Discourse continuity promotes children's learning of new objects labels

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Abstract

The present study examined the influence of continuity of reference (i.e., discourse continuity) on children's learning of new objects labels. Four-year-old children were taught three new label/objects pairs, where the speaker's references to objects were either continuous (i.e., clusters of utterances referred to the same object) or discontinuous (i.e., no two sequential sentences referred to the same object). In two experiments, children learned new word/object mappings more successfully when object labels were accompanied by continuous references to the same object. This research reveals how discourse cues support children's encoding of new words, and in doing so, advances our understanding of the specific features of parents' language input that facilitate children's language development.

Keywords: discourse continuity; word learning; child-directed speech

Introduction

Children are adept at analyzing the complexities of their language input in order to learn new words, but there is also substantial variability in their learning. In order to better understand these differences, researchers have examined various features of caregivers' input shown to influence vocabulary growth, including social cues (such as eye gaze and pointing; e.g., Booth, McGregor, & Rohlfing, 2008; Brooks & Meltzoff, 2008), structural cues (such as repetition and utterance length; Brent & Siskind, 2001; Lew-Williams, Pelucchi, & Saffran, 2011; Schwab & Lew-Williams, 2016), visual cues (such as the size of labeled objects in the visual field or their perceptual salience; Pereira, Smith, & Yu, 2014; Pruden, Hirsh-Pasek, Golinkoff, & Hennon, 2006), and auditory cues (such as intonation and pitch; e.g., Ma, Golinkoff, Houston, & Hirsh-Pasek, 2011; Singh, Nestor, Parikh, & Yull, 2009). Here we focus on a contextual cue of parents' speech that may also facilitate children's vocabulary development: the content or structure of the discourse exchange. Specifically, *discourse continuity*, or the clustering of utterances that reference the same topic, may promote children's word learning (e.g., Frank, Tenenbaum, & Fernald, 2013). Recent research on this topic suggests that discourse continuity does promote children's in-the-moment disambiguation of word-referent mappings in noisy referential contexts (Horowitz & Frank, 2015), but it is not yet clear whether discourse continuity also contributes to children's encoding of new words in less ambiguous contexts, i.e., when caregivers hold and talk about an object in front of children, as is common in natural communication. Thus, the present study tests whether discourse continuity influences the learning of multiple new object labels in 4-year-old children.

Previous research has revealed that young children are sensitive to various aspects of the discourse context and structure. For example, 24-month-olds have been shown to understand that adults pay attention to – and talk about – novel aspects of an interaction (Akhtar, Carpenter, & Tomasello, 1996). That is, children are able to learn a new word when an adult labels an object that is novel to the discourse context from only the adult's own point of view. Relatedly, two-year-olds have been shown to use speakers' speech disfluencies to predict their intended referents during object labeling (Kidd, White, & Aslin, 2011). Finally, cross-linguistic research has revealed that children who hear more consistent referential patterns within discourse – specifically, regarding the use of either null, pronominal, or lexical verb arguments – tend to produce more consistent patterns earlier, compared to children exposed to inconsistent discourse patterns (Guerriero, Oshima-Takane & Kuriyama, 2006). Nevertheless, there is little research to date that specifically looks at children's ability to take advantage of *discourse continuity*, or the idea that neighboring utterances are likely to refer to the same topic (e.g., Frank, Tenenbaum, & Fernald, 2013; Hoff-Ginsberg, 1994; Ochs & Shieffelin, 1983). For example, if a child simply hears, "I rode a camel!", he or she might come to the incorrect conclusion that a *camel* is some sort of automated vehicle. If instead the child hears, "I took a trip to the desert. I rode a camel! He was so sweet and let me pet him," he or she might use the topic continuity between *camel* and other words in the discourse in order to discern the meaning of *camel* (i.e., an animal living in the desert), as well as to encode its meaning more concretely and accurately.

