, which participants needed to fixate on and click. This enabled the eyetracker to perform a drift correction, and encouraged participants to attend as each trial began. As soon as the
participants clicked on the dot, the visual stimulus appeared and the soundfile began to play. The instruction began within 150 msec of the onset of the soundfile.

Predictions

If our participants behave as those in Dahan et al.’s (2002) experiment 1, we expect the deaccented condition to produce a bias toward the given cohort, which should be reflected in an earlier target preference for the anaphoric than nonanaphoric conditions. By contrast, accented nouns should be biased slightly toward the new cohort (see the discussion section for more on this point). The pronominal condition can only be interpreted as anaphoric, and is expected to produce similar results as the deaccented/anaphoric condition.

Results

In both this and experiment 2, the primary analysis is the comparison of the accent and no accent conditions, with anaphoric and nonanaphoric target nouns. The pronominal condition provides a measure of whether participants were interpreting the second instruction with respect to the context established by the first, since pronouns are typically associated with the most accessible entity in the context that matches the pronoun – here the object moved on the first trial. This also provides a baseline for the speed with which participants might be expected to use the discourse context in this task.

Two dependent variables are analyzed: 1) errors in moving the object, and 2) eye movements. Eye movements are analyzed in terms of the average number of looks; each look begins at the onset of a saccade to an object, and lasts until the participant makes a
saccade to a new object. Saccades are grouped together with following fixations because they are ballistic, so the saccade reflects the participant’s decision to look at that object.

Errors. The presentation software recorded trials on which the participant initially clicked on the wrong object. Six participants made one error, and always in the new / no accent condition; these errors occurred on four different items (average 6% across participant means). An analysis of variance with the four principal conditions revealed an interaction (F1(1,35) = 7.0, p < .05), although it was marginal in the items analysis (F2(1,29) = 3.54, p = .070). There were no errors in the pronominal condition.

Eye movements. Figure 2 presents the average looks to display objects in both the pronominal and deaccented/anaphoric conditions. As predicted, both pronouns and deaccented anaphors show an early target preference: looks to the target began to diverge from looks to the competitor very rapidly, about 300 msec after the onset of the referring expression. Although there are slightly more looks to the target in the pronominal condition, the conditions are not reliably different from one another, with either target or competitor looks as the dependent variable (all F’s < 1). In sum, participants are responding to both the pronominal and deaccented conditions in a similar way, showing target identification about 300 ms after target onset.
Adults: Pronouns and Deaccented NP Anaphors

Figure 2. Experiment 1 results -- looks to target and competitor objects in the deaccented/anaphoric and pronominal conditions. Vertical lines represent the offset of the pronoun (first line) and deaccented noun (second line).

The comparison of interest is between the anaphoric and unanaphoric conditions for both accented and deaccented noun phrases. Figure 3 compares looks to the target object for deaccented (top panel) and accented (bottom panel). The most informative effects are those that occur early, soon after the onset of the referring expression, because these are likely to indicate how accenting affects on-line hypotheses about the referent of the expression. There is an early advantage for the anaphoric (given) target over the
nonanaphoric (new) target when the noun is deaccented, but this difference disappears in the accented condition.

There is a later advantage for the nonanaphoric (new) target in the accented condition, suggesting a possible preference for a new referent in this condition. However, this difference cannot be uniquely attributed to the accenting preferences. In both deaccented and accented conditions (in both experiment 1 and 2), there is a late advantage for the nonanaphoric (new) target. Put another way, looks to the new target peak higher than looks to the given target, in all conditions. It is possible that listeners do not need to spend as much time looking at the given cohort, simply because they are already quite familiar with it. Also, because this advantage occurs relatively late, it is less likely to reflect listeners initial hypotheses about the referent of the unfolding referring expression. Therefore, a cautious interpretation is that these data show a clear advantage for the given target in the anaphoric condition with a deaccented expression, but no difference with an accented expression.

