Indexicals in Shifty Contexts:
Problems for Language Acquisition

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1. Introduction

Successful language acquisition depends on children learning how contextual factors apply in sentence interpretations. These factors play a significant role in acquiring contextually determined expressions, such as indexical pronouns (*I* and *you*) whose semantic value is determined by the context in which they are uttered (Schlenker, 2009). For example, the indexical *I* in *I'm riding a bike*, is always the speaker, and its referent changes when this sentence is uttered by different speakers. This means that children must learn how to interpret contextual factors, like speaker and addressee, to determine the referents of indexical pronouns within different contexts.

The received view in the literature is that indexicals are directly referential; that is, their referent is fixed solely by who the speaker and the addressee are in the context of the utterance (Kaplan, 1989). Since indexical referents are fixed, natural languages were assumed to not have operators that shift the context that is used to evaluate the referent of an indexical, what Kaplan (1989) called *monsters*. Kaplan's view on *monsters* was motivated both conceptually and empirically. Conceptually, one does not need to know anything about the world to know that the utterance *I am here now* is *a priori* true. In contrast, if we replace the indexicals *I*, *here*, and *now* with their particular referents, determining if *Ana was in Oxford on January 14* is true would require knowing something about the world. Empirically, the behavior of English indexicals is in line with a direct referential theory: English *I* always refers to the speaker and does not shift reference even when embedded in a possibly different context. For example, *I* in both *I'm riding a bike* and *John said that I'm riding a bike* is always the speaker. The context from John's saying isn't relevant to fix the correct referent of the indexical.

Even though English indexical data support the idea that indexical expressions cannot shift referents in natural languages, recent cross-linguistic data has challenged this empirical picture. In languages such as Zazaki, Amharic, Aghem, Navaho and Slave (Anand & Nevins, 2004; Schlenker, 2003;

2009; Hyman, 1979; Speas, 2000), indexical pronouns vary in their ability to receive shifted reference in embedded contexts under *say*.[1] For example, Zazaki *ɛz* (*I*) initially appears well-behaved; the indexical in (1a) can only be interpreted as the speaker. However, a closer examination reveals that it can shift reference to the subject if embedded under *say* (1b). In other words, Zazaki *ɛz* can be interpreted as either *I* or *Hesen* in (1b) as indicated by the gloss.

(1) a. Hɛseni termine kɛno kɛ   ɛz newɛsha.
        Hesen   believes does that I sick.am.
        'Hesen believes that I am sick.'
     b. Hɛseni va   kɛ   ɛz dɛwletia.
        Hesen   said that I rich.am
        'Hesen said that I am/he is rich.'

Though one might argue that this is not a case of a referent shift, but rather just a quotation, empirical data supports the case of reference switch. Anand and Nevins (2004) present data from extraction and NPI licensing in Zazaki that demonstrate that these are not quotative contexts. They also show that the interpretative possibilities of shifting indexicals are highly restricted. For instance, indexicals seem to shift together; that is, within the same utterance Zazaki indexicals have to pick up reference from the same context. In example (2), the indexicals *ɛz (I)* and *to (you)* can be determined either by the context of utterance (gloss a) or by the context of the embedding sentence itself (gloss b). Note that, crucially, both of the referents come from the same context. In contrast, attempts to mix referents from the two contexts are deemed to be ungrammatical (glosses c and d).

(2) Vizeri   Rojda   Bill-ra va kɛ   ɛz to-ra   miradisa.
     Yesterday Rojda   Bill-to said that I you-to angry.be-PRES
   a) 'Yesterday Rojda said to Bill that I am angry at you.'
   b) 'Yesterday Rojda said to Bill that I$_{ROJDA}$ am angry at you$_{BILL}$.'
   c) *'Yesterday Rojda said to Bill that I am angry at you$_{BILL}$.'
   d) *'Yesterday Rojda said to Bill that I$_{ROYDA}$ am angry at you.'