Most existing research on the topic of discourse continuity and children's language learning has examined the use of discourse continuity in child-caregiver interactions (Frank, Tenenbaum, & Fernald, 2013; Rohde & Frank, 2014). Rohde and Frank (2014) analyzed discourse continuity in parents' interactions with their children using three different methods: raw annotations of speakers' referent, the output of a computational model, and judgments made by human coders. Across the three methods, the researchers determined that many topic-signaling cues – such as pronoun use and sentence-final reference – found in adult discourse are also present in child-directed speech. They conclude that the function of these cues in child-directed speech may be to help children acquire additional referential information from their input, particularly when individual utterances are ambiguous. Hoff

(2010) revealed that children produce topic-continuing discourse themselves, particularly during certain language-rich activities such as reading. Other work suggests that speakers' discourse continuity might be relevant for supporting a key component of children's language development: the learning of new words. Frank, Tenenbaum, & Fernald (2013) found that caregivers' references to objects in a child-parent play session were more continuous (or "clumpy") than would be expected by chance. Moreover, computational modeling work has shown some evidence of the importance of discourse continuity for word learning. In their word-learning model, Luong, Frank, and Johnson (2013) set speakers' intended referent to be continuous across utterances. This discourse information, combined with social cues, led to some improvements in the model's word learning performance. Together, these studies suggest that discourse continuity exists in adult-child interactions and provides helpful cues to word learning, yet they are unable to conclusively determine whether or not discourse continuity improves children's word-learning abilities.

Erika Hoff (2003) began to answer this question – of whether continuity of discourse promotes children's word learning – by looking at topic-continuing replies, i.e., caregivers' utterances that continue a topic previously introduced by the child. Hoff found that the amount that mothers used topic-continuing replies predicted their children's vocabulary growth ten weeks later, suggesting that continuity in mother-child interactions may indeed promote children's language learning. Horowitz and Frank (2015) went further by testing whether children are able to use a speaker's discourse continuity as a strategy for determining object reference in ambiguous word learning situations. In their study, children ages 2-6 years completed a novel word-learning task, where the only cue to reference was the placement of a labeling event within the discourse structure of the interaction. Specifically, children heard an object label (with no associated gestural cues to the referent) flanked by descriptions of either toy A or toy B (which were accompanied by gestural cues). If children are able to use discourse continuity as a cue to reference, they should be able to determine the object/label pairing if the labeling event occurs between two descriptions of the *same* object (either toy A or toy B), i.e., if the labeling episode is discourse continuous. If the labeling event occurs between two descriptions of *different* objects (toy A and toy B), the label/object pair should be indeterminable. The results revealed that children were in fact only able to successfully determine the referent when labels were discourse continuous. Moreover, children only started showing successful disambiguation by age 3-4, and showed even better learning through ages 5 and 6, suggesting that children's ability to use discourse information in determining object reference might develop over the course of childhood.

Discourse continuity clearly seems to be helpful for disambiguation, i.e., determining reference in uncertain situations. However, it has not yet been determined whether discourse continuity, in addition to helping determine an accurate word/object mapping in the moment, is also helpful for children's encoding of a new word that is clearly the focus of attention. Not only is the latter common in caregiver-child interactions (e.g., Pereira, Smith, & Yu, 2013), but so is caregivers' tendency to refer to a string of objects in sequence. As speakers rapidly shift focus from one object to the next in conversation, it is possible that providing context for each labeling episode through topic continuity helps children successfully encode and remember new object labels. In the present paper, we test this prediction in 4-year-olds by teaching them three new words, either with or without discourse continuity. If discourse continuity does in fact promote children's word learning, we predicted that children who heard clusters of continuous reference to objects would show better learning of object labels (defined as proportion of object/label mappings correctly identified in the test phase) compared to children who heard object references distributed over the course of the learning phase.