A similar pattern was found in looks to the competitor objects. Figure 4 presents competitor looks in each condition. When the expression was deaccented (top panel), there were more looks in the nonanaphoric condition, i.e. when the competitor was given. When the expression was accented (bottom panel), there was very little difference. There is a very small initial advantage for the nonanaphoric condition, possibly due to a baseline preference to look at the given cohort; this is later reversed to show a slight advantage for the anaphoric condition.
Figure 3. Experiment 1 results -- looks to the target cohort following deaccented (top panel) and accented nouns (bottom panel).
Figure 4. Experiment 1 results -- looks to the competitor cohort following deaccented (top panel) and accented nouns (bottom panel).
Statistical analyses of this pattern were conducted by averaging looks to the target and competitor objects from 300 to 1000 msec after the onset of the noun phrase, which are shown in Table 4. This revealed a significant interaction for both target looks (F1(1,25) = 7.01, p < .05; F2(1,29) = 8.30, p < .001) and competitor looks (F1(1,35) = 4.316, p < .05; F2(1,29) = 5.13, p < .05). Planned comparisons between the anaphoric and unanaphoric conditions revealed that the interaction is driven by a significant difference for the deaccented expression (target: F1(1,35) = 8.61, p < .01; F2(1,29) = 12.30, p < .001; competitor: F1(1,25) = 7.655, p < .01; F2(1,29) = 12.23, p < .005), but no significant difference for the accented expression (all F’s < 1).

Table 4

Experiment 1 Online Results -- Proportion looks to target and competitor objects during 300-1000 window. SE in parentheses.

<table>
<thead>
<tr>
<th></th>
<th>Target looks</th>
<th>Competitor looks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Deaccented / Anaphoric</td>
<td>51% (4%)</td>
<td>12% (2%)</td>
</tr>
<tr>
<td>Deaccented / Not Anaphoric</td>
<td>38% (3%)</td>
<td>23% (3%)</td>
</tr>
<tr>
<td>Accent / Anaphoric</td>
<td>35% (4%)</td>
<td>20% (3%)</td>
</tr>
<tr>
<td>Accent / Not anaphoric</td>
<td>38% (3%)</td>
<td>22% (3%)</td>
</tr>
<tr>
<td>Pronominal</td>
<td>53% (3%)</td>
<td>8% (2%)</td>
</tr>
</tbody>
</table>
Discussion

The results of experiment 1 replicated the interaction between accenting and the discourse status of potential referents that was reported by Dahan et al. (2002). There was more competition from a given cohort competitor when the noun phrase was deaccented and nonanaphoric, reflecting a bias toward considering given (already mentioned) objects as referents for deaccented expressions. By contrast, accented expressions showed no such bias. Experiment 1 also included a pronominal condition, which produced the same early bias toward the given cohort as in the deaccented/anaphoric condition.

The current results differ from those of Dahan et al.’s (2002) experiment 1, in that the accented condition did not show any early facilitation for the new cohort. While Dahan et al. reported more competitor looks in the anaphoric accented than nonanaphoric accented conditions, the current data contain roughly equal competitor and target looks. The current data also reveal overall fewer target looks, and more competitor looks, in the 300-1000 ms window. One possible explanation is that our accented stimuli were longer on average (686 ms, vs. Dahan’s 539). This means that the ambiguous portion of the word extended for a longer period of time in our experiment, so both cohort names were consistent with the input for a larger portion of the 300-1000 ms window.

On the other hand, the lack of facilitation for the discourse-new referent with accented expressions is consistent with how accenting occurs in speech. Deaccented expressions have a strong probability of being used to refer to something highly accessible and given in the discourse context. Accented definite NPs, on the other hand, seem to be less specialized. They can felicitously be used to refer to something that has not been previously mentioned, as long as the referent is identifiable (see Chafe, 1976,
Prince, 1992; Gundel et al., 1993). At the same time, they can refer to something given, particularly if it is not highly accessible. For example, 52% of words with given referents were accented in Hirschberg's (1993) sample (and 87% of words with new referents). Related evidence comes from Watson et al.'s data, in which acoustically prominent tokens were frequently produced for reference to both new and given but less accessible entities. Similarly, Terken & Hirschberg (1994) found accenting when the referent was given but not in a syntactically parallel position.