Indexical shifting is also constrained in more idiosyncratic ways both within and between languages. For example, different verbs can shift referents and they can differ in the indexicals they can shift, but some verbs, such as *believe* and *know*, never license shifted reference. Also, some indexicals shift obligatorily, some optionally, and some not at all depending on the language and the particular verb they are embedded under (Anand & Nevins, 2004).

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[1] Typologically, all languages that are reported to allow shifted reference do so with the verb *say*. Some languages also allow shifted reference with *tell* (Slave) and *want* and *think* (Navajo, Slave), suggesting that the class of verbs that can shift reference are quite constrained (Anand, 2006).

To account for these cross-linguistic differences, linguistic theory has proposed that the features of both indexicals and embedding verbs may be at play. Concerning indexical features, Schlenker (2009) argues that cross-linguistically, indexicals optionally bare a contextual reference feature that require the indexical to make reference to the context. In a language like Amharic this context feature is optional and its indexicals may refer to a non-contextually specified referent, while in English and Zazaki this context feature is obligatory and their indexicals must refer to a contextually specified referent. Concerning embedding verbal features, Anand and Nevins (2004) argue that cross-linguistically, embedding verbs optionally bare a context-shifting operator that shifts either all or just part of the context. In a language like Zazaki, the verb *say* may bare a context-shifting operator that shifts all contextual referents and all of its indexicals must shift reference when this operator is present, while English *say* does not bare a context-shifting operator and its indexicals never shift reference.

Apart from its empirical significance, this data also suggests that natural languages' capacity to shift indexical reference could influence how children acquire indexicals since children must determine whether their language can or cannot shift reference when embedded. Previous acquisition studies show that non-embedded indexicals, which lack an embedding sentence context and are therefore never licensed to shift referents, pose no problem for language acquisition: children are able to successfully produce pronouns by the age of 18 months or earlier (Strayer, 1977; Macnamara, 1980), and by the time they are around 2.5 years old or earlier, they are able to successfully comprehend them as well (Charney, 1980; Oshima-Takane, 1985; Strayer, 1977; Moyer et al., 2015).

However, embedded contexts might pose more of a problem since the contextual factors that apply in these cases may be more complex depending on the properties of the target language. Given the theories sketched out above, what children must learn during the acquisition of indexicals is not only which if any of their indexicals takes a contextual reference feature optionally, but also which if any of their embedding verbs bares a context-shifting operator. Based on what we know about the cross-linguistic picture concerning embedded indexicals and their ability to shift reference, it must be that children, while acquiring embedded constructions, are able to determine whether their language's indexicals do or do not shift reference when embedded; however, the time it takes to learn this may be quite protracted, especially if the data needed is rather sparse.

Simplifying the theoretical picture a bit, there are at least three possible hypotheses for how children acquire embedded indexicals. The first hypothesis is that children initially assume that indexical reference is fixed. This assumption would then be revised if the input contained shifted indexicals, leading the child to reject their initial assumption and hypothesize that indexicals can shift. Under this first hypothesis, children start out with English-like indexicals, and would then be lead to Amharic/Zazaki indexicals through the course of acquisition. The second alternative is that children initially assume

that indexicals can shift. This assumption would then be revised as the child failed to encounter shifted indexicals in the input. Under this second hypothesis, children start out with Amharic/Zazaki-like indexicals and then are lead to English indexicals through the course of acquisition. The third alternative is that children are uncommitted to either shifting or fixed indexicals, and are guided by the data to commit to one or the other. This third hypothesis predicts that children may behave like they possess Amharic/Zazaki-like indexicals, but they are still weighing the evidence in favor of shifted or fixed indexicals.

In this research, we explore the shape of the input data and children's interpretations of embedded indexicals over three studies. The first study (section 2.1) examined corpora to determine the frequency of unambiguous cases of embedded indexicals in the input. The second study (section 2.2) explored whether the broad context found in corpora supports the intended interpretation of embedded indexicals. Finally, a truth value judgment (TVJ) task (section 2.3) was used to investigate if English-acquiring children ever interpret English indexicals with shifted (non-English) interpretations.

