

Sarcasm Recognition in Children with Hearing Loss: The Role of Context and Intonation

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Learning to accurately identify sarcasm demonstrates theory of mind and is an important step in mastering adult discourse. We investigated whether a published method of assessing sarcasm could be applied to children with hearing loss. Adults and children typically use two linguistic cues differentially to identify sarcasm: context and intonation. We expected that children with hearing loss would interpret fewer stories as sarcastic and would rely less on intonation cues in their interpretations when compared to children who have normal hearing. The present study included children, aged 5-9 years-old, with normal hearing or mild to severe sensorineural hearing loss. Both groups of children listened to eight stories with varying combinations of context and intonation cues to sarcasm and then answered questions probing for the speaker's intent. Both groups relied less on intonation cues than on context cues to identify sarcasm, and children with hearing loss relied less on intonation cues than children with normal hearing. Children whose parents used more sarcasm were more likely to use sarcasm and more likely to identify sarcastic intent. Children in this age range are still developing understanding of sarcasm. The presence of hearing loss may impede acquisition of this mode of discourse, perhaps reflecting differences in language experience or theory of mind. Although children were assessed successfully following the published method, we recommend future studies include a condition reflecting presence or absence of facial cues of sarcasm and a measure of theory of mind.

Introduction

To develop into mature language users, children must transition beyond literal understanding of spoken language. In adult social discourse, listeners attend to more than the factual sense of words and sentences. Indeed, an utterance's literal meaning may intentionally misrepresent the speaker's intended message. This is especially apparent in verbal irony.

Irony is a language form in which a speaker communicates a meaning different than the literal sense of an utterance, frequently noting an unmet expectation (Bryant & Fox Tree, 2005). Types of irony include hyperbole, understatement, and sarcasm. In adult conversation, 7-8% of statements are ironic (Tannen, 1984; Gibbs, 2000). The most common form of irony used by adults is sarcasm (Capelli, Nakagawa, & Madden, 1990). Although the terms *irony* and *sarcasm* are often used synonymously, sarcasm is a specific type of irony. The intention of sarcasm is to mock or deride, and the target of sarcasm is always an individual (Lee and Katz, 1998; Laval & Bert-Erboul, 2005).

Sarcasm is a complex form of language, and relatively slow to develop. A child's understanding of sarcasm relies on a developed theory of mind. Theory of mind is the ability to recognize or infer the mental state of oneself and of others (Premack & Woodruff, 1978). When a child observes two persons in conversation and one person makes a sarcastic statement towards the other, to comprehend the

statement as sarcastic, that child must recognize that the speaker intends a meaning different than the literal meaning of the utterance *and* that the speaker knows that the listener knows that the speaker did not mean to be taken literally (Capelli et al., 1990). This can be described in terms of first-order and second-order beliefs (c.f., Winner, 1997). To identify sarcasm, the child needs to understand that the belief of the speaker – the first-order belief – contradicts the spoken statement (e.g., “You have a beautiful voice” can only be understood as ironic if the child recognizes that the speaker does not believe the voice is beautiful). If the child fails to recognize the first order belief, the child will think the speaker is being complimentary – the literal interpretation of the statement – despite contextual cues that the voice is unpleasant. Additionally, the child needs to understand the speaker's and target's coordinated belief of the ironic statement – the second-order belief. If the child recognizes the second-order belief (e.g., that the speaker and target are both aware that the target's voice is not beautiful), then the child will recognize the statement as sarcastic. Conversely, if the child fails to recognize the second-order belief, the child will assume that the target does not recognize the irony (e.g., the child may think that the target believes the target's voice is beautiful, and will perceive the speaker's statement as supporting that belief – a way to preserve the target's feelings when the voice may in truth be unpleasant). Because of this complexity, it is hypothesized that

there is a gradual developmental progression in comprehension of sarcasm, from a very primitive understanding to full appreciation (Capelli et al., 1990).

