Cognition 191 (2019) 103977

Contents lists available at ScienceDirect

Cognition

journal homepage: www.elsevier.com/locate/cognit

Original Articles

Experience with morphosyntactic paradigms allows toddlers to tacitly anticipate overregularized verb forms months before they produce them☆

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ARTICLE INFO

Keywords:
Language acquisition
Grammatical categories
Distributional analysis
Overregularization
English past tense

ABSTRACT

When do children acquire abstract grammatical categories? Studies of 2- to 3-year-olds' productions of complete morphosyntactic paradigms (e.g., all legal determiners with all nouns) suggest relatively later category acquisition, while studies of infant discrimination of grammatical vs. ungrammatical sequences suggest earlier acquisition. However, few of the latter studies have probed category generalization by examining how learners treat gaps in their input, and none have found evidence that learners before the age of 2 years fill gaps in VERB paradigms. Therefore, the three experiments presented here asked whether 16-month-olds tacitly expect to hear forms like *breaked* by presenting them with overregularized verbs vs. (1) nonce verbs + *–ed*, (2) real English nouns + *–ed,* and (3) the correct irregular counterparts. The pattern of listening preferences suggests that toddlers anticipate overregularized forms, suggesting that they have a general proto-category VERB, to which they expect the complete set of verb inflections to apply.

1. Introduction

Grammatical categories (e.g., nouns, verbs, adjectives, etc.) are the building blocks of language. Young language learners must work through the complicated linguistic task of partitioning the words they hear into category-like groupings. Further, they must be able to differentiate grammatical categories based on context, since many words do not belong to a single category (e.g., *That's a nice* ***comb****, Let's* ***comb*** *your hair*; e.g., Conwell & Morgan, 2012). But when do children begin to form abstract grammatical categories and how can we tell? Two answers to the *when* question have been given – *later* and *earlier*. Two answers have also been given to the *how can we tell* question – by studying what children say in expressive language and by studying discrimination in receptive language. Importantly for the current work, proponents of the later learning of grammatical categories tend to focus on what children say, whereas at least some proponents of earlier learning focus on infant receptive language discrimination. The unique contribution of the current work is that it focuses on a type of utterance that has been used to argue for later learning of the VERB category – specifically *overregularizations* like *breaked* or *catched*, in which children fill gaps in the morphosyntactic VERB paradigm. Although these overregularizations in production occur at around 3 years of age, we use a comparable gap-filling approach in receptive language to ask if much younger children anticipate such overregularized forms.

Let us begin by outlining the *later* versus *earlier* accounts of grammatical category acquisition and the evidence typically used for each. According to the *Constructionist* view, children's grammars are constructed on a word-by-word basis, with each word behaving at first like an island that is not abstractly connected to other words of the same category (Tomasello, 1992, 2000a, 2000b). As noted above, the evidence for this view focuses mainly on what children say. With respect to verbs, two types of production data have been used. First, children's productions of irregular verbs have been described as exhibiting a U-shaped function in which correct forms are produced (e.g., *broke*), followed by a period of overregularization (e.g., *breaked*) starting at about 2- to 3-years-old, followed by the correct form again (Brown, 1973). For proponents of the later learning of grammatical categories, the first period indicates a rote learning of individual verb forms used in previously heard contexts. The second overregularization stage on this view reflects the child's tacit understanding that to form the past tense, *–ed* is added to the *category* VERB. The second stage occurs at some time around age 3 years, thereby suggesting a rather late partitioning of words into grammatical categories. Another type of production data that has been used to argue for later emergence of grammatical categories is gaps in children's own productions. For example, when verbal grammatical morphemes emerge (e.g., the past tense *–ed* morpheme),

☆ This work was supported by NSF DDIG 1729862 and NSF BCS 1724842.
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https://doi.org/10.1016/j.cognition.2019.05.014
Received 15 October 2018; Received in revised form 10 May 2019; Accepted 16 May 2019
0010-0277/ Published by Elsevier B.V.

these morphemes are not evenly distributed across all verbs (Tomasello, 1992, 2000a, 2000b). Instead, children's accuracy and productivity with grammatical morphemes increases as a function of language experience, and thus, variability in individual children's use of grammatical morphemes can be explained in the variability of exposure to the form and the child's ability to extract patterns to formulate some internal grammatical rule and eventually form an abstract grammatical category (Tomasello, 2000a, 2000b). A similar logic has been applied to gaps in children's use of determiners (e.g., Pine & Lieven, 1997; Pine & Martindale, 1996; Pine, Freudenthal, Krajewski, Grzegorz, & Gobet, 2013; *cf* Valian, 1986). Pine and Lieven (1997) found that there was nearly no overlap between the set of nouns 2- and 3-year-olds used with the determiner *a* and the determiner *the*, suggesting the children did not have an abstract representation of DETERMINER; rather, individual children learned item-based constructions from their environment.

