Developmental shifts in children's use of register-specific words

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Abstract

Child-directed language (CDL) features words such as *doggy*, *night-night*, and *tummy* that are rarely used in adult-directed language (ADL). Characteristics of CDL word forms, such as diminutivization and reduplication, explain why they may be learned and produced earlier by children. However, it is not yet clear how or when children 'switch' to using ADL equivalents—*dog*, *goodnight*, *stomach*. Through analysis of speech transcripts from CHILDES and the Language Development Project corpus, we show that children significantly increase their production of ADL word forms across age, with the average CDL-to-ADL transition point at 2.5 years. Many of the linguistic features that distinguish CDL vs. ADL registers (e.g., lexical and syntactic complexity) similarly differentiated the local speech contexts surrounding CDL vs. ADL word forms in children's input, which is primarily CDL in these corpora. Learners may therefore be able to capitalize on these linguistic cues to support their discovery of register along with context-appropriate CDL/ADL pair use.

Keywords: child-directed language; word production; linguistic input; speech register; corpus analysis

Introduction

Across their first few years of life, children come to know hundreds if not thousands of words (Fenson et al., 1994; Mayor & Plunkett, 2011). Word production typically begins around age one, followed by a vocabulary 'explosion' or 'spurt' during toddlerhood (Ganger & Brent, 2004; see also McMurray, 2007), and then continued, measurable increases in vocabulary size thereafter (Rice & Hoffman, 2015). Here, we investigate one dimension of this dramatic developmental change: the appearance and use of words from distinct registers.

Vocabulary first gets off the ground, in part, with words that are specifically tailored to young learners (e.g., *tummy*, Ferguson, 1964). Hallmark features of child-directed language (CDL), such as iconicity (Laing, Vihman, & Keren-Portnoy, 2017), diminutivization (Kempe, Brooks, & Gillis, 2005), and reduplication (Ota, Davies-Jenkins, & Skarabela, 2018) may support early word learning. These effects are in addition to the cross-cutting influence of a word's frequency, concreteness, length, and association with infancy on early learnability (e.g., *bottle* and *bib*: Braginsky, Yurovsky, Marchman, & Frank, 2019; Frank, Braginsky, Yurovsky, & Marchman, 2017; Perry, Perlman, Winter, Massaro, & Lupyan, 2018).

While CDL-specific words (e.g., *night-night*, *doggy*, *tummy*) are overrepresented in children's early vocabularies, they are eventually replaced by ADL equivalents (*goodnight*, *dog*, *stomach*). However, these words do not fully disappear. Instead, they become designated for use in a specific context—communication with infants and young children (e.g., Sachs & Devin, 1976; Shatz & Gelman, 1973). The addition of a word like *stomach* to a children's vocabularies may mark their growing awareness that word choice should be tailored to the current interactional context (Clark, 1997, e.g., 2018). We do not, at present, know when children begin to make shifts from CDL to ADL word use or precisely how such a shift is supported or initiated. Our investigation starts where this transition is most easily observed, with CDL/ADL word pairs: (e.g., *doggy/dog*, *night-night/goodnight*, *tummy/stomach*), as opposed to words that become less relevant with time (e.g., *diaper* and *peekaboo*).

Comprehension and production of language varieties

Classically, we might expect the appearance of both CDL and ADL labels for the same referent to be a problem for early word learning—particularly when the variants have little to no overlap in phonological form (e.g., *bunny/rabbit* vs. *doggy/dog*). Indeed, children often assume that new labels refer to new items rather than interpreting them as synonyms for words that they already know (i.e., "mutual exclusivity": Markman & Wachtel, 1988; see Lewis, Cristiano, Lake, Kwan, & Frank, 2020, for a recent meta-analysis). Yet, children seem to learn multiple CDL/ADL variants without issue.

One potential way to explain children's learning of both labels is to consider the social context of CDL vs. ADL use. While labeling an animal as *doggy* vs. *dog* may not communicate anything distinct about the referent itself, the production of one form vs. the other may indicate something meaningful about *who* is being addressed or producing the label. That is, differences in register could serve to 'explain away' the otherwise problematic redundancy of multiple labels in these pairs (Clark, 1990). Indirect evidence for this idea comes from findings that the mutual exclusivity effect is modulated by children's experience with multiple languages (Byers-Heinlein & Werker, 2009; Houston-Price, Caloghiris, & Raviglione, 2010) and the social conditions under which multiple labels are introduced (e.g., by speakers of a familiar or unfamiliar race: Weatherhead, Kandhadai, Hall, & Werker, 2021). Further, children's speech to younger children (Sachs

& Devin, 1976; Shatz & Gelman, 1973) and their awareness of socially meaningful linguistic variation (Ikeda, Kobayashi, & Itakura, 2018; Liberman, Woodward, & Kinzler, 2017; Soley & Sebastian-Galles, 2020) suggests that they recognize the importance of social context for language use from relatively early on.