Experiment 1

In Experiment 1, we tested the extent to which continuity of reference influences children's learning of three new word/object pairs. In the *Continuous* condition, clusters of three utterances included one labeling utterance directed toward a particular object, accompanied by two additional utterances describing – but not explicitly labeling – the same object. In the *Discontinuous* condition, children heard the same labels for each object and the same object-directed utterances as in the Continuous condition, but the discourse was not continuous (e.g., a label for Object A might be immediately followed by commentary about features of Object B). Each label or object-directed utterance was unambiguous, i.e., it was accompanied by the speaker gazing toward and grasping the object. At test, children were presented with a two-alternative forced choice reaching task in order to measure their knowledge of each object label. If discourse continuity does in fact promote children's word-learning abilities, children should show more successful learning of correct object/label mappings in the Continuous compared to the Discontinuous condition.

Method

Participants Participants were 40 4-year-old children (M=46.41 months, SD=3.71, Range=42.1-53.63). Twenty-three participants were male, and all participants came from monolingual English-speaking homes. Children had no history of pervasive developmental delays. Twenty children were randomly assigned to each of two experimental conditions: a *Continuous* or *Discontinuous* condition, described in detail below. Three additional participants were tested but not included due to fussiness/refusal to cooperate (n=2) or taking an extended break halfway through test trials (n=1)

Figure 1. Schematic depicting sample trials in the learning phase for the Continuous and Discontinuous conditions in Experiment 1. Between each trial, the speaker rested both hands in her lap and smiled at the participant.

Stimuli and Design Three novel words—*gazzer, cheem,* and *tobu*—corresponded to one of three novel objects, each characterized by a different color, texture, and shape (see Figure 1). Half of participants were exposed to one set of word/object pairings, and half were exposed to a second, counterbalanced set of pairings.

In the *Continuous* condition, blocks of three adjacent trials in the learning phase referred to the same object. Either the first or second trial was a *labeling* trial, while the other two trials provided identifying visual information about the object (e.g., "*This is a gazzer. / This is small and green. / This feels really spiky.*"). There were two blocks of trials for each novel word/object pair. Each object was referred to six times total (2x per object label).

The *Discontinuous* condition consisted of the same exact trials as the *Continuous* condition, but trials within each block of the learning phase were pseudo-randomly ordered such that no two adjacent utterances referred to the same object (see Figure 1). Thus, participants heard the same number of total references to each object and the same number of object labels as in the Continuous condition, but discourse continuity was absent.

Procedure During the experiment, an experimenter sat across from the participant at a table and told him or her, "*We're going to play a game together! Just watch and pay attention because I'm going to ask you some questions about these things later. Are you ready? Here we go!"*

During the learning phase, the experimenter placed all three objects in a line directly in front of her on the table (in one of two counterbalanced orders). On each of 18 learning trials (approximately four seconds in duration), the experimenter began with her hands in her lap. Then she 1) smiled at the participant, 2) looked down at an object, 3) grabbed the object, raised it slightly, and tilted it up, 4) looked back at the participant and said a labeling or object-directed sentence about the object, 5) looked back at the object and set it back down, and 6) put her hands back in her lap. Two counterbalanced trial orders were used for each condition across participants.

The test phase began immediately after the learning phase. The experimenter removed all three objects from the table and told the participant that she was now going to ask some questions. Next, the experimenter took two objects at a time, placed them in an uncovered basket, and put the basket on the table. Without looking down at the objects, the experimenter slid the basket toward the participant. Then she asked the participant to choose one of the objects and hand it to the experimenter (e.g., "Which one is the *cheem*? Can you give me the *cheem*?"). During each test trial, the experimenter maintained eye contact with the participant. If a child initially touched more than one object, the object that was finally handed to the experimenter was recorded as his or her choice. There were 12 test trials total (four trials per object/label pairing). Two counterbalanced test orders were used across participants. Across conditions, participants saw the same pairs of two novel objects, positioned on the left and right sides of the basket.

Finally, children's vocabulary was assessed using the Peabody Picture Vocabulary Test (PPVT) (Dunn & Dunn, 2007). The PPVT is a standardized measure to assess children's receptive vocabulary by asking them to identify familiar words from a flipbook of pictures. Children were also rewarded with stickers following the test phase and again during and after the administration of the PPVT.