Although much of the work arguing for later acquisition of grammatical categories is decades old, the argument still appears in quite recent and visible work. For example, Meylan and colleagues applied a Bayesian statistical model to a very large set of 2- to 3-year-olds' utterances to ask whether the later or earlier account of the acquisition of the determiners *a* and *the* was better supported (Meylan, Frank, Roy, & Levy, 2017). They concluded that, "In the key case study of English determiner productivity, applying our model to new, dense data yielded support for constructivist accounts and further constrained the developmental timeline within these accounts. While children's earliest multiword utterances may be island like, grammatical productivity emerges rapidly thereafter." It is important to note that this recent study, like nearly all studies using children's own productions to argue for the later view of grammatical category acquisition, focuses on how children fill or do not fill gaps in morphosyntactic paradigms. That is, even if a child has never heard *a* with the familiar noun like *cake*, does she nevertheless produce *a cake* herself?

Let us now turn to earlier accounts of grammatical category acquisition. Two such accounts can be found in the literature. One focuses on the universality of grammatical categories among human languages. On this view, humans are born expecting their linguistic input to exhibit a set of categories, and language development entails linking the preexisting categories with the words and phrases in the learner's input (e.g. Pinker, 1984; Valian, 1986). One approach to linking these innate categories to the words available in the linguistic environment that has been proposed entails children having preexisting expectations about the connection between certain kinds of meanings and certain grammatical categories (Pinker, 1984). Simplified, this *Semantic Bootstrapping* view holds that children are born expecting that words referring to objects are nouns and words referring to actions are verbs. Having established some basic lexical items (e.g., *dog*, *play*) based on these expectations, later, children can infer the categories of more abstract words (e.g., *beauty*, *feel*) by noting their distributional properties within a sentence. For example, members of the grammatical category NOUN tend to co-occur with determiners and members of the grammatical category VERB tend to co-occur with auxiliaries and inflections like *–ing* and *–ed*.

A different version of the earlier categories view picks up where Semantic Bootstrapping leaves off – specifically, words that belong to the same grammatical category will appear in similar distributional patterns across utterances, and this information is robust enough to be the foundation for the task of abstraction and the later development of more syntactically complex structures (Gerken, Landau, & Remez, 1990; Gerken & McIntosh, 1993; Maratsos & Chalkley, 1980; Mintz, Wang, & Li, 2014; Moran et al., 2018). On some *distributional* accounts, the only ability that is innate is a predisposition to discern distributional patterns and form generalizations based on these patterns (e.g., Maratsos & Chalkley, 1980). Unlike the Semantic Bootstrapping account, the child's task is not necessarily linking innate grammatical categories to encountered words and phrases in the target language, but creating clusters of words and phrases that occur in the same distributional contexts. For instance, the cluster of words that we might call VERB is the set of words that share some or all of the following contexts: immediately follow *I, you, he, she, we, they,* immediately precede *–ing, -s, -ed*.

Because both earlier accounts of grammatical category acquisition focus on the use of distributional information, typically the co-occurrence of grammatical morphemes and content words, at some point in the acquisition process, one form of evidence taken to support these accounts is the ability to encode the patterns of occurrence of closed class or grammatical morphemes, such as determiners, auxiliary verbs, and verb inflections. This ability is typically assessed by either testing the learner's ability to discriminate or comprehend legal versus illegal combinations of grammatical morphemes and content words in their own language (e.g., Gerken et al., 1990; Gerken & McIntosh, 1993; Hirsh-Pasek & Schweisguth, 2001; Höhle, Weissenborn, Kiefer, Schulz, & Schmitz, 2004; Höhle & Weissenborn, 2003; Kedar, Casasola, & Lust, 2006; Nazzi, Barriere, Goyet, Kresh, & Legendre, 2011; Santelmann & Jusczyk, 1998; Shady & Gerken, 1999; Shafer, Shucard, Shucard, & Gerken, 1998; Shi, Cutler, Werker, & Cruickshank, 2006; Soderstrom, White, Conwell, & Morgan, 2007; van Heugten & Johnson, 2010). Other studies have focused on whether children can learn new combinations of grammatical morpheme-like and content word-like elements in a brief laboratory exposure and discriminate previously heard combinations from new ones (e.g., Gervain, Nespor, Mazuka, Horie, & Mehler, 2008; Gómez, 2002; Gómez & Gerken, 1999; Gómez & Lakusta, 2004; Gómez & Maye, 2005). These studies suggest that children are able to encode patterns of adjacent co-occurrence by about 12 months and patterns of non-adjacent co-occurrence by about 18 months. Moreover, computational and statistical analyses of linguistic corpora show successful categorization of words based on analyses of such co-occurrences, lending further credence to the idea that children could engage in a similar approach to grammatical category formation (Chemla, Mintz, Bernal, & Christophe, 2009; Mintz, 2002; Mintz, Newport, & Bever, 2002; Moran et al., 2018; St. Clair, Monaghan, & Christiansen, 2010). In summary, the prerequisite sensitivities for abstract grammatical category formation are in place several months to a year before research on children's productions provide evidence of categories.