We hypothesize that children may contend with CDL/ADL word pairs by associating the contrasting forms with different modes of use (i.e., by classifying each form as belonging to a distinct register). To test this idea, we first need to establish (a) when children begin to shift away from producing CDL-specific words, and (b) how children may be able to use bottom-up linguistic input cues to associate lexical variants with their associated registers (i.e., CDL vs. ADL).

Current investigation

We examine a small but core subset of 15 CDL-specific words in English (e.g., *doggy*, *night-night*, *tummy*) that are prevalent in children's early vocabularies but are eventually replaced by ADL words—*dog*, *goodnight*, *stomach*. In Study 1, we analyze over 60,000 utterances of spontaneous speech from children up to seven years of age to establish when ADL forms become more dominant in children's own productions. That is, when do children switch from using CDL forms to using ADL forms? Our data suggest that the average age of 'CDL-to-ADL switchover' occurs around 2.5 years.

We then explore the features of children's input that could support this switch by examining the extent to which CDL and ADL words are used in distinct linguistic contexts by adults. Further processing of nearly 70,000 non-target-child utterances (primarily from adult caregivers and addressed to the target child) revealed that CDL and ADL variants co-occur with reliably different patterns of prosodic, lexical, and syntactic information—cues that likely help learners associate them with different modes of use, or emerging representations of register.

Together, these studies push us to consider children's vocabulary development not as a simple accumulation of words or numeric increase in vocabulary size but rather a deepening and restructuring of the lexicon with growing linguistic and social maturity. The words *dog* and *stomach* do not entirely replace *doggy* and *tummy*—rather, the contrasting forms become reserved for use with different addressees.

Study 1: When do children shift from CDL to ADL forms?

We tracked children's use of 15 CDL/ADL word pairs (Table 1) from early infancy up to age seven. Since CDL forms rarely appear in ADL, we predicted that children would shift away from production of these CDL-specific forms with increasing age. That is, we expected to see replacement of CDL forms with ADL forms in children's own speech across time.

Method

Corpora

We analyzed 8,251 transcripts in the North American English collection of the Child Language Data Exchange System (CHILDES) database (MacWhinney, 2000) for children up to 7 years of age. The included transcripts were drawn from 52 individual corpora and featured 980 children (age range = 1–84 months, M = 33.5 months). To further gain purchase on our research question with *longitudinal* data, we also analyzed child production data from the Language Development Project (LDP) corpus (see Huttenlocher, Waterfall, Vasilyeva, Vevea, & Hedges, 2010; Rowe, 2008, for further details regarding participating families, recording procedures, and transcription). LDP data included 622 transcripts from 59 English-learning children recorded every 4 months for approximately 90 minutes from age 14 to 58 months.

Target words

Fifteen CDL/ADL word pairs (30 total target words) were selected based on two criteria: the appearance of at least one form on the MacArthur-Bates Communicative Development Inventory (CDI, Fenson et al., 1994), and sufficient frequency of occurrence in CHILDES (at least 100 child-produced tokens and 100 other-produced tokens per form). Pairs were also selected based on our own subjective judgment that the same object, animal, routine, or body part could be reasonably labeled with either form by young children.[1] Across all transcripts, 64,852 child-produced utterances contained at least one target word and were included in our analysis.

Table 1: CHILDES frequency for 15 CDL/ADL word pairs. Child-produced counts include tokens produced only by the target child.