Results and Discussion

Word learning was measured in terms of the proportion of word/object pairs that children correctly identified in the test phase. A two-tailed independent samples *t*-test showed that learning was significantly greater in the Continuous condition (M=.88, SE=.03) compared to the Discontinuous condition (M=.77, SE=.04; t(34.27)=2.05, p<.05, d=.65; see Figure 2). Additionally, between conditions, there was no significant difference in children's mean age (Continuous: M=46.96 months, SD=4.13; Discontinuous: M=45.86 months, SD=3.26; t(36.05)=.94, p=.35) or mean standardized PPVT score (Continuous: M=118.63, SD=11.96; Discontinuous: M=114.21, SD=15.05; t(34.26)=1.0, p=.32). Interestingly, however, learning was significantly greater than chance for both the Continuous

(t(19)=12.28, p<.001) and Discontinuous conditions (t(19)=6.20, p<.001), suggesting that children are able to successfully learn the novel words even without discourse continuity. However, continuity of reference does seem to provide an additional word-learning boost.

Because we tested children ranging from 3.5 to 4.5 years of age, we examined a possible interaction between age and discourse continuity on children's word learning. A 2x2 factorial Analysis of Variance (ANOVA) with age and condition (Continuous or Discontinuous) as between-subjects factors revealed a significant main effect of condition (F(1, 36)=4.31, p<.05), but no significant main effect of age (F(1, 36)=2.04, p=.16) and no significant condition x age interaction (F(1, 36)=.80, p=.38). Thus, across the 3.5- to 4.5-year range, discourse continuity supported children's word learning equivalently.

These results suggest that discourse continuity promotes word learning for 3.5- to 4.5-year-old children. Importantly, however, the "discourse" in our experiment provided relevant visual information about each object, such as its color or texture (in a similar manner to Horowitz & Frank, 2015). Thus, it remains unclear whether topic continuity in this experiment facilitated learning due to the *informative* discourse that accompanied object labels, or whether simply having continuity of object reference drove the more successful learning in the Continuous condition. In particular, we wanted to determine whether continuity of *uninformative* discourse – i.e., discourse that provided relatively neutral information about the objects (e.g., "This is good and neat") – would promote children's word learning in a similar manner. In Experiment 2, we sought to answer this question by replicating Experiment 1, but using uninformative instead of informative discourse.

Experiment 2

Experiment 2 sought to replicate the results of Experiment 1 using uninformative discourse. In each condition (Continuous/Uninformative and Discontinuous/ Uninformative), object labels were the same as in Experiment 1, but accompanying discourse provided no relevant information about each object. If the relevant contextual cue boosting children's performance in this task is continuity of reference more generally – and not the pairing of object labels with important visual information in the discourse – we again expected children to show more successful learning of object/label mappings in the Continuous/Uninformative condition compared to the Discontinuous/Uninformative condition.

Method

Participants Participants were 40 4-year-old children (M=46.37 months, SD=3.36, Range=42.27-53.13). Sixteen participants were male, and all participants came from monolingual English-speaking homes. Children had no history of pervasive developmental delays. Twenty children were randomly assigned to one of two experimental conditions: a *Continuous/Uninformative* or *Discontinuous/ Uninformative* condition, described in detail below. Two additional participants were tested but not included due to experimenter error (n=1) or being bilingual (less than 85% English exposure) (n=1).

Stimuli and Design The words and objects used were identical to Experiment 1. The *Continuous/Uninformative* condition was identical to the *Continuous* condition from Experiment 1, except that object-directed utterances provided no identifying visual information about each object (e.g., "*This is a gazzer. / This is good and neat. / This is nice and cute.*"). Object-directed utterances in the Continuous/Uninformative condition were matched to sentences in the Continuous condition from Experiment 1 in total number of syllables. The *Discontinuous/Uninformative* condition consisted of the exact same trials as the *Continuous/Uninformative* condition, but trials within each block of the learning phase were ordered such that no two adjacent utterances referred to the same object. Thus, as in Experiment 1, participants in this condition heard the same number of total references to each object and the same number of object labels as the Continuous conditions, but there was no discourse continuity.