2. Studies
2.1. Corpus study

To determine whether children are exposed to enough data to infer that indexicals can or cannot shift when embedded, the input must include *say*-embedded indexicals and be unambiguously embedded. Examples of unambiguously and ambiguously embedded context are in (3) and (4) respectively. An unambiguously embedded indexical pronoun must be embedded under the complementizer *that*. Without a complementizer the clause containing an indexical is often ambiguous between a quotation and an embedded context. For instance, in (3) *me* always picks up the speaker as the referent, but in (4) *me* refers to the speaker if it is analyzed as embedded and to Naima if it is analyzed as a quotation.

(3) Naima says that you want to talk to me.

(4) Naima says you want to talk to me.

The aim of the corpus study was to see whether the unambiguous cases are, indeed, as rare in the input as assumed. If the unambiguous input children get is rare, this could, in fact, complicate acquisition.

2.1.1. Methodology and results

Text excerpts of recorded conversations between adults and children were taken from the Providence and Brown corpora in the CHILDES database (MacWhinney, 2000). We analyzed child-directed speech in Providence and Brown corpora from the CHILDES database. Constructions we were interested

in were both indexical (*I*, *me*, *mine*, *my*, *you*, *your*, *yours*) and non-indexical pronouns (*he*, *his*, *him*, *she*, *her*, *hers*) that are embedded under the verb *say* both with and without the complementizer *that*. The results show that of the 95,528 indexicals in the two corpora, only 218 (0.23%) are *say*-embedded, out of which only 16 (0.02%) are unambiguously embedded. Thus out of the 218 that are *say*-embedded only 7.33% are embedded with *that;* that is, unambiguously embedded. As for the non-indexical pronouns, there are 56 cases of *say*-embedded non-indexical pronouns, out of which only 5 (1.82%) are embedded with *that*.

Table 1. Corpus study results: Indexical and non-indexical pronouns embedded under the verb *say*.

	Embedded with *that*	Embedded without *that*	TOTAL
Indexical	16	202	218
Non-indexical	5	51	56
TOTAL	21	253	274

2.2. Stimulation experiment

The corpus analysis showed that unambiguously embedded indexicals are quite rare in the input with only 0.02% out of the total number of indexicals, and 7.33% out of the total number of *say*-embedded indexicals. With such spare data, it would be vitally important for children to be able to access the intended interpretation of the embedded indexicals. To see if children might have been able to do that for these critical cases, we conducted a simulation experiment to explore if broad discourse context helps establish the intended interpretation of embedded indexicals.

2.2.1. Methodology and results

To test the extent to which language contexts are informative about the referent of an indexical, we used a variant of the human simulation paradigm (Gillette et al., 1999; Orita et al., 2013; Kako, 2005; Piccin & Waxman, 2007). In this study adult participants guessed the identity of a missing word on the basis of linguistic context. The paradigm is based on the assumption that since the participants know there is a word missing, but are not given its identity, the process of selecting what word they think bests fits the missing word would be similar to the one where a learner hears a word and must select what it means during language acquisition.

Participants. 30 participants were drawn from Amazon's Mechanical Turk. All speakers said they were native speakers of English and that they were over the age of 18. Participants received $3 for their participation.

Materials. 75 text excerpts from the corpora used above were adapted for our study. Each excerpt contained a critical sentence with a *say*-embedded indexical (25 1st person, 25 2nd person) or non-indexical pronoun (25 3rd person). Context was provided by the 20 sentences preceeding and 10 sentences following the critical sentence. Excerpts that did not meet these requirements were not included; otherwise, excerpts were chosen randomly. The indexical/non-indexical pronoun in the critical sentence was deleted and replaced with a blank and the sentence was bolded. At the end of each excerpt, the participant was asked to choose the best completion for the blank in the bolded sentence and were always given a form appropriate 1st, 2nd, and 3rd person pronoun to choose from. A truncated example is given in (5).

(5) GRANDFATHER: I know but, but so what?
     MOTHER: I don't like it.
     GRANDFATHER: I mean nobody knows.
     MOTHER: I don't like it, it's too gaudy.
     GRANDFATHER: all right I'll take it back.
     GRANDFATHER: if you don't want it, you don't want it?
     MOTHER: I said _____ wanted it.
     GRANDFATHER: uh?
     MOTHER: doesn't mean I have to wear it every minute.