Consistent with this, Dahan et al. (2002, experiment 1) found only weak evidence for a preference to fixate the nonanaphoric target with accented expressions, compared with deaccented expressions (p. 301). They suggested that the absence of a strong target bias was due to the distribution of accented expressions, as mentioned above. This explanation was supported by the results of their second experiment, which found that accented expressions were preferentially interpreted as coreferential with given, but not highly accessible entities, as with the second, accented mention of candle in *Put the sock on the candle. Now put the CANDLE*... 

In sum, the adults in experiment 1 revealed a probabilistic bias toward an anaphoric interpretation of deaccented expressions, similar to the bias observed with a pronoun; by contrast, there was no particular bias with accented expressions. This reflects the way accenting occurs in production, and is consistent with the findings of Dahan et al. (2002). Experiment 2 investigated whether 4 and 5 year old children would exhibit the same on-line sensitivity to accenting.
Experiment 2: 4-5 year old children

Method

Participants. 27 children in the Chapel Hill/Durham area participated in the experiment in exchange for a small toy; their parent received $5 for each child participating. 7 participants were excluded from analysis, 3 because of technical problems, 2 because the child did not attend to the task (e.g. talking during the critical items), and 2 because they were confused about many items or made too many mistakes on the context instruction. This left 20 participants in the analysis. 11 were girls, 9 were boys. The average age was 59 months.

Method and Materials. Half the items from Experiment 1 (n=15) were used, with the same recorded instructions and pictures. The average acoustic characteristics of this subset of items is shown in Table 5, and the durations for Now, put, and the for this subset of items are shown in Table 6. As in Experiment 1, the target words were higher in pitch and had longer durations and following pauses in the accented condition, compared with the deaccented and pronominal conditions; in addition the initial words (Now put the) were also longer in the accented condition. The cohort pair for one filler (gun/gum) was inadvertently included at first; it was changed to clown/cloud after a few participants because it was inappropriate for the age group².

² I am grateful to Alessandra Gutiérrez-Arnold (age 4) for bringing this to my attention.
Table 5

Experiment 2 – Acoustic characteristics of the target word in each condition

<table>
<thead>
<tr>
<th></th>
<th>Accent</th>
<th>Deaccented</th>
<th>Pronoun</th>
</tr>
</thead>
<tbody>
<tr>
<td>Target word duration</td>
<td>726</td>
<td>342</td>
<td>95</td>
</tr>
<tr>
<td>Following pause</td>
<td>198</td>
<td>8</td>
<td>0</td>
</tr>
<tr>
<td>Maximum pitch</td>
<td>284</td>
<td>196</td>
<td>192</td>
</tr>
<tr>
<td>Minimum pitch</td>
<td>121</td>
<td>163</td>
<td>172</td>
</tr>
</tbody>
</table>

Table 6

Experiment 2 - Average duration for the initial words in each condition

<table>
<thead>
<tr>
<th></th>
<th>Accent</th>
<th>Deaccented</th>
<th>Pronoun</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Now</em> duration</td>
<td>377</td>
<td>321</td>
<td>329</td>
</tr>
<tr>
<td><em>Put</em> duration</td>
<td>174</td>
<td>130</td>
<td>121</td>
</tr>
<tr>
<td><em>The</em> duration</td>
<td>113</td>
<td>80</td>
<td>--</td>
</tr>
</tbody>
</table>

Only half the conditions were included, those with an accented *Now*. Thus, there were four conditions resulting from the cross between givenness and accenting, plus the pronominal condition. These five conditions were rotated through the 15 critical items, and combined with 6 filler items into five lists. As before, the target/competitor assignment to each member of a cohort pair was counterbalanced across two versions of each list, one where the cohort a was the target, one where cohort b was the target. This resulted in 10 lists, each of which had a forward and backward order.
In all items, the first instruction resulted in the object being moved to the shape immediately next to its original position (as was the original design for experiment 1). This preserved the spatial distinction between all four objects at the onset of the second instruction, such that one was in each corner of the display. This was necessary because of the video-based method for monitoring eye movements.