Procedure The procedures for the learning phase, test phase, and administration of the PPVT in Experiment 2 were identical to the procedures in Experiment 1.

Results and Discussion

Again, word learning was measured in terms of the proportion of word/object pairs that children correctly identified in the test phase. A two-tailed independent samples t-test showed that learning was significantly greater in the Continuous/Uninformative condition (M=.88, SE=.03) compared to the Discontinuous/Uninformative condition (M=.72, SE=.04; t(34.64)=2.93, p=.006, d=.92; see Figure 2). Additionally, between conditions, there was no significant difference in children's average age (Continuous: M=46.27 months, SD= 3.20; Discontinuous: M=46.47 months, SD=3.60; t(37.50)=-.18, p=.86) or average standardized vocabulary score (Continuous: M=119.5, SD=13.13; Discontinuous: M=114.72, SD=12.62; t(35.83)=1.14, p=.26).

Because we tested children ranging from 3.5 to 4.5 years of age, however, we again examined a possible interaction between age and discourse continuity on children's word learning. A 2x2 factorial Analysis of Variance (ANOVA) with age and condition (Continuous or Discontinuous) as between-subjects factors revealed a significant main effect of condition (F(1, 36)=8.27, p=.007), but no significant main effect of age (F(1, 36)=.01, p=.92) and no significant condition x age interaction (F(1, 36)=.62, p=.44). Similar to Experiment 1, across the 3.5- to 4.5-year range, discourse continuity promoted children's word learning equivalently. Additionally, similar to Experiment 1, there was significant learning compared to chance for both conditions (Continuous: t(19)=11.83, p<.001; Discontinuous:

$t(19)=4.95$, $p<.001$), again suggesting that continuity of reference supports word learning in the absence of discourse continuity.

Comparing across Experiment 1 and Experiment 2, there was no significant difference in learning between the Continuous and Continuous/Uninformative conditions ($t(37.95)<.01$, $p>.99$, $d<.01$), or between the Discontinuous and Discontinuous/Uninformative conditions ($t(37.99)=-.81$, $p=.42$, $d=.26$). A 2x2 mixed analysis of variance (ANOVA) with experiment (1 or 2) as a between-subjects factor and condition (Continuous or Discontinuous) as a within-subjects factor revealed a significant main effect of condition ($F(1, 76)=12.47$, $p<.001$, $\eta^2_p=.14$), but no significant main effect of Experiment ($F(1, 76)=.44$, $p=.51$, $\eta^2_p=.005$), and no significant condition x experiment interaction ($F(1, 76)=.44$, $p=.51$, $\eta^2_p=.005$). Thus, Experiment 2 successfully replicated the results of Experiment 1 in an uninformative discourse context. Together, these results suggests that continuity of reference generally – and not just continuity of informative discourse – seems to promote children's word learning.

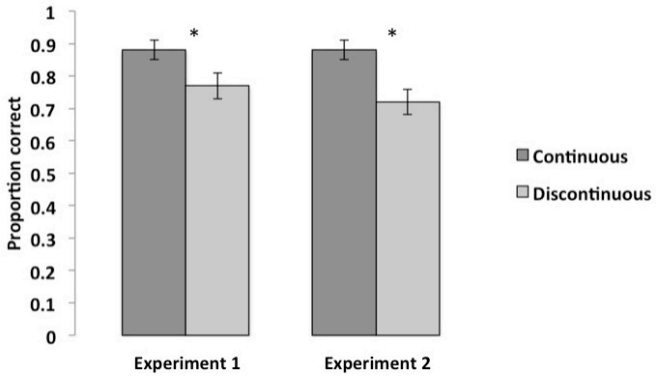

Figure 2: Mean proportion object/label mappings correctly identified in Experiment 1 (Continuous vs. Discontinuous conditions) and Experiment 2 (Continuous/Uninformative vs. Discontinuous/Uninformative conditions). Error bars show +/- 1 *SEM* across participants.