Yet, the exact developmental progression of irony is unclear. Children appear able to determine the non-literal meanings of irony by six years of age, but they do not distinguish between the pragmatic purposes of these speech acts (e.g., to mock, deride, or be funny), until later in middle childhood (Dews et al., 1996; Glenwright & Pexman, 2010). Young children are more likely to produce ironic statements in the form of hyperbole (e.g., "I have the biggest sandwich in the world") than in other forms, such as sarcasm or understatement (Recchia, Howe, Ross, & Alexander, 2010). Thus, only some aspects of irony are accessible to young children. Comprehension of irony, and in particular sarcasm, may depend on the strength of cues available to infer the speaker's intent (Nakassis & Snedeker, 2002). Adults take advantage of two primary cues for detecting sarcasm: the context in which the utterance is made and the intonation in which the utterance is spoken. The contextual cue is most consistent, as the literal meaning of the utterance is opposite from what the corresponding circumstances would justify. The presence of sarcastic intonation is less consistent; however, slower tempo, greater intensity, and a lower pitch level are significant indicators of sarcasm (Rockwell, 2000). The cues for sarcasm are independent. It is possible for sarcasm to be expressed without a specific intonation when contextual cues are available (Bryant and Fox Tree, 2005). Conversely, in the absence of contextual cues, listeners are able to discriminate between posed sarcasm (where a speaker reads an utterance "sarcastically") and non-sarcasm based on vocal cues alone (Rockwell, 2000). Children use context and intonation to understand sarcasm differently than adults. Whereas adults and middle-school aged children could identify sarcasm from contextual cues alone, third-grade children could only recognize sarcasm when both intonation and contextual cues were available (Capelli et al., 1990). A later study, using a closed-set response format found the same relationship in a group of younger children. Seven-year-old French-speaking children were able to recognize sarcasm on the basis of contextual cues alone whereas five-year-olds required an intonation cue to recognize sarcasm (Laval and Bert-Erboul, 2005). Both studies conclude that intonation is an earlier developing cue than context for understanding sarcasm. This finding is not universal. Winner and colleagues (1987) found that six-year-old children's understanding of sarcasm was equivalent in the presence or absence of intonational cues, and that intonation did not improve understanding of sarcasm until around eight years of age.

Less is known about how children with hearing loss develop understanding of sarcasm. Characteristics of this population may

impede development of this skill. Children with poorer auditory resolution may be less sensitive to the pragmatic information provided by intonation cues. Children with cochlear implants are poorer than children with normal hearing at recognizing falling and rising contours of speech (See, Driscoll, Gfeller, Kliethermes, & Oleson, 2013) and at identifying emotions corresponding to affective speech prosody (Hopyan-Misakyan, Gordon, Dennis, & Papsin, 2009). Children with hearing aids have better perception of intonational cues than children with cochlear implants, possibly due to better frequency resolution in the low frequencies (Most & Peled, 2007).

Additionally, children with hearing loss may struggle with perceiving the intent behind sarcasm, as it requires theory of mind, an area where this population lags (Peterson, 2004; Schick, de Villiers, de Villiers, & Hoffmeister, 2007). There appears to be a linguistic influence on theory of mind development. For example, deaf children of hearing parents had worse theory of mind than deaf children of deaf parents (Schick, et al., 2007). This was attributed to poor language modeling to the deaf children when hearing parents were attempting to use manual communication, and to poor access to auditory language when hearing parents were using oral communication. Similarly, children with hearing loss who demonstrated better oral language skills developed competency in the false belief task earlier than children with worse oral language skills (Gonzalez, et al., 2007). Certain theory of mind tasks, such as understanding of false belief, resolve during adolescence in children with hearing loss (Gonzalez, Quintana, Barajas, & Linero, 2007).

A third factor which may influence comprehension of verbal sarcasm is experience with this language form. A child who is not exposed to sarcasm may not develop skills in comprehending and using this mode of discourse until later. Children with hearing loss may have delays in development of sarcasm comprehension due to lack of experience. The decreased auditory access of a child with hearing loss results in an overall lack of linguistic experience, including ironic discourse. Additionally, speech that parents direct to children with hearing loss may be different than that directed to children with normal hearing. Speech directed to children with hearing loss may be more directive or descriptive (Cheskin, 1981; Cheskin, 1982). Children with hearing loss who have more experience with conversational exchanges with their parents in turn demonstrate better receptive language ability (VanDam, Ambrose, & Moeller, 2012). We expect a similar effect of experience on children's ability to understand sarcasm.

Considering the influence of auditory and linguistic experience on identification of sarcasm, we hypothesized that children with hearing loss would have a poorer understanding of sarcasm than age-matched children with normal hearing. This hypothesis was

based on the assumption that children who are hard-of-hearing have had reduced and altered auditory and language input and experience to assist them in developing awareness of sarcasm cues. Understanding how children with hearing loss interpret irony is important for developing targeted interventions supporting their acquisition of sophisticated adult discourse style. We report on our experience piloting a protocol investigating this hypothesis among a group of children using hearing aids.