     Which word best completes the blank in the **bold** sentence?
     a) I
     b) you
     c) she

Procedure. Participants were given 1 hour to complete this study. Participants were told that these excerpts were from real recorded conversations between adults and children. They were instructed to read the excerpts and pick the word (from the list of 3 pronouns) they thought best completed the blank.

Results. Mean accuracy across the three conditions is given in Figure 1. Overall, adult participants were much better than chance (t=29.809, p<.001) with mean accuracy of 0.86 for the *I* cases and 0.87 for the *you* cases. However, indexical pronouns were slightly less accurate than non-indexical pronouns (z= -1.660, p=.0969) whose mean accuracy was 0.94.
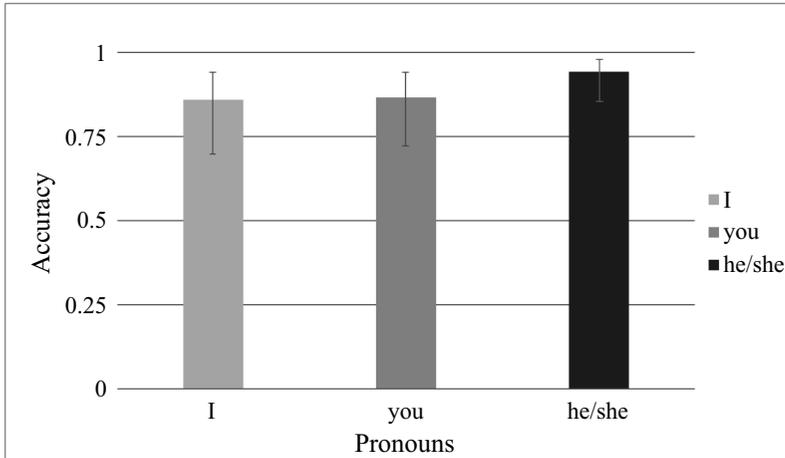
Figure 1. Simulation study: Accuracy by indexical (*I*, *you*) or pronoun (*he*/*she*).

These results suggest that the broad discourse context might be rich enough to allow children to access the intended interpretation of indexicals, suggesting that they can use this information when acquiring embedded indexicals. One caveat, however, is that adults showed more difficulty with indexical pronouns as opposed to non-indexical pronouns, suggesting that *say*-embedded indexicals may be somewhat more fragile in their interpretation.

2.3. TVJ task

Based on previous studies, acquisition of indexical pronouns (at least in non-embedded context) should be complete by age 2.5. By this time, children are able to successfully comprehend and produce indexicals in non-embedded contexts (Strayer, 1977; Macnamara, 1980; Charney, 1980; Oshima-Takane 1985; Moyer et al., 2015). As for their embedded counterparts, the first two studies have shown that even though the unambiguous cases of embedded indexicals are rare in the input, the broad discourse context seems to be rich enough for the correct interpretation of these indexicals to be available to children. This suggests that children could acquire indexicals in embedded contexts as quickly as they do in non-embedded contexts. To test this possibility, we conducted a truth-value judgment (TVJ) experiment to determine whether children ever understand indexicals embedded under *say* with non-English (shifted) interpretations well past the age at which they have successfully acquired indexical pronouns more generally.

2.3.1. Methodology

Participants. The TVJ study was conducted on two groups: a group of 24 English-speaking adults living in Oxford, UK, and 18 English-acquiring 3-5 year-olds from different pre-schools in Boston, USA (mean age=4.2).

Materials. 24 experimental scenes were constructed that depict a narrator (Tom) and a picture of the narrator with his two friends, John and Sally (Figure 2). Each scene was paired with twelve possible sentences in which the narrator reported what his friend John had said to him about the picture. The sentences manipulated the embedded subject (indexical *I*, pronominal *he*, or proper name *Sally*) whether the utterance was unambiguously embedded with an overt complementizer *that* or was quotational. Examples of unambiguously embedded sentences for Figure 2 are given in (6) along with their expected truth-value given an English interpretation.