However, if we require of the receptive language studies the same type of evidence used in the production studies, namely the filling of gaps in morphosyntactic paradigms, the evidence for earlier category formation is somewhat weaker. In one study, 14- to 16-month-old German-learning toddlers were able to use adjacent real determiners to treat novel content-like words as belonging to a distributionally-defined class (Höhle et al., 2004). Children were exposed to a familiarization phase with either real German determiner-pseudoword sequences (noun context) or real German pronoun-pseudoword sequences (verb context). During test, all toddlers heard two types of passages: pseudowords used in new distributional contexts consistent with German nouns and pseudowords used in distributional contexts consistent with German verbs. Thus, half of the test passages were inconsistent with the sequences with which each toddler was familiarized. There were no other cues to category (e.g., phonotactic, etc.) beyond the distributional context, and the grammatical morphemes used during familiarization were not used at test. The children who were familiarized with determiner-pseudoword sequences showed a novelty preference for the passages with pseudowords used in verb contexts, suggesting the pseudowords appeared in distributional contexts the toddlers did not expect. No such effect was found in toddlers who were familiarized with pronoun-pseudoword sequences. A similar study was conducted with French-learning 14-month-olds (Shi & Melançon, 2010), and the results presented a similar picture: toddlers were able to discriminate real French determiner-pseudoword from real French pronoun-pseudoword test sequences when they were familiarized with determiner-pseudoword sequences, but not when they were familiarized with pronoun-pseudoword sequences.

The asymmetry in the pattern of results in these two studies might

indicate that noun contexts are discovered earlier than verb contexts. Relatedly, it is possible that, when learning new words in one's target language, toddlers have a greater expectations about learning new nouns than new verbs. Or, the asymmetry might indicate that different grammatical morphemes in different languages may be more or less reliable predictors of the category membership of co-occurring nouns and verbs. In support of the latter view, the indefinite article in German is followed by a noun more often than not, while the personal subject pronoun in German can proceed members of the grammatical categories of verb, noun, adverbs, or determiners (Höhle et al., 2004; van Heugten & Johnson, 2010). Thus, it seems likely that the personal pronoun is a less reliable cue to grammatical category than the indefinite article, at least in German.

In another line of research that asked whether toddlers could fill gaps in *new* morphosyntactic paradigms in the lab, 17-month-old English-learners were presented with a Russian gender paradigm in which masculine nouns were presented with two case markers and feminine nouns with two different case markers. Crucially, some noun-case marker pairs were withheld (gaps), and children were tested on their discrimination of the withheld pairs versus ungrammatical pairs (e.g., feminine noun with masculine case marker; Gerken, Wilson, & Lewis, 2005). 17-month-olds were indeed able to discriminate legal from illegal gaps.

The three studies just outlined provide some support for the view that grammatical categories are acquired earlier rather than later. However, the fact that there are relatively few of these gap-filling studies, and the fact that the two studies that examined grammatical categories in the toddler's target language (German and French) did not find evidence for the category VERB indicate that the support for the earlier account is not unequivocal. Performing the gap-filling test on toddler perceptual discrimination for the category VERB is the goal of the current research.

In addition to the relatively scant receptive language evidence that children can fill gaps in morphosyntactic paradigms, it is important to realize that this ability, if children truly have it, is something of a double-edged sword. That is because of the existence of *two types of gaps* in co-occurrence patterns in their input – *linguistically motivated gaps* and *accidental gaps*. An example of a linguistically-motivated gap is that the noun *paint* can occur with *some* and *the* but not *a*, whereas *cookie* can occur with *the* and *a* but not *some*. Are mass nouns like *paint* treated as belonging to a different proto-category than count nouns like *cookie*? Similarly, are regular verbs like *kick*, which can occur with *–ing, –s*, and *–ed,* treated differently than irregular verbs like *break*, which do not occur with *–ed*? These non-accidental gaps in the distributional paradigms of forms like *kick* vs. *break* are a result of language-based inconsistencies in the grammar.