Methods

Participants

Data from seven children with mild to severe sensorineural hearing loss fit bilaterally with hearing aids and seven age-matched children with normal hearing between the ages of 5 and 9 years were included in the study (Table 1). Pure-tone thresholds of children with hearing loss were measured and hearing aid function was verified electroacoustically. Normal hearing status of age-matched children was verified through pure-tone screening at 20 dB HL. Within the hearing loss group, four children were first fit with amplification prior to age 3 years and the remaining children were first fit between 3 and 4 years of age. Four children were diagnosed with congenital hearing loss; 1 child was diagnosed with progressive hearing loss; the etiology of the remaining children's hearing loss was unknown. Average maternal education level was 16.7 years for the hearing loss group and 17.9 years for the normal hearing group; the difference between groups was insignificant, $t(11) = 1.29, p = .24$. Average receptive vocabulary level (Peabody Picture Vocabulary Test raw score; Dunn, 2007) was 117.3 for the hearing loss group and 144.0 for the normal hearing group; children with normal hearing exhibited significantly larger vocabulary than children with hearing loss, $t(11) = -2.55, p < .05$.

Children with hearing loss wore their hearing aids throughout the experiment. All parents spoke English as their native language and all children were learning oral English as their primary communication modality.

Test Materials

Eight story templates from Capelli et al. (1990) were used in the current study. Each story template had four different versions derived from each combination of two alternative story bodies and two alternative ending remarks (Appendix). Story bodies either provided information that was *discrepant* with the literal interpretation of the ending remark or information that was *neutral*, consistent with a literal interpretation of the ending remark. Discrepant contexts should lead to an interpretation of

sarcastic intent, whereas neutral contexts should lead to a literal interpretation. All instances of sarcasm involved the form of irony in which speakers mean to convey the exact opposite of their literal meaning.

The stories were read by a male actor and digitally recorded in a sound-treated booth with a Marantz PMD671 audio recorder. Story bodies and endings were recorded separately. The two alternative ending remarks had identical wording; however, the remark was said in a neutral or sincere tone of voice in one case, and in a sarcastic tone of voice in the other. For the sarcastic intonation, the actor exaggerated the modulation of pitch and increased syllable duration relative to the neutral intonation. A group of adults listened to the ending remarks in isolation and were able to discriminate between the sarcastic and neutral intonations. The four permutations of each story were edited and matched for uniform root mean square amplitude levels using Adobe Audition (Adobe Systems Incorporated, 2007). Stories were not matched for length; however, there was no systematic variation in story length, i.e., sarcastic stories were sometimes longer and sometimes shorter than the neutral stories.

Story types were defined as:

- No Cue - neutral context with neutral prosody, providing no cues for sarcasm;
- Context Only - discrepant context with neutral prosody, providing only a context cue;
- Intonation Only - neutral context with sarcastic prosody, providing only an intonation cue; and
- Both Cues - discrepant context with sarcastic prosody, providing both context and intonation cues.

Table 1. Individual ages and mean age of children in each group. Individual data and mean data for aided speech intelligibility index (SII) and four-frequency pure tone average (PTA) of the better ear for children with hearing loss. Aided speech intelligibility index is an indicator of the proportion of speech cues that are audible to a child through their hearing aid. Unaided pure tone average is an indicator of the degree of the child's hearing loss.

| Subject | Age (y;m) | Better ear aided SII | Better ear unaided PTA (dB HL) |
|----------------------------|------------------|----------------------|--------------------------------|
| HL1 | 6;1 | .58 | 56.25 |
| HL2 | 7;10 | .69 | 48.75 |
| HL3* | 6;5 | .88 | 17.50 |
| HL4 | 7;8 | .54 | 76.25 |
| HL5 | 7;10 | .74 | 55.00 |
| HL6 | 8;11 | .62 | 62.50 |
| HL7 | 8;2 | .49 | 75.00 |
| <i>MEAN (SD) CHL Group</i> | <i>7;7 (1;0)</i> | <i>.65 (.13)</i> | <i>55.9 (19.8)</i> |
| NH1 | 9;4 | | |
| NH2 | 8;0 | | |
| NH3 | 7;11 | | |
| NH4 | 7;8 | | |
| NH5 | 5;7 | | |
| NH6 | 6;11 | | |
| NH7 | 7;7 | | |
| <i>MEAN (SD) CNH Group</i> | <i>7;7 (1;2)</i> | | |

Note: Subject HL3 had a precipitous high frequency hearing loss, and wore hearing aids bilaterally despite the normal pure tone average.