	CDL tokens		**ADL tokens**	
Pair	**Child**	**Other**	**Child**	**Other**
doggy/dog	2,249	2,644	3,519	5,113
kitty/cat	1,552	3,309	2,779	4,443
tummy/stomach	435	623	112	360
daddy/dad	9,603	10,048	2,313	1,031
mommy/mom	20,294	17,070	7,616	2,552
bunny/rabbit	1,237	2,597	1,060	1,397
duckie/duck	307	647	1,933	3,003
blankie/blanket	174	224	825	874
froggy/frog	154	434	970	1,846
potty/bathroom	511	786	161	270
night night/goodnight	149	153	102	446
dolly/doll	745	1,054	674	2,697
horsey/horse	1,149	1,034	1,749	2,575
piggy/pig	405	1,212	1,276	2,139
birdie/bird	399	588	1,879	3,358

[1] While onomatopoeic words can be used in a similar manner to the CDL-specific words in our test set (e.g., *choo-choo* serving as a CDL-specific label for *train*, or *quack-quack* for *duck*), these iconic items were not included because they are primarily used as sound effects rather than labels for objects or animals (Skarabela, Pool, & Ota, 2018). The polysemous nature of iconic word usage does not provide as clear of a test of replacement of CDL forms with ADL forms over time.

Results

We asked when CDL forms are replaced by ADL forms in children's own speech. Using the *lme4* package (version 1.1.27.1: Bates, Mächler, Bolker, & Walker, 2015) in R (version 4.1.0: R Core Team, 2021), we fit a mixed-effects binomial logistic regression model predicting children's production of CDL vs. ADL forms, with target child age (in months, scaled) as a single fixed effect. Random slopes and intercepts for word pairs were also included[2]. For each target word token, the form was coded as either 0 (CDL) or 1 (ADL). Thus, the model captures, for each age, the probability of using ADL forms over CDL forms.

Children significantly increased their production of ADL forms over age ($\beta = 0.54$, $SE = 0.11$, $t = 4.92$, $p < 0.001$). The average CDL-to-ADL transition point (i.e., the point at which ADL forms were produced >50% of the time) was at approximately 28 months (i.e., around 2.5 years; Figure 1).

The trend of increasing ADL form production was significant for 13 of 15 word pairs, but the exact trajectory of shift varied greatly across items (Figure 2). In some cases, CDL forms were replaced by ADL forms early on (e.g., *doggy/dog* and *kitty/cat* around 2 years). For other pairs, the age of switchover was much later (e.g., *tummy/stomach* and *potty/bathroom* around 5 years). Finally, a clear point of switchover was not observed for some pairs because ADL forms were already produced >50% of the time from the earliest ages sampled (e.g., *duckie/duck* and *blankie/blanket*).

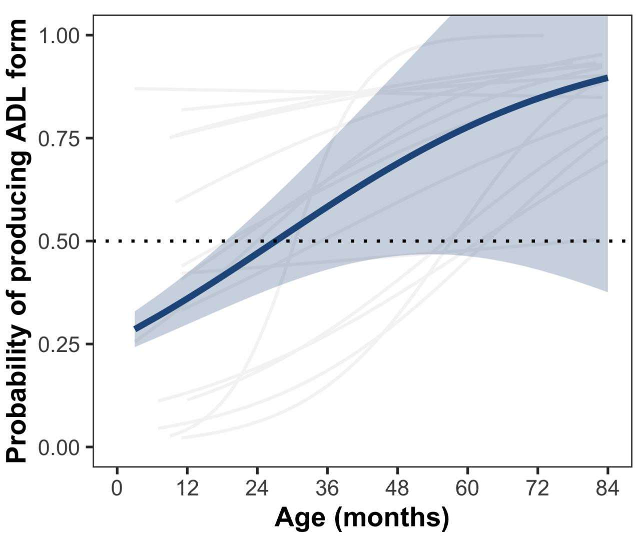

Figure 1: Model-predicted increase in production of ADL forms across age, with shaded standard error region. Gray lines depict individual word-pair trajectories.

[2]glmer(form ∼ age (months, scaled) + (1 + age | word pair), family = binomial)

Figure 2: Individual word-pair trajectories for increasing production of ADL forms (blue) and decreasing production of CDL forms (red) with age. Points indicate proportions for each 1-month age bin. Vertical gray lines at 28 months indicate the overall model-predicted CDL-to-ADL transition point across all words.

Discussion

Analysis of children's own spontaneous speech revealed developmental shifts in their production of CDL vs. ADL forms, with the latter becoming increasingly more prominent over age. While we found substantial variation in the exact trajectories of CDL-to-ADL vocabulary shift for the 15 word pairs, the overall trend towards ADL production was clear. We take children's shifts away from CDL forms and towards ADL forms as indirect evidence of their early formation of CDL and ADL as distinct registers.

Study 2: What linguisitc information in children's input supports their shift from CDL to ADL forms?