On each list, the target and competitor objects on the 15 experimental items were as evenly distributed across the four positions as possible. The display was similar to that in Figure 1, except that the location of the shapes was rearranged so that the target and competitor object would always be horizontal from each other. This orientation was different from the adult experiment; the change was made to encourage a higher rate of looks to the competitor cohort, since horizontal eye movements are more frequent than vertical or diagonal ones (Dahan, Tanenhaus, & Salverda, in press).

Procedure and coding. Children performed the same task as in Experiment 1, except that the pictures were displayed on a magnet board, instead of on a computer. The four shapes were painted onto the corners of the board, and the pictures for each object were connected to magnets and placed on the board for each trial. The board stood at a slight incline off vertical, and the child stood in front of the board, looking down at it. The pictures were in easy reach, so children could carry out each instruction by moving the magnetic picture with their hands.

Children’s eye movements were monitored using a digital camcorder that was trained on their face through a hole in the middle of the board (for a similar methodology, see Snedeker and Trueswell, 2004). This image was sent to a frame-accurate Sony DSR-30 digital VCR, which recorded 30 images per second. Because the camera was placed
behind the pictures, experimenters could code the video while blind to the location of the target and competitor objects.

The instructions were played out of a different computer, running the same software as used in Experiment 1. The sound played from a speaker near the child. Sound was recorded either through a microphone that was connected to the digital VCR (the first few subjects), or through a direct line from the computer into the digital VCR. Both methods yielded frame-accurate sound, so the coder could identify eye movements with respect to critical words in the auditory input.

Before each experiment began, the parent and child (or children) were welcomed to the lab and introduced to the experimenters. While the parent filled out the consent form and lab questionnaire, the experimenters showed the child(ren) the equipment. After explaining the task, the child completed two practice items, and was given a chance to ask questions before going on to do the experiment. Each child was tested with only the parent and experimenters in the room.

If the child made an error on any of the critical trials (e.g., moving the wrong object or moving it to the wrong shape), the error was recorded by an experimenter on a sheet of paper. The same experimenter recorded events that invalidated the trial, e.g. if the child talked during the critical instruction, or made a mistake on the first instruction by either moving the wrong object or moving an object to the wrong shape.

Each frame of the video record was later inspected to determine the child’s direction of gaze, beginning at the onset of the second (critical) instruction. Coders first went through the tape, listening for the onset of Now, and marking the time of onset on a
spreadsheet. The sound was then turned off, to allow coders to be blind to the experimental condition while coding eye movements.

Gazes were coded in one of the following categories: upper left, upper right, lower left, lower right, center, other, or trackloss. Following the same method of analysis as in Experiment 1, coders identified the onset of each saccade, and grouped it with the following fixation. Trackloss could be the result of blinks or other obstructions of the eye image, for example if the child moved their head away from the video camera. Trackloss due to blinks were grouped as part of the following fixation.

Gazes to each of the four corners were later categorized as gazes to the target object, competitor object, or unrelated objects, based on where each object had been on a particular item. Recall that the first instruction always resulted in an object being placed on the shape immediately next to it. This meant that gazes to each corner were ambiguous between looks to an object or a shape. However, looks to the target and competitor objects were not likely to be much influenced by looks to the shape in the same corner, because the location shape in the second instruction (the most likely shape to be fixated) was never the same as either the target or competitor object. Furthermore, there is no evidence of increased looks to the destination corner (compared with the other unrelated item) until quite late (from target onset, 1600 ms in accented conditions; 1400 ms in deaccented conditions, and 900 ms in pronominal conditions: 900 ms).