(6) a. John said that I am wearing a scarf. (Expected: TRUE)
    b. John said that I am wearing a hat. (Expected: FALSE)
    c. John said that he is wearing a hat. (Expected: TRUE)
    d. John said that he is wearing a scarf. (Expected: FALSE)
    e. John said that Sally's wearing boots. (Expected: TRUE)
    f. John said that Sally's is wearing a hat. (Expected: FALSE)

These sentences were recorded by a native English speaker who was instructed to utter the sentences with either normal prosody in the case of unambiguously embedded sentences, or with quotational prosody, including a prosodic break after *said* and a reset of the sentence prosody at the beginning of the quoted clause, in the case of quotation. Recordings introducing the participant to the narrator and his friends, along with questions that asked if what John reported was right, were also made.
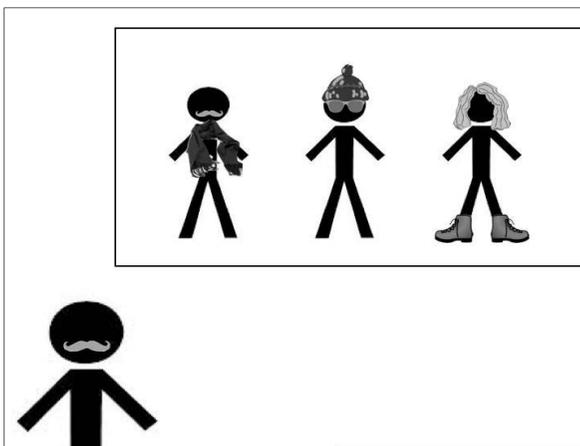

Figure 2. Experimental screen.

Procedure. Each participant was sat down in front of a laptop on a table. On the screen they saw several cartoon characters who were presented in different scenes with different objects (e.g. on a party, on the beach, riding bikes) and heard audio recordings. At the beginning of the experiment, the participants were introduced to the narrator, Tom, to each of the friends, John and Sally. The narrator told participants that he was a detective and that his friend John wanted to become his assistant, but the narrator was not sure if John noticed details very well and asked the participant to help him decide if John correctly reported the details of a series of pictures with him and his friends. After becoming acquainted with the narrator and his friends, each participant saw 24 different experimental screens. The narrator was present on every screen, and he reported what John had said about the pictures. The narrator would first set up the picture (for Figure 2: *Here we are in winter*) and then the participant heard two prompts. The first prompt was about what John said about the narrator or himself (for Figure 2, embedded: *John said that he is/I am wearing a hat*, or quotative: *John said, "I am/He is wearing a hat"*). The second prompt was about what John said about Sally (for Figure 2, embedded: *John said that Sally's wearing a hat*, or quotative: *John said, "Sally is wearing a hat"*). Embedded vs. quotative conditions were counterbalanced so that half of the participants saw the first 12 scenes with embedded sentences followed by 12 scenes with quotative sentences, while the other half saw 12 scenes with quotative sentences first, followed by 12 scenes with embedded sentences. After each sentence prompt, the participant was asked if John was right. Their response was written down by the examiner.

Results. Mean accuracy for English speaking adults is given in Table 2. This group was very accurate in responding with the expected English interpretations in embedded sentence conditions, with all three referent conditions showing virtually ceiling-level performance. Somewhat surprisingly, however, English speaking adults were not as accurate in quotative sentence conditions. In particular, they performed poorly on the 3rd person *he* condition. We suspect two things account for this poor performance. First, quotative prosody may not have been robust enough to unambiguously signal a quotation, leaving some cases ambiguous between being embedded and quotative. Second, it may have been pragmatically odd for the narrator to have reported 3rd person *he* quotations given these scenes. Based on the difficulty encountered by our adult participants on the quotative conditions, we focus on the embedded sentence conditions below.

**Table 2. Adult accuracy by embedded/quotative condition.**

	Embedded	Quotative
I	0.98	0.87
he	0.97	0.64
Sally	0.99	1.00

Mean accuracy for English acquiring children is given in Table 3. Overall, children's interpretations seem to be largely adult like; however, children's performance on indexical *I* did not differ from chance in embedded sentence conditions (t=1.530, p=.133).