Meanwhile, children are also exposed to accidental gaps in distributional paradigms, which are chance-based: even though *kick* can co-occur with *–ed* to make *kicked*, it is possible that the child language learner is not exposed to any examples of *kicked* based on pure coincidence. As an illustration, we did an analysis of the Adam corpus (Brown, 1973) from the CHILDES database (MacWhinney, 2000). We looked at common verbs understood by 16-month-olds (per the MacArthur CDI; Dale & Fenson, 1996) and investigated the morphemic contexts in which they appear in child-directed speech. From the data in Table 1, it is reasonable to assume that children are exposed to many accidental gaps. For instance, while Adam was exposed to the regular verbs *cry, dance, help, kiss* and *love* + *–s* and + *–ing*, he was not exposed to these verbs + *–ed*. Even though they are all legal co-occurrences in English, these past tense forms are accidently missing from Adam's input during these observational periods. This is not to say that we believe Adam never heard any of the forms in his linguistic input; rather, he, or any child, is very unlikely to hear or encode every English verb as co-occuring with every grammatical morpheme. This is just to say that children must generalize away from the specific input to which they are exposed if they are to develop the grammar of the language around them.

Table 1
Illustration of accidental gaps in the child-directed speech of the Adam corpus (Brown, 1973).

	–ed	*–ing*	*–s*	Totals
Break	0	8	1	9
Bring	0	3	0	3
Catch	0	2	0	2
Close	7	0	0	7
Cry	0	24	2	26
Dance	0	12	1	13
Drink	0	9	4	13
Fall	0	5	5	10
Finish	70	1	0	71
Help	0	1	2	3
Hug	5	0	0	5
Jump	5	6	2	13
Kick	2	1	0	3
Kiss	0	1	0	1
Love	0	0	1	1
Look	12	64	113	189
Open	6	4	6	16
Play	12	81	7	100
Run	0	5	1	6
Take	0	29	15	44
Throw	0	7	3	10
Totals	119	263	163	545

The existence of linguistically-motivated versus accidental gaps poses a generalization problem for which there are at least three solutions. One solution is simply not to generalize (and thereby not fill input gaps) until later in the development process when more information is available. That is, consistent with a later account of grammatical category acquisition, children's productions of forms like *breaked* at about age 3 years reflect the development period when generalization over the category VERB actually begins (e.g., MacWhinney, 2000). This solution predicts that 16-month-olds will *not* anticipate forms like *breaked*.

A second solution is to employ an approximation to Bayesian statistics, keeping track of how often an unheard form *should* have been heard if it is grammatical. For example, in the data in Table 1, past tense forms occur 22% of the time (119/545), progressive forms 48%, and present tense forms 30%. For the irregular verb *take,* which does not appear in the documented input to Adam in the past tense, it should occur in the past tense about 10 times (0.22×44) if it is grammatical. In contrast, *dance*, which also does not occur in the past tense, should have occurred only about 3 times (0.22×13). Thus, the *taked* gap may constitute more of a suspicious coincidence (Griffiths & Tenenbaum, 2007) than the *danced* gap, perhaps allowing the learner to infer that the *taked* gap is linguistically motivated (and not anticipate that it will be filled) while the *danced* gap is not (and anticipate that it should be filled). There is some evidence that even 9-month-olds are able to engage in tacit inference of this sort (Gerken, 2006, 2010). This solution also predicts that 16-month-olds will *not* anticipate forms like *breaked*.

A third solution is to treat the grammar as relatively uniform (gapless) and to find explanations for persistent gaps and other statistical anomalies later when the learner knows more about the language and how it is used. Thus, given the strength of the verb inflection paradigm in English, the learner might initially assume that if *–ed, -ing*, and *–s* occur on *look* (and many other verbs), and *–ing* and *–s* occur on *break,* then *–ed* should occur on *break* too. Note that this account is very similar to the explanation offered for the 2nd and 3rd stages of the U-shaped function of English past tense overregularization in production (Marcus et al., 1992); it simply moves the story earlier in time to make predictions about perceptual discrimination. Unlike the other two solutions, this solution predicts that 16-month-olds *will* anticipate forms like *breaked.*

The question we address in the experiments presented here is: How

Table 2
Stimuli used in Exp. 1, Exp. 2, and Exp. 3.