The No-Cue stories call for a literal interpretation of the utterance, whereas the Both-Cues stories call for an interpretation of sarcasm. Interpretation of the Context-Only stories is subjective – a sarcastic interpretation of the utterance is indicated by its conflict with the story context; however, the neutral intonation neither supports nor denies sarcastic intent from the speaker. An interpretation of sarcasm is most appropriate for this condition (Bryant & Fox Tree, 2005; Capelli et al., 1990). Interpretation of the Intonation-Only stories is also subjective – the literal meaning of the utterance is justified by the context, thus a literal interpretation is appropriate, but the sarcastic intonation of the speaker suggests that the speaker's intent is contrary to the literal meaning. Adults perceive the utterance as bizarre and incongruent; however, and previous research indicates that adults will typically classify the speaker intent as sarcastic (Bryant & Fox Tree, 2005; Capelli et al., 1990).

Procedure

Upon arrival to the appointment, the participant and parent reviewed and signed the consent form for inclusion in the study. The parent completed a questionnaire which asked for various demographic information including date of birth of the child, as well as information related to sarcasm exposure. Specifically, the parent was asked to rate on a four-point scale (never, rarely, occasionally, frequently) how often he/she uses sarcasm and how often he/she hears the participating child use sarcasm. The term sarcasm was not specifically defined to the parent.

Each child sat in the center of an acoustically-treated sound booth facing the sound-field speaker. The examiner read the following instructions to the child per Capelli et al. (1990): "I'm interested in how children understand stories. I'm going to play a tape of some stories and then ask you a few questions to find out what you thought about each story." The examiner allowed the child to ask any questions, and then presented the eight stories in turn via loudspeaker at 65 dB SPL.

After each story, the child answered four questions. Question 1 was open-ended, asking the child to classify speaker intent (e.g., "Why did Wendy say that?"). The response was categorized as sincere, sarcastic, lying, or other if the response did not fit the previous three categories. For example, "Because she was saying it to be mean" was coded as sarcastic; "Because she was probably excited" was coded as sincere; and "Because she didn't mean it, but she was just trying to be nice" was coded as lying. Question 2 was closed-ended, probing for understanding of story content (e.g., "Did Dick catch the ball or not?"). Question 3 was closed-ended, probing for understanding of speaker intent (e.g., "Did Wendy mean that Dick's catch was good or not good?"). Question 4 was open-ended, asking for the child's rationale for their response to the previous question (e.g., "How do you know that?"). The

rationale was categorized as context, intonation, literal meaning, or other if the response did not fit the previous three categories. For example, "Because he didn't catch the ball" was coded as context; "Because she talked funny when she said it" was coded as intonation; and "Because she said it was a nice catch" was coded as literal meaning. Specific wording of questions for each story is available in Capelli, et al. (1990).

The children's responses to these questions were transcribed. The transcriptions were given to two blinded research assistants for coding of responses to the open ended questions. Reliability was at 71% for Question 1 and 59% for Question 4. A third blinded rater was brought in to code the responses where discrepancies between Rater 1 and 2 occurred. Reliability between Rater 1 and 3 was 93% for Question 1 and 93% for Question 4. Rater 1's ratings were used for analysis.

We made two predictions about the identification of sarcasm by children with hearing loss. First, we predicted that these children would perform worse than children with normal hearing in all conditions involving sarcasm, (i.e., Context-Only, Intonation-Only, and Both-Cues stories). This would be evident in performance differences for Question 1 and Question 3. Second, we predicted that children with hearing loss would demonstrate a reduced ability to use intonation cues to identify sarcasm. Thus, the addition of intonation cues would yield a negligible benefit over the contextual cue alone. We reasoned that children with hearing loss would be delayed in their ability to interpret the temporal and pitch differences of intonation cues to identify sarcasm due to overall limited access and exposure to auditory cues of speech. This would be evident in responses to Question 1 and Question 4. We did not predict differences in responses to Question 2, the probe for story context.

Results

Because our subject pool was small, we conducted nonparametric analyses to measure effects of hearing loss (Mann-Whitney test) and story type (Kruskal-Wallis test) on children's performance on the four questions.

Question 1 (speaker intent classification)

A series of Mann-Whitney tests was performed to identify an effect of hearing loss on classification of speaker intent. Children with hearing loss were significantly less likely than children with normal hearing to classify a speaker's intent as sarcastic, $U = 268.5, p < .01$. They were also significantly more likely to provide a classification of other, i.e., one that did not fit into a category of sincere, sarcastic, or lying, $U = 497, p < .05$. There was no difference between groups on the proportion of responses labeled sincere, $U = 392, p = 1.00$, or lying, $U = 394, p = .96$.