The eye movement data were coded by two research assistants. They double-coded the data of one participant who was outside the age range of this study, and therefore not reported here. The two coders achieved 94% agreement on the location of
the gazes; agreement on the location of the onset of the critical words *Now* was within ±0.06 frames, and the onset of the target word was ± 0.77 frames

**Results**

20 items (or 7% of the total) were excluded from analysis because of technical problems (n=5), too much trackloss (n=1), the child moved the wrong object on the first instruction (n=6), or the trial was interrupted by someone saying something, including when the child asked for clarification after the first instruction (n=8). 10 subjects had at least one item excluded.

Table 7

Experiment 2 Offline Results -- Percentage items on which the child erroneously moved the cohort competitor or reached for it before moving the target object.

<table>
<thead>
<tr>
<th></th>
<th>% errors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Deaccented / Anaphoric</td>
<td>3% (3%)</td>
</tr>
<tr>
<td>Deaccented / Not Anaphoric</td>
<td>24% (6%)</td>
</tr>
<tr>
<td>Accent / Anaphoric</td>
<td>5% (3%)</td>
</tr>
<tr>
<td>Accent / Not anaphoric</td>
<td>2% (2%)</td>
</tr>
<tr>
<td>Pronominal</td>
<td>0% (0%)</td>
</tr>
</tbody>
</table>

**Action Errors.** On some trials children moved the wrong object, reached for an incorrect object before moving the correct one, or moved an object to the wrong shape. Of particular interest are the trials where the child reached for or moved the cohort competitor, which suggested an inability to recover from an initial bias toward the
competitor object. As shown in Table 7, cohort errors were more likely to occur in the nonanaphoric deaccented condition (24%) than the other three conditions (5% or less). An ANOVA revealed a significant interaction between accenting and the referent type (F1(1,19) = 13.55, p < .005, F2(1,14) = 9.61, p < .01). There were also main effects of both accenting and referent type (all F’s > 6), which were driven by the deaccented conditions. Pairwise comparisons revealed a main effect of referent type for the deaccented conditions (F1(1,19) = 12.98, p < .005, F2(1,14) = 14.48, p < .005), but not the accented conditions (F’s ≥ 1). The same pattern obtains if we consider only whether the child actually moved the competitor, which occurred 16% of the time in the New/no accent condition, compared with 0%-2% in the other conditions. There were no errors in the pronoun condition.

Eye movements. Figure 5 displays children’s looks to the target and cohort competitor objects for both the pronominal and anaphoric/deaccented conditions. Like adults, children had more looks to the given target than the new competitor for both pronouns and deaccented anaphors, although slightly later, beginning around 500 msec after the onset of the target word. However, children differed from adults in that the pronominal condition resulted in slightly more looks to the competitor with a deaccented noun anaphor than with a pronoun (F1(1,19) = 11.98, p < .005; F2(1,14) = 18.13, p < .001). There was no reliable difference in looks to the target object (F’s < 1). These results establish preschoolers’ ability to do this task and map an expression to a referent on-line (cf Swingley, Pinto & Fernald, 1999, where younger children mapped words to referents about 600-700 ms after noun onset).
As before, the critical question was whether accented and deaccented expressions would result in different performance in the anaphoric and nonanaphoric conditions. An inspection of Figure 6 reveals a similar pattern as in the adult data following the onset of the critical word. In the no accent condition (top panel), there are more looks to the target in the anaphoric (given target) condition than the nonanaphoric condition. Likewise, Figure 7 reveals more looks to the competitor in the nonanaphoric condition, where the
competitor is given. In the accented conditions (bottom panels), there is no difference.
The graphs reveal a slightly later effect than in the adult data, beginning about 500 msec after the onset of the target word.