We next explored children's input (i.e., other-produced speech), asking what linguistic information could support their shift from CDL to ADL forms. We conceptualize our second study as an investigation of the cues that could help learners associate CDL and ADL words with their appropriate registers.

CDL, as a register, is differentiated from ADL at multiple linguistic levels, including prosodic, lexical, and syntactic differentiations (e.g., Soderstrom, 2007). In English, CDL is associated with higher overall pitch as well as greater variability in pitch contours (Fernald, 1989; Vosoughi & Roy, 2012). CDL utterances are often produced more slowly (Ko & Soderstrom, 2013; e.g., Vigliocco, Shi, Gu, & Grzyb, 2020; but see also Martin, Igarashi, Jincho, & Mazuka, 2016). CDL also typically includes less lexical diversity (Hills, 2013) and more words that children already know (Foushee, Griffiths, & Srinivasan, 2016). Syntactically, CDL is characterized as less complex than ADL. CDL utterances are typically shorter (Brent & Siskind, 2001; Martin, Igarashi, Jincho, & Mazuka, 2016) and feature simpler constructions (Cameron-Faulkner, Lieven, & Tomasello, 2003).

Here, we tested whether the linguistic features that differentiate CDL vs. ADL at the register level also differentiate the local speech contexts surrounding CDL vs. ADL forms—even in speech that is primarily addressed to children from their adult caregivers (i.e., language from a single register). In other words, can form be predicted on the basis of individual utterance-level prosodic, lexical, or syntactic cues?

We hypothesized that utterances with CDL forms, relative to utterances with ADL forms, would be associated with (1) higher mean pitch, (2) greater pitch variability, (3) slower speaking rates, and (4) less lexical complexity. We also predicted that CDL utterances would contain (5) fewer rare words, (6) fewer words overall, and (7) fewer verb phrases. If these linguistic cues reliably differentiate CDL vs. ADL word usage contexts, then they could provide a viable source of information to support children's association between these words and their corresponding registers.

Method

Corpora

We analyzed 69,709 other-produced utterances (i.e., utterances not produced by the target child) in the CHILDES transcripts from Study 1. The majority of utterances were produced by children's primary caregivers (n = 58,071, or 83.3%). While, by and large, the utterances are not annotated for addressee, our manual scanning of the CHILDES corpora suggested that the vast majority of this speech is addressed to the target child. Study 2 analyses exclude the LDP corpus because it is not comprehensively timestamped.

Linguistic input predictors

All input analyses were conducted over individual utterances containing at least one of the 30 target words from Study 1. We quantified prosodic, lexical, and syntactic information to describe each utterance.

Prosodic level We measured three types of prosodic information: **mean pitch** (Hz), **pitch range** (Hz), and **speech rate** (words per second). These measures were calculated over all timestamped utterances in CHILDES (42.3% of other-produced utterances). Utterances shorter than 58 ms were excluded from analysis.^[This lower bound was set by identifying the the shortest possible duration of an utterance containing at least one word in four manually annotated North American English corpora (see Bergelson et al., 2019 for details) Pitch information was extracted using Praat software (Boersma & Weenink, 2016).

Lexical level We measured two types of lexical information: complexity and rarity. **Lexical complexity** was defined as the negative log proportion of known words in each utterance (consistent with Foushee, Griffiths, & Srinivasan, 2016; Kidd, Piantadosi, & Aslin, 2012). A word was considered 'known' if the age of acquisition (AoA) estimate (Fenson et al., 1994; Frank, Braginsky, Yurovsky, & Marchman, 2017) was less than or equal to the age of the target child when they heard the utterance. Utterances with proportionally fewer known words are considered more lexically complex. **Lexical rarity** was determined based on overall frequency in CHILDES. For all words with at least 10 tokens[3], we calculated a rarity score as the negative log proportion of other-produced tokens in CHILDES (i.e., number of tokens for a given word divided by the sum of all tokens of all words in the full corpus). We then averaged the rarity scores for all individual words in a given target utterance. Utterances with more low-frequency words are considered more lexically rare.

Syntactic level Syntactic measures included both the utterance **length** (in words) and **number of verb phrases**. The number of words per utterance was automatically extracted using the *childesr* package (Braginsky, Sanchez, & Yurovsky, 2021). The number of verb phrases per utterance was determined using *spaCy3*, an automatic syntactic parser (Honnibal, Montani, Van Landeghem, & Boyd, 2020).