General Discussion

In two experiments, we show that continuity of reference promotes 4-year-old children's learning of new object labels. Moreover, the speaker's discourse does not need to provide informative content in order to promote children's word learning – simply having continuity of reference in child-directed speech seems to be sufficient to support learning. Thus, not only does discourse continuity help children determine ambiguous word/object mappings in the moment (Horowitz & Frank, 2015), but also, it helps children encode multiple new object labels in the context of rapidly shifting adult-child interactions.

A great deal of recent research has focused on children's ability to track statistical co-occurrences in language in order to learn word-referent mappings (e.g., Smith & Yu, 2008), but fewer studies have focused on children's ability to use information about the structure of discourse in order to learn new words. Because children have been shown to be adept at tracking object-label regularities over time, in some contexts these kinds of contextual cues may not be necessary. More likely, however, discourse cues, in addition to socio-pragmatic cues, help children encode information about word/object co-occurrences over time, presumably by increasing their salience. Relatedly, Pereira, Smith, and Yu (2013) have suggested that there are optimal visual moments for learning new word/object pairs. That is, when objects appear in a clean, stable view in front of a child while it is being labeled, that child is more likely to learn the object's label. Here, continuity of reference may provide a similarly optimal *contextual* moment for learning a new word/object pair, where each word and referent are clearly linked within the discourse, allowing children to attend to their features or potential functions.

The present results are convergent with findings showing that repetition of words across neighboring utterances is helpful for learning (e.g., Onnis, Waterfall, & Edelman, 2008; Schwab & Lew-Williams, 2016). In particular, previous research has shown that repetition of object labels in blocks of successive utterances promotes two-year-olds' encoding of new word/object pairings. Here, at least with older preschool-age children, simply referencing one object for several sentences in a row – without repeating the object label itself – may enable the learner to better encode a word/object pairing. It is possible that repetition of object labels themselves – compared to continuity of reference more generally – promote word learning differentially along the developmental continuum. For example, previous work suggests that children's ability to exploit discourse continuity to disambiguate moments of reference increases as children age, with children under 3 years not showing the ability to take advantage of discourse cues in this context (Horowitz & Frank, 2015). In a similar manner, the need for caregivers to repeat object labels in neighboring sentences may *decrease* over time as children *increase* their proficiency in inferring information from the discourse, i.e., become better at learning from discourse continuity. Future research should aim to directly examine differences in the influence of partial repetition and discourse continuity on children's learning across a wider age range, as well as relate children's learning abilities to differences in caregivers' naturalistic use of these cues in the home.

Finally, it is not yet clear from the present results whether children's increased learning in the Continuous conditions is a facilitation or interference effect. Specifically, it may be the case that continuity of reference promotes learning, or that discontinuity in object reference interferes with learning because of rapid shifts in attention to different objects. We are currently pursuing follow-up studies to determine whether visual continuity is sufficient to support children's word learning in this experimental context, or whether visual discontinuity interferes with learning. If children learn words similarly regardless of continuous or

discontinuous visual exposure, this would suggest that continuity in a speakers' discourse in particular seems to promote children's word learning.

Overall, the present experiments reveal that discourse continuity promotes 4-year-old children's learning of new object labels, and this seems to be true regardless of the content or informativity of the discourse. Previous research on discourse continuity has found that natural child-directed discourse tends to be "clumpy" (Frank, Tenenbaum, & Fernald, 2013), and continuity of discourse helps children disambiguate between possible referents in the moment (Horowitz & Frank, 2015). The present work goes further by suggesting that clusters of reference to particular objects can help children more successfully encode new words in the context of hearing sequential label/object pairings, as speakers rapidly shift focus from one object to the next. This research has implications for our understanding of how differences in caregivers' language input can influence children's vocabulary development.

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