The reliability of this pattern was assessed by analyzing the percentage of looks to target and competitor objects between 500-1000 msec after the onset of the target word (See Table 8). Like in experiment 1, pairwise comparisons supported the observed trends: When the expression was deaccented, there were more looks to the target in the anaphoric than the nonanaphoric condition (F1 (1,19) = 7.97, p < .05; F2 (1,14) = 9.12, p < .01), and there were more looks to the competitor in the nonanaphoric condition (i.e., when the competitor was given), compared with the anaphoric condition (F1(1,19) = 7.232, p < .05; F2(1,14) = 8.56, p < .05). By contrast, when the target word was accented, there were no differences between given and new conditions in looks to either target or competitor objects (all F’s < 1).
Figure 6. Experiment 1 results -- looks to the target cohort following deaccented
(top panel) and accented nouns (bottom panel).
Figure 7. Experiment 1 results -- looks to the competitor cohort following deaccented (top panel) and accented nouns (bottom panel).
Table 8

Experiment 2 Online Results -- Proportion looks to target and competitor objects during 500-1000 window. SE in parentheses.

<table>
<thead>
<tr>
<th>Condition</th>
<th>Target looks</th>
<th>Competitor looks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Deaccented / Anaphoric</td>
<td>47% (6%)</td>
<td>24% (5%)</td>
</tr>
<tr>
<td>Deaccented / Not Anaphoric</td>
<td>27% (5%)</td>
<td>43% (6%)</td>
</tr>
<tr>
<td>Accent / Anaphoric</td>
<td>37% (6%)</td>
<td>21% (4%)</td>
</tr>
<tr>
<td>Accent / Not anaphoric</td>
<td>35% (6%)</td>
<td>26% (6%)</td>
</tr>
<tr>
<td>Pronominal</td>
<td>51% (5%)</td>
<td>12% (3%)</td>
</tr>
</tbody>
</table>

However, the interaction failed to reach significance for both target looks (F1(1,19) = 2.78, p = .112; F2(1,13) = 1.47, p = .245) and competitor looks (F1(1,19) = 1.88, p = .186; F2(1,14) = 1.48, p = .26). Instead, there were marginal or main effects of referent and accenting for competitor looks (referent: (F1(1,19) = 4.33, p = .051; F2(1,14) = 7.86, p < .05; accenting: F1(1,19) = 3.566, p = .074; F2(1,14) = 11.90, p < .005). There was also a marginal or main effect of referent for target looks (F1(1,19) = 3.99, p = .060; F2(1,14) = 5.634, p < .05), and no effect of accenting (F’s < 1). However, these main effects were driven by the facilitation for the target in the deaccented/anaphoric condition, and the facilitation for the competitor in the deaccented/nonanaphoric condition.
Discussion

Experiment 2 established preschoolers’ ability to use accenting information during reference comprehension, essentially replicating the adult data in Experiment 1. Like adults, 4 and 5 year olds looked at the given cohort more quickly when the expression was deaccented, but showed no bias when the expression was accented. Although these effects occurred later than with adults, they began around 500 msec after the onset of the target noun. This is about 150 after the noun offset in the deaccented condition, and prior to noun offset in the accented condition. Since it takes about 200 msec just to program and launch an eye movement (Martin, Shao, & Boff, 1993), these results suggesting that discourse accessibility is guiding the on-line interpretation of a deaccented noun before the target word is completed.

On-line biases had lasting effects on children’s responses to the instructions as well. They were most likely to reach for the cohort competitor or actually move it in the deaccented/nonanaphoric condition, again suggesting a preference for the given object with deaccented expressions. The level of error was much higher than for adults: even if we only consider items on which they actually moved the cohort competitor, children made 16% errors in the nonanaphoric/deaccented condition, whereas adults only made 6% errors. This suggests that 4 and 5 year old children may be less able than adults to recover from their initial biases, consistent with Trueswell, Sekerina, & Logrip’s (1999) findings of syntactic perseveration with the same age group.