Results

We ran individual mixed-effects binomial logistic regression models of ADL or CDL word form use for each of seven linguistic input predictors. Models included fixed effects of linguistic predictor (scaled), target child age (in months, scaled), and their interaction as well as random intercepts for individual word pairs and speakers[4]. For each target word token, the form was coded as CDL (0) or ADL (1), so coefficient estimates provide a measure of the strength of association between a predictor and ADL form. All main effects of linguis-

[3]Manual checks revealed that many of the lowest-frequency words in CHILDES included idiosyncratic or erroneous transcriptions, so we excluded words with fewer than 10 tokens from our estimates of lexical rarity to reduce noise in this measure.

[4]glmer(form $\sim$ linguistic predictor (numeric, scaled) * age (months, scaled) + (1 | word pair) + (1 | speaker), family = binomial)

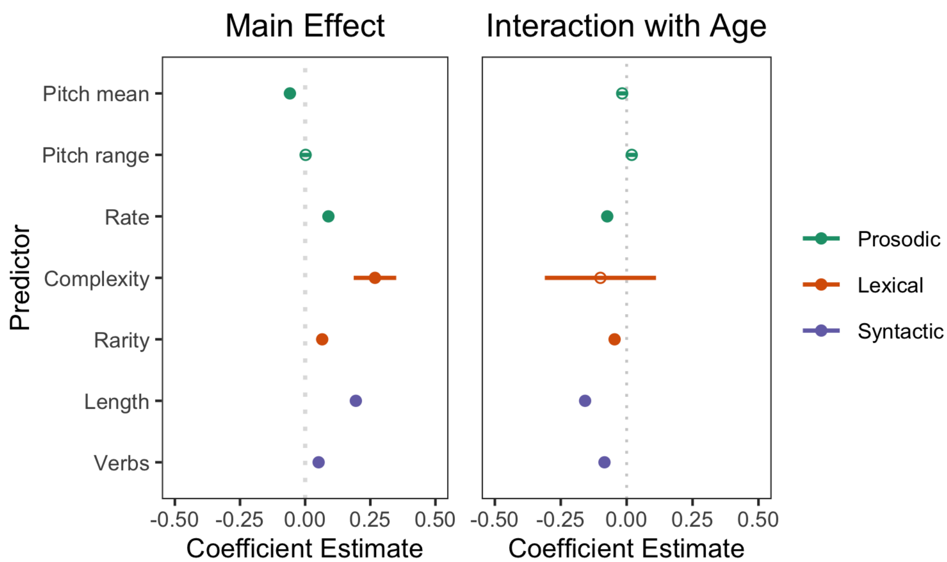

Figure 3: Coefficient estimates for linguistic predictors of form. Positive main effects indicate that utterances are more likely to contain ADL forms when they have higher values for that predictor (e.g., faster speech rates). Positive age interactions indicate an increasing effect of the predictor with age. Error bars depict standard errors of the coefficient estimates, and filled circles represent significant effects ($p < 0.05$).

tic predictors and interactions with age are shown in Figure 3.

At the prosodic level, we found significant effects for two of the three input predictors tested. Utterance-level **pitch range** was not predictive of form ($\beta = 0.002$, $SE = 0.02$, $t = 0.10$, $p = 0.919$) and did not significantly interact with age ($\beta = 0.02$, $SE = 0.02$, $t = 1.11$, $p = 0.268$). However, utterance-level **mean pitch** was a negative predictor of ADL form ($\beta = -0.058$, $SE = 0.02$, $t = -3.02$, $p = 0.003$). That is, utterances with higher overall mean pitch were more likely to contain CDL forms, with no significant interaction with age ($\beta = -0.02$, $SE = 0.02$, $t = -0.96$, $p = 0.337$). **Speech rate** (i.e., words produced per second) was a positive predictor of ADL form ($\beta = 0.09$, $SE = 0.02$, $t = 4.86$, $p < 0.001$). Utterances spoken more quickly were more likely to contain ADL forms. This input predictor also negatively interacted with age ($\beta = -0.07$, $SE = 0.02$, $t = -3.96$, $p < 0.001$), indicating a decreasing strength in predictive power across developmental time.