A series of Kruskal-Wallis tests was performed to identify an effect of story type on classification of speaker intent. Classification

of speaker intent was found to be significantly different for the sincere story type only, $\chi^2(3, N = 56) = 17.2, p < .01$. Pairwise comparisons demonstrated that children were significantly more likely to rate these stories as 1 than 4, and more likely to rate these stories as 1 than 2. See Figure 1 and 2 for graphical comparisons between the two groups, as well as with the slightly older children and adults from Capelli et al. (1990).

Question 2 (story content comprehension)

A Mann-Whitney test indicated that children with hearing loss gave significantly more correct responses to Question 2 than children with normal hearing, $U = 1260, p < .01$. A Kruskal-Wallis test demonstrated no effect of story type on proportion of correct responses to Question 2, $\chi^2(3, N = 112) = 6.3, p = .10$. Figure 3 depicts proportion of correct responses to Question 2 for each group by story type.

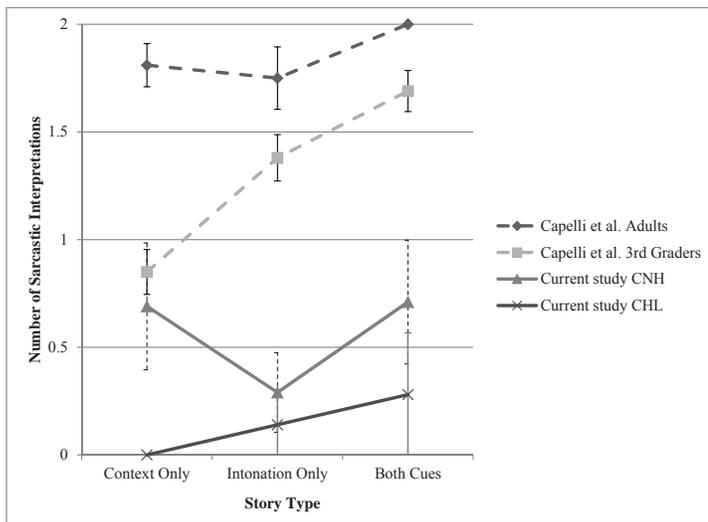


Figure 1. Mean number of interpretations of sarcasm for each of the three sarcastic story types (out of two possible), including results from the normal-hearing adult group and the normal-hearing third-grade group (most closely matched in age to the children in our study) from Capelli, Nakagawa, and Madden (1990). Error bars equal one standard error.

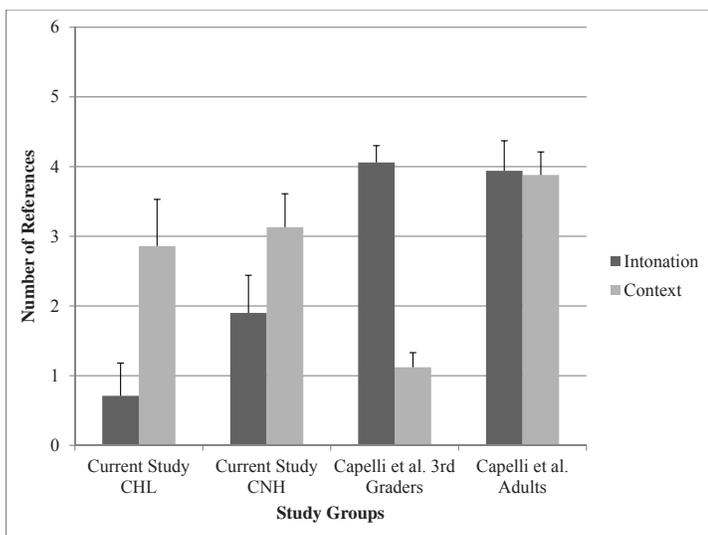


Figure 2. Mean number of times subjects referred to intonation and context for the sarcastic stories (out of six), including results from the normal-hearing adult group and the normal-hearing third-grade group (most closely matched in age to the children in our study) from Capelli, Nakagawa, and Madden (1990). Error bars equal 1 standard error.

Question 3 (speaker intent comprehension)

A Mann-Whitney test indicated no difference in the proportion of correct responses to Question 3 by children with hearing loss and children with normal hearing, $U = 1372, p = .18$. A Kruskal-Wallis test demonstrated a significant effect for story type, $\chi^2(3, N = 112) = 28.0, p < .01$. Pairwise comparisons analysis showed that children were significantly more likely to provide correct responses for the No-Cue and the Both-Cue stories than for the Intonation-Only and Context-Only stories. There was no significant difference in accuracy between the No-Cue and Both-Cue stories nor between the Intonation-Only and Context-Only stories. Figure 4 depicts proportion of correct responses to Question 3 for each group by story type.