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3 This number may be an inflated estimation of competition from the cohort, since the software program used in experiment 1 did not report the object chosen when there was an error, so some of these may have been errors with unrelated objects.
Results from the pronoun condition also showed that children can appropriately match the referring expression with the discourse context, and do so rapidly. Pronouns, like deaccented definite noun phrases, tend to be used for referents that are given and highly accessible. Children demonstrated sensitivity to this pattern, focusing on the given cohort with a pronoun equally or more quickly as with a deaccented noun phrase.

**General Discussion**

The results presented here reveal that 4 and 5 year old children are fairly adept at using accenting information during their on-line interpretation of referential expressions. Although the children made more mistakes and had slower looks to the cohort objects than did the adults, the basic pattern of their data was the same: earlier looks to the target when the expression was anaphoric and deaccented or pronominal, later looks and more competition from the cohort when the expression was anaphoric and accented. Nonanaphoric expressions yielded later looks overall, but no preference for either given or new objects.

The findings of a given-object preference with only deaccented expressions mirrors the way accenting occurs in speech. Deaccented and attenuated noun phrases tend to refer to given, highly accessible entities. By contrast, accented and acoustically prominent noun phrases tend to be used for both discourse-new entities and given but less accessible entities (Watson et al., 2006). Given this pattern, a deaccented expression is a very good indication that the referent is highly accessible, whereas an accented expression provides less information (i.e., it could refer to either something given or something new).
These results clearly establish that children can use accenting information to inform their on-line decisions about the referent of a noun phrase, at least when accessibility is strongly established. Although children’s looks were slightly slower than adults, the given-cohort preference occurred approximately 150 ms after the offset of the target noun, on average, suggesting rapid integration of the speech input with the accessibility of candidate objects.

However, there are at least two possibilities we must consider with respect to the question of children’s knowledge of the pragmatic specialization of accenting. The first is that children, like adults, are sensitive to the pragmatic specialization of accented and deaccented expressions. That is, they selectively interpret deaccented expressions as referring to something given and highly accessible, but are less biased with accented expressions. Under this interpretation, accenting is instrumental in directing the listener to either associate the referring expression with an already given and accessible entity, or to retrieve a less accessible representation, possibly one that has to be built for the first time, based on the speech input (Dahan et al., 2002; Terken & Nooteboom, 1987). This discourse bias is integrated in parallel with the unfolding acoustic information, directing listeners hypotheses about the most likely referent at each point in time.

On the other hand, the present findings raise the possibility of a second interpretation, which assumes only a general bias towards given information, and does not assume any knowledge of how accenting is used with respect to given and new referents. Since deaccented expressions are less acoustically explicit, they contain less bottom-up information. If this leads to any doubt about the identity of the word, listeners might be forced to rely instead on their top-down knowledge, i.e. by linking it with the
more familiar object. Since accented expressions contain more bottom-up information, top-down information is not necessary. On this interpretation, it is the ambiguity of the input that drives the contribution of any discourse biases, and not the specific knowledge that attenuated expressions are used more often with accessible referents (Bard & Anderson, 1994).

The strongest evidence for the pragmatic specialization account would be a preference for the discourse-new referent for accented words. Although the present experiments did not find this, other experiments in the literature have reported evidence that adults understand accented expressions faster when they refer to something that is either not previously mentioned (Dahan et al., 2002, exp. 1), or something not mentioned in a parallel syntactic position (Dahan et al., 2002, exp. 2; Terken & Nootenboom, 1994).