**Table 3. Children's accuracy by embedded/quotative condition.**

	Embedded	Quotative
I	0.58	0.42
he	0.96	0.13
Sally	0.99	0.99

A comparison of child and adult performance is shown in Figure 3.
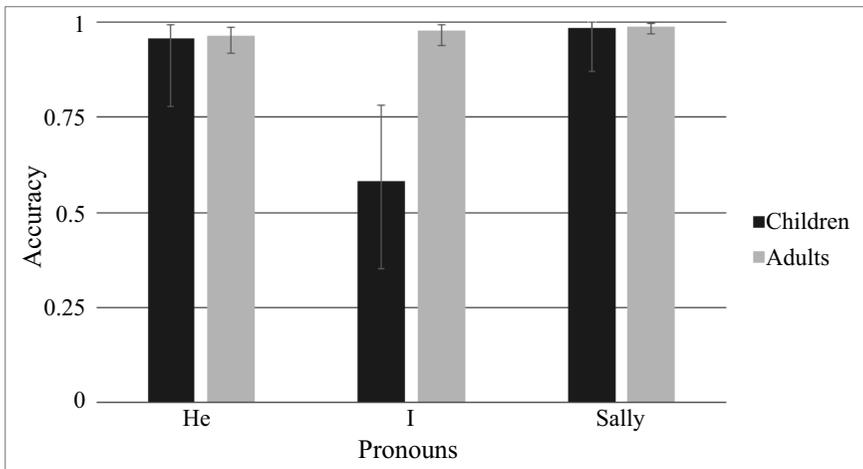
Figure 3. Adult vs. children accuracy in embedded condition only.

To examine whether children were acquiring embedded indexicals over the ages present in our experimental group, we conducted a regression analysis to look for effects of age on accuracy, shown in Figure 4. The 3rd person condition showed significant improvement from age 3 to age 5 (p=0.033, t= 2.327, slope= 0.1901), however, no such improvement was found for the 1st person *I* condition (p=0.633, t= 0.487, slope= 0.065). The proper name referent condition also showed no improvement (p= 0.137, t= 1.567, slope= 0.084), though this is because performance was already at ceiling across all ages.
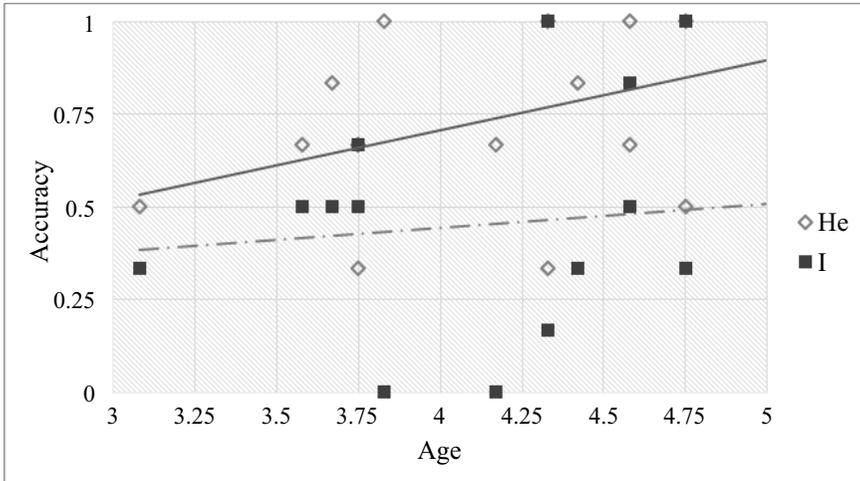
Figure 4. Children's age and accuracy. The improvement in accuracy for 3rd person *he* is given by the solid line; the improvement in accuracy for 1st person *I* is given by the dashed line.