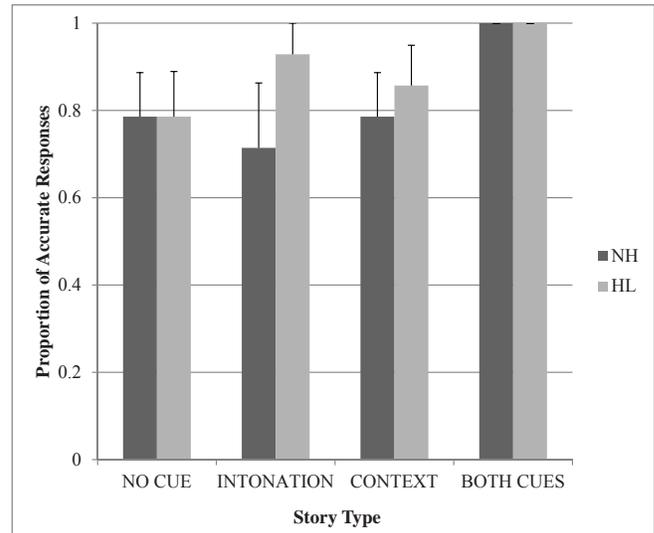


Figure 3. Proportion of accurate responses to Question 2 by story type. Question 2 probed for comprehension of the action in the story that prompted the sarcastic/neutral response. Error bars equal 1 standard error.

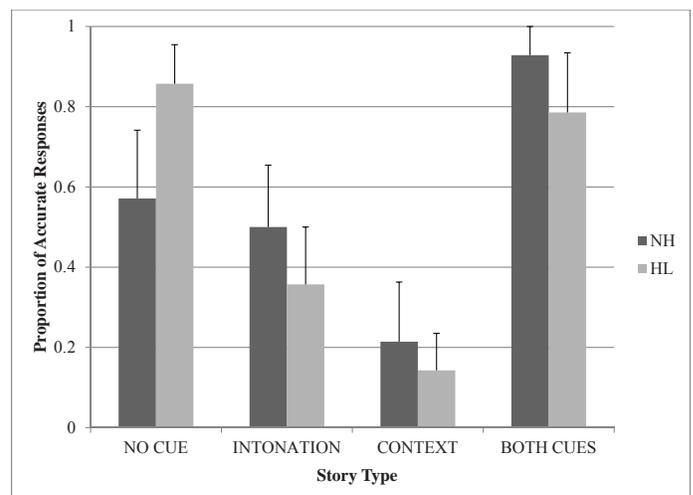


Figure 4. Proportion of accurate responses to Question 3 by story type. Question 3 probed for comprehension of the intent of the speaker of the sarcastic/neutral response. A response was considered accurate if the child's response matched the intonation of the speaker. Thus, in the context only condition, the response was scored as correct if the child responded that the speaker (using neutral intonation) meant what he/she said, even though it was contrary to the action of the story. Error bars equal 1 standard error.

Question 4 (response rationale)

A series of Mann-Whitney tests was performed to identify an effect of hearing loss on classification of the rationale for the speaker's response. As with Question 1, children with hearing loss were significantly less likely than children with normal hearing to classify a speaker's intent as sarcastic based on intonation, $U = 276, p < .05$, and also significantly more likely to provide a classification of other, i.e., one that did not fit into a category of context, intonation, or literal interpretation, $U = 502.5, p < .05$. There was no difference between groups on the proportion of responses labeled context, $U = 343, p = .39$, or literal interpretation, $U = 461.5, p = .12$. A series of Kruskal-Wallis tests was performed to identify an effect of story type on classification of speaker intent; no significant effects were found.

Parent ratings of sarcasm use

Parents rated their own and their children's sarcasm use on a four point scale, from 0, "Never uses sarcasm," to 3, "Frequently uses sarcasm". Average parent ratings of their own frequency of sarcasm use were the same, whether they had children with hearing loss, $M = 1.79, SD = .81$, or children with normal hearing, $M = 1.79, SD = .99$, suggesting that parents' frequency of sarcasm use did not depend on their child's hearing status. Children with hearing loss were rated as slightly less likely to use sarcasm, $M = 1.29, SD = .48$, compared to children with normal hearing, $M = 1.43, SD = .79$, but this was not significant, $t(12) = .41, p = .69$. Correlational analyses were performed to investigate how frequency of sarcasm use influenced performance on sarcasm identification. There was a large, positive correlation between parents' ratings of their frequency of sarcasm use and their child's frequency of sarcasm use, $r(12) = .58, p < .001$. Finally, there was a small, positive correlation between children's frequency of sarcasm use and correct identification of sarcastic intent for Question 1, $r(12) = .29, p < .01$.