At the lexical level, we found significant effects for both input predictors tested. Utterances with higher levels of **lexical complexity** ($\beta = 0.27$, $SE = 0.08$, $t = 3.28$, $p = 0.001$) and **lexical rarity** ($\beta = 0.07$, $SE = 0.01$, $t = 5.73$, $p < 0.001$) were more likely to contain ADL forms. Lexical complexity did not interact with age ($\beta = -0.10$, $SE = 0.21$, $t = -0.47$, $p = 0.637$); whereas, lexical rarity negatively interacted with age such that there was a decreasing effect of this predictor over time ($\beta = -0.05$, $SE = 0.01$, $t = -3.95$, $p < 0.001$).

At the syntactic level, we found significant effects of **utterance length** and **number of verb phrases**. Utterances with more words ($\beta = 0.19$, $SE = 0.01$, $t = 16.30$, $p < 0.001$) and more verb phrases ($\beta = 0.05$, $SE = 0.01$, $t = 4.44$, $p < 0.001$) were more likely to contain ADL forms. Moreover, both linguistic predictors negatively interacted with age (Length: $\beta = -0.16$, $SE = 0.01$, $t = -14.61$, $p < 0.001$; Verbs: $\beta = -0.08$, $SE = 0.01$, $t = -7.70$, $p < 0.001$), suggesting that the strength of these predictors decreases across developmental time.

Discussion

Analyses of children's input revealed reliable differences in the patterns of linguistic information surrounding CDL vs. ADL forms. Many of the prosodic, lexical, and syntactic features that broadly differentiate CDL vs. ADL registers similarly partitioned utterances containing CDL vs. ADL forms. Notably, these differences in local speech context emerged even in language that was primarily addressed to children from their primary caregivers (i.e., language likely from a single register—CDL). This finding underscores the idea that register production reflects stylistic linguistic choices by the person producing the utterance and does not require the prototypically associated context (e.g., a caregiver can use ADL-like utterances when talking to a young child).

While we do not yet know if these linguistic cues are actually exploited by learners, this study identifies which patterns appear learnable in principle. More broadly, this work provides support for the possibility that associations with CDL vs. ADL registers are helping learners grasp the differences in the context of CDL vs. ADL form use and gradually transition away from use of more contextually-constrained CDL-specific words. A next step is to experimentally test how well children across this age range perceive words as CDL or ADL relevant given the surrounding linguistic context.

General Discussion

In the current work, we establish that children shift away from production of CDL-specific words over age. As predicted, these child-centric words are 'replaced' by ADL equivalents—at least until they again become relevant when talking to younger children. Further, we identify patterns in children's linguistic input that could support their discovery of associations between CDL/ADL words and their typical modes of use (i.e., incipient representations of register).

More than vocabulary size: Understanding words and using them in context

By analyzing spontaneous language production in the present study, we find variation in form that is often overlooked but may be crucial for understanding how vocabularies develop. Popular caregiver-reported (Fenson et al., 1994) and researcher-administered (Dunn & Dunn, 1965) vocabulary measures typically ask for a binary indication of whether a child 'knows' a word. For good reason, these surveys and tests often gloss over variations in form. This standardization helps with generalizing over many idiosyncracies, allowing for large-scale, even cross-linguistic comparisons (e.g., Frank, Braginsky, Yurovsky, & Marchman, 2017, 2021). At the same time, glossing over variations in form presents a missed opportunity to investigate more nuanced aspects of vocabulary development. The present findings on the transition between CDL and ADL forms help demonstrate that vocabulary development taps into other major aspects of children's language learning, including their socialization as users of the language in their community.

Developing linguistic and social knowledge in tandem

Children's linguistic knowledge builds around and together with their social knowledge. The lexical variants of CDL vs. ADL registers are just one example of socially meaningful linguistic variation. Variation also appears across languages, dialects, accents, and other types of registers (e.g., pedagogical, narrative, etc.). Over time, children become increasingly aware of the fact that language style is modulated by a variety of social factors, including the identities of speakers (e.g., from different social groups: Liberman, Woodward, & Kinzler, 2017) along with their addressees (e.g., young children vs. adults: Ikeda, Kobayashi, & Itakura, 2018; Soley & Sebastian-Galles, 2020). We focus here on multiple labels for the same referent, but learners also face the inverse problem: one label for different referents (e.g., Casey, Potter, Lew-Williams, & Wojcik, 2021; Meylan, Mankewitz, Floyd, Rabagliati, & Srinivasan, 2021). We see these puzzles of word learning as interrelated; learning is happening at multiple levels—not just the words themselves, but strong associations between words and their surrounding contexts (linguistic, social, etc.). Considering the interaction between these different factors can help us reason about learning mechanisms and children's representations—again not just of words but related social information too.

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