Further evidence to support the pragmatic specialization interpretation comes from the timecourse of the effects presented here. If listeners only consult their top-down biases when the bottom-up speech input is too degraded to be fully interpretable, listeners would need to first determine whether the bottom-up input was sufficient, and only then turn to their discourse biases. This might even predict faster resolution of accented than deaccented nouns. Yet deaccented expressions led to very fast looks to the given cohort, revealing a bias before the word was fully heard. In the adult data (exp. 1), comprehension of the deaccented anaphoric nounphrase was just as fast as the pronominal anaphor, with target identification beginning around 300 msec after the onset of the referring expression. This occurs despite the fact that the pronoun is shorter, and there is no ambiguity about whether the pronoun depends on the discourse context, since all pronouns require external information for their interpretation. The children (exp. 2)
had slightly slower target looks with the deaccented anaphor, compared with the pronoun, but still much faster than in the accented conditions.

Thus, the most plausible interpretation of the data in experiments 1 and 2 is that children, like adults, know that deaccented expressions tend to be used for highly accessible entities, and they use this to facilitate their interpretation of a definite noun phrase. Moreover, 4 and 5 year old children, like adults, are able to integrate the acoustic properties of both noun and pronoun anaphors with the discourse context rapidly enough to be able to use it during on-line language comprehension.

Children’s relatively adult-like comprehension in the current experiment stands in contrast to other reports in the literature, where children do not use discourse accessibility to constrain their interpretation of pronouns (Arnold et al., in press), or do not do so on-line (Song & Fisher, 2005). Children’s comparative success in the current study reflects the prediction that children should show greater success when there is a large difference in the accessibility of potential referent entities. In the current study, the given cohort was highly salient, being the only object moved on the previous trial, whereas the unmentioned new cohort was not brought to the attention of the participants at all. While Song & Fisher’s study also used a strong manipulation of accessibility, their participants used it more slowly, most probably because of their young age (3 years). In sum, the current experiments establish the ability of young children to rapidly use accenting and discourse accessibility to constrain on-line reference comprehension.
References


Author Note

This research was supported by NIH grant HD-41522 to the author. Many thanks to all of the adult participants in Experiment 1, and to the parents and children who came to campus to participate in Experiment 2. I am grateful to Rebecca Altmann for her extensive work on a pilot version of Experiment 1, and to Shin-Yi Lao for her invaluable help with experiment 2, including recruiting the subjects, collecting and coding data, and organizing the coded data. Many thanks also to Alex Christodoulou, Glenn Kern, Yi Li, Tatiana Meteleva, and Daniel Peterson for their help collecting and coding the data, and to Bob McMurray for the use of his data analysis program. Humberto Gutiérrez-Rivas generously helped construct the magnet board display for experiment 2.
Appendix A

Target and competitor cohorts for critical items

<table>
<thead>
<tr>
<th>Both Experiment 1 and Experiment 2:</th>
<th>Experiment 1 only:</th>
</tr>
</thead>
<tbody>
<tr>
<td>bacon, bagel</td>
<td>whistle, windmill</td>
</tr>
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<td>cake, cape</td>
<td>beaker, beetle</td>
</tr>
<tr>
<td>camel, camera</td>
<td>cloud, clown</td>
</tr>
<tr>
<td>candy, candle</td>
<td>coat, comb</td>
</tr>
<tr>
<td>fish, fist</td>
<td>dollar, dolphin</td>
</tr>
<tr>
<td>hammer, hanger</td>
<td>harp, heart</td>
</tr>
<tr>
<td>horse, horn</td>
<td>spider, spiral</td>
</tr>
<tr>
<td>lemon, leopard</td>
<td>rooster, ruler</td>
</tr>
<tr>
<td>mouth, mouse</td>
<td>carrot, carriage</td>
</tr>
<tr>
<td>mushroom, moustache</td>
<td>spool, spoon</td>
</tr>
<tr>
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<td>plate, plane</td>
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<td>picture, pickle</td>
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<td>turkey, turtle</td>
</tr>
<tr>
<td>watermelon, waterfall</td>
<td>bandaid, banjo</td>
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</tbody>
</table>