Discussion

Children's Interpretations of Sarcasm

We predicted that children with hearing loss would be poorer identifiers of sarcasm than children with normal hearing. Our data supported this hypothesis as children with hearing loss showed fewer sarcastic interpretations to Question 1 (speaker intent classification), although their responses to Question 3 (speaker intent comprehension) were no worse than those of children with normal hearing.

We also predicted that children with hearing loss would be less sensitive to intonation as a cue to sarcasm compared to children with normal hearing. This hypothesis was substantiated as children with hearing loss showed fewer sarcastic interpretations to Question 1, fewer responses based on intonation to Question 4 (rationale for Question 3 response), and better accuracy for

Question 2 (story content comprehension). This last finding was surprising as we expected there to be no difference in story content comprehension between groups. As evident from Figure 3, this was largely due to children with hearing loss more accurately comprehending the story content in the Intonation-Only stories. For example, in one Intonation-Only story, Dick successfully catches the ball but Wendy tells him "Nice catch" with sarcastic intonation. Children with hearing loss were more likely to accurately comprehend the story content (e.g., that Dick caught the ball). One possible explanation is that children with normal hearing were more influenced by the intonation of the speaker to revise their understanding of the story.

It is reasonable to expect hearing loss to affect development of comprehension of sarcasm. This ability relies on perception of a unique prosodic signature as well as developed theory of mind - two areas where children with hearing loss have identified weaknesses. Considering its prevalence in conversational speech, children who do not understand sarcasm may experience more frequent breakdowns in communication and may be perceived as communicatively awkward. Given the results of the correlational analysis, it appears that parents who use sarcasm more often, thereby increasing their children's exposure to verbal irony, may be helping their children develop comprehension of this mode of discourse.

This study is the first to our knowledge to assess sarcasm comprehension among children with hearing loss. The assessment framework published by Capelli, et al (1990) provided a foundation for this assessment. Children with hearing loss were able to follow the instructions and make classifiable responses. Many of the responses of children with hearing loss were similar to those of children with normal hearing.

We predicted that children with hearing loss would be poorer identifiers of speaker intent than children with normal hearing in story conditions involving sarcasm. Children with hearing loss identified the speaker's intent as sarcasm on the open-ended probe significantly less than children with normal hearing overall. This may indicate that children with hearing loss do not understand when sarcasm is present as well as children with normal hearing, or that they are poorer describers of the speaker's intent. On the closed-ended probe for comprehension of speaker's intent, children with hearing loss performed the same as children with normal hearing. Thus it would seem that children with hearing loss have a more difficult time describing a speaker's intent than they do at actually understanding the intent. This may be related to differences in expressive language skills or facility verbalizing concepts related to theory of mind, domains where children with hearing loss have been identified as being weaker (Fitzpatrick, Crawford, Ni, & Durieux-Smith, 2011; Peterson, 2004). Indeed,

the children with hearing loss in this study demonstrated smaller vocabularies than the children with normal hearing.

We predicted that children with hearing loss would demonstrate a reduced ability to use intonation cues to identify sarcasm. In our sample, the role of intonation in children's identification of sarcasm was small, regardless of hearing status. Children relied heavily on contextual cues provided by the story to determine whether a speaker's intent was contrary to their literal statement. This is consistent with the findings of Winner (1987) showing that intonation was not a relevant cue until children were 8 years of age and older.

As mentioned, differences between children with hearing loss and children with normal hearing on sarcasm identification were subtle. However, regardless of hearing status, children in our sample were not able to identify sarcasm as well as the third-grade students in Capelli et al. (1990). This comparison is based on children's ability to report sarcasm as the speaker's intent in response to an open-ended question. Of the groups of children studied by Capelli, our children were closest in age to her third-grade group (8-9 year olds); however, on average, the children in our study were younger than the children in her study. Thus, the difference in performance may be an effect of development. It is interesting to note that all children in the present study were able to correctly infer the speaker's intention for the sarcastic stories when given a forced-choice question. This finding suggests that five- to nine-year-old children may be able to grasp some aspects of sarcasm and non-literal language, but do not have the vocabulary or skills to describe their interpretation as well as Capelli's third-graders. This conclusion is consistent with the research of Glenwright & Pexman (2010) which found that children were able to determine the non-literal meanings of both sarcasm and irony by six-years-old, but did not distinguish between the pragmatic purposes of those speech acts until later in middle childhood.