3. General discussion

The results of the corpus study confirmed the assumption that unambiguously embedded indexicals are, in fact, very rare in the input. These results suggest that the input might not support the rapid acquisition of embedded indexicals and that indexical acquisition might therefore take place over a more protracted period of time. A second worry is that with such few exposures, children may be unable to access the intended referent, making the acquisition path all the more difficult to traverse. However, the simulation study results showed that broad context can be rich enough for adults to successfully determine the intended referent of an indexical for these rare cases in the input. This suggests that children may, in fact, be able to use what few exposures they have to the relevant input early in acquisition to determine whether their language is able to shift reference, though our results that adults are slightly less accurate with indexicals compared to non-indexical pronouns, implying that it might be more difficult to successfully determine the intended referents of indexicals than of non-indexical pronouns.

Taken together with the previous research on the acquisition of indexicals, these two studies suggest that the acquisition of embedded indexical pronouns could be fairly easy. Previous acquisition studies show that acquisition of indexical pronouns in non-embedded contexts goes smoothly, with children able to successfully comprehend and produce indexicals by the time they are 2.5 y.o. Worries about the rarity of unambiguously embedded indexicals in the input might not be an issue, since the broad discourse context seems to be rich enough to give children access to the intended interpretation of indexicals in these

critical cases. However, the results of the TVJ study suggest that 3 to 5 y.o. English-acquiring children continue to consider the possibility that embedded indexicals can shift reference, showing more flexibility in interpreting *say*-embedded *I* than would be expected given that their interpretations of unembedded indexicals are mainly adult-like.

Considering the acquisition hypotheses we laid out at the end of the introduction, the evidence found in the TVJ study gives us reason to reject the first, e.g. that children initially assume that indexical reference is fixed. Given that English acquiring children do not receive input suggesting that their indexicals can shift reference, this first hypothesis predicts that we would not see shifted reference in the TVJ experiment, contrary to what was found. However, the evidence from the TVJ study can support either of our other two hypotheses. It could be that children begin with the assumption that indexicals can shift, and then as they accumulate evidence that none of their language's indexicals are shifting, revise that hypothesis. This evidence is also consistent with the position that children are initially uncommitted about the representation of indexicals, and over time use the evidence they are given to converge on their target language's representation. In both cases, shifted reference for English acquiring children is expected even though these children have no evidence from the input that their indexicals shift. At issue then is the time course of acquisition and how much data a child needs to either revise their initial assumption or to conclude for one hypothesis over the other. Future research will be needed to address this question.

Returning to the subtle variation between languages concerning indexical shifting, we also note that shifted reference behavior may reflect multiple grammatical possibilities which remain untested at this time. Considering the indexicals themselves, shifted behavior may result from the optionality of a context reference feature (Schlenker, 2009) but from the perspective of embedding verbs, it is the presence of a context-shifting operator that drives behavior. In the cases of operators, however, Anand and Nevins (2004) note that indexicals must shift together (see (2) above), suggesting a way to diagnose whether the kind of indexical-shifting is present in English acquiring children is related to optional indexical features or the presence of verb operators. Additionally, different verbs license the shifting of different contextual referents in different languages. For instance, *say* has been found to shift context in all indexical-shifting languages, whereas *tell*, *want*, and *think* are only found in a subset of these language. Every language also shifts both first and second person indexicals, but for those with multiple shifting verbs, some of those verbs only shift first person indexicals. This variability further complicates the acquisition picture though there may an implicational hierarchy at play that guides the child when acquiring indexicals, an idea that remains to be shown.

4. Conclusion

Although Kaplan's (1989) ban on reference shifting suggests a simple pathway for indexical acquisition, recent cross-linguistics data has found that shifted indexicals exist in natural languages, suggesting a more complex grammar underlying indexicals which might cause difficulties in acquisition. In addition to acquiring the context sensitive nature of indexicals, a child needs to learn whether their language is a language that allows or disallows shifted indexicals. Together, our three studies show that even though children acquiring a fixed indexical language might be able to get everything they need from the input, despite of rarity of embedded indexicals, they continue to provide shifted interpretations of indexicals long after they are thought to have mastered indexical reference. This suggest that children's actual knowledge of indexicals is begin acquired over a more protracted period of time than initially thought.

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