Role of Experience

An additional finding of this study was the relationship between use of sarcasm and sarcasm identification. Children who used sarcasm more often were more likely to identify it. These children had parents who used sarcasm more often, as well. This demonstrates that at least some children with hearing loss are able to identify and interpret sarcasm correctly. Ross Brackett and Maxon (1991) advocate the implementation of communication management principles in auditory habilitation. This includes focus on social interactions such as conversational rules and situational context. Assessing children's understanding of spoken irony in communication management programs for older children with hearing loss may be appropriate considering 7-8% of informal adult discourse is ironic.

Interpretation of this data should be tempered due to the nature of a pilot study. The small number of subjects led us to use nonparametric analyses of the sarcasm data. Even with this small data set, the results did not discourage our hypotheses regarding the delayed development of this pragmatic skill in children with hearing loss.

Further research is warranted to understand how intonation and context interact to direct a child's focus to the intended meaning of a speaker's utterance. Capelli et al. (1990) found that adults relied heavily on both context and intonation when inferring a speaker's meaning whereas children relied less on context. Laval and Bert-Erboul (2005) found that French five-year-olds interpreted sarcasm based on intonation, and seven-year-olds used context and intonation. Conversely, Winner (1987) found that intonation was not a cue supporting identification of sarcasm until age 8 years. Our results are more in line with those of Winner in that five- to nine-year-old children used contextual cues to infer a speaker's meaning, but derived minimal benefit from intonation cues. Research on a larger group of children with hearing loss may reveal additional significant outcomes.

Our methods and materials were taken from those used in a previous study (Capelli, et al, 1990) and applied to children with hearing loss. This is the first investigation of sarcasm comprehension in this population to our knowledge. Children with hearing loss are at risk for delays in theory of mind (Schick, et al, 2007) and comprehension of abstract forms of communication, both areas tapped by sarcasm. After our experience with this initial investigation of the understanding of non-literal speech forms in children with hearing loss, we would recommend that future studies include older children with hearing loss to examine whether their abilities diverge from children with normal hearing as they mature. In addition, we recommend including measures of theory of mind and expressive language.

Future researchers may consider experimenting with other contextual cues, such as visual cues and speaker familiarity. Non-acoustic features of sarcasm have been identified, including flattening of facial expression, eye-rolling, eye-blinking, and smirking, with the strongest cues coming from the mouth (Attardo, Eisterhold, Hay, & Poggi, 2003; Rockwell, 2001). Typical children reportedly recognize sarcasm correctly from non-acoustic cues earlier than they do from linguistic and contextual cues (Laval & Bert-Eboul, 2005). This may explain why many parents in our study were comfortable using sarcasm with their children. Indeed, family use of sarcasm may play a role in children's understanding. In the present study, parents who used more sarcasm rated their children as more frequent users of sarcasm. Additionally, some parents reported anecdotally that their children seemed to understand sarcasm better when it came from older siblings. Intonational cues

of sarcasm vary stylistically from speaker to speaker. Thus the intonational cues available from the unknown speaker in this study may be different from a familiar family member – one whose style of sarcastic intonation the child may recognize.

Sarcasm is an ideal domain for testing the influence of auditory and visual modalities on language comprehension. Future investigations will provide additional insight on the development of adult discourse styles in children with hearing loss.

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Appendix

The eight stories used in this study were taken verbatim from Capelli, et al (1990); please see their original study for more details. Each story has four alternative versions, using combinations of two different story bodies – neutral or discrepant – and two different intonations – neutral or sarcastic. Below is an example of the neutral and discrepant versions of the first story. Note that Wendy's utterance (underlined) could be spoken with neutral or sarcastic intonation depending on story type.

Story 1 – Neutral context conditions (No Cue; Intonation Only)

Dick and Wendy were playing catch with a football at recess. Wendy threw out a long pass, and Dick went running full speed for it. He jumped in the air and then had to fall over backwards to catch it. "Oooh, nice catch," said Wendy.

Story 1 – Discrepant context conditions (Context Only; Both Cues)

Dick and Wendy were playing catch with a football at recess. Wendy threw out a long pass, and Dick went running full speed for it, when he slipped in the mud. His feet flew out from under him and he landed flat on his bottom. The ball bounced off his head and landed next to him in the mud. "Oooh, nice catch," said Wendy.