Overregularized Irregulars	Nonce verbs + *–ed* (Exp. 1)	Nouns + *–ed* (Exp. 2)	Correct Irregular Verbs (Exp.3)
Snoopy **catched** the ball	Snoopy **/bɪʌkt/** the ball	Snoopy **book–ed** the ball	Snoopy **caught** the ball
Snoopy **drinked** the milk	Snoopy **/vaɹgəld/** the milk	Snoopy **orange–ed** the milk	Snoopy **drank** the milk
Snoopy **throwed** the toy	Snoopy **/fimd/** the toy	Snoopy **crib–ed** the toy	Snoopy **threw** the toy
Snoopy **falled** down the hill	Snoopy **/jækt/** down the hill	Snoopy **sock–ed** down the hill	Snoopy **fell** down the hill
Snoopy **breaked** the door	Snoopy **/lɛndəld/** the door	Snoopy **truck–ed** the door	Snoopy **broke** the door
Snoopy **taked** the apple	Snoopy **/spɛft/** the apple	Snoopy **hair–ed** the apple	Snoopy **took** the apple
Snoopy **bringed** the bottle	Snoopy **/wifəld/** the bottle	Snoopy **spoon–ed** the bottle	Snoopy **brought** the bottle
Snoopy **runned** in the park	Snoopy **/spoft/** in the park	Snoopy **doll–ed** in the park	Snoopy **ran** in the park

do children handle gaps in the forms they detect from the available input about morphosyntactic paradigms? Specifically, how do children handle linguistically-motivated differences in contexts that occur between regular and irregular verbs? Although we acknowledge that each of the three solutions to the two-types-of-gaps problem is likely to be more complicated than the caricatures that we have given, it is nevertheless instructive that different classes of grammatical category acquisition mechanisms make different predictions. As indicated above, only the third solution, in which the learner treats the grammar as relatively uniform and the evidence for verb inflection paradigms as strong, predicts that 16-month-olds will anticipate forms like *breaked*.

In the experiments that follow, we focus on children within the age range typically tested in grammatical categorization studies. We asked whether 16-month-olds predict that previously heard irregular verbs should occur with the English grammatical morpheme, *–ed*. Experiment 1 investigated whether toddlers could discriminate between overregularized verbs and phonotactically-matched nonce verbs marked for the past tense. Experiment 2 assessed the generalizability of toddlers' preference for the overregularized verbs and compared their listening times for overregularized verbs to English nouns + *–ed*. Experiment 3 examined whether toddlers could discriminate between overregularized verbs and their correct counterparts. Taken together, the experiments strongly suggest that 16-month-olds treat English verbal morphemes (e.g., *–s, –ing, –ed*) as sufficiently associated that they expect that *–ed* will apply to verbs to which they have never heard it applied and that overregularized forms are suitable alternatives to the correct irregular counterparts based on distributional information.

2. Experiment 1

In order to test toddlers' predictions about the co-occurrence of *–ed* and members of the category VERB, we first compared overregularized past tense forms with nonce verbs + *–ed*. If there was a null effect, toddlers may not be registering any difference between the two sets of never-before-heard stimuli. It was predicted, however, that these toddlers would discriminate between forms like **breaked* and phonotactically English-like nonce verbs + *–ed*. Which form will children prefer? Studies in which children's own language (no familiarization phase) is pitted against a modified version of that language typically show a familiarity preference (Houston-Price & Nakai, 2004; Jusczyk, Friederici, Wessels, Svenkerud, & Jusczyk, 1993; Santelmann & Jusczyk, 1998; Shady, 1996), while studies that familiarized children with novel stimuli immediately before testing have found a novelty preference (e.g., Höhle et al., 2004). Since our study does not include a familiarization phase, and the toddlers' linguistic environment serves as the familiarization, our experiments are more similar in structure to the studies that show a familiarity preference (Jusczyk et al., 1993; Jusczyk, Luce, & Charles-Luce, 1994; Santelmann & Jusczyk, 1998). Therefore, we hypothesized that toddlers would exhibit longer looking times for overregularized stimuli based on *familiarity* with the association between known VERB + *–ed* given distributional information — a preference reflecting the toddlers' representation of English and a generalization that results in the filling of a gap in a morphosyntactic paradigm.

2.1. Methods

2.1.1. Participants

Sixteen toddlers contributed data to this experiment (8 female, *M* age = 16.25). Participants were all from English speaking homes with no family history of speech, language, or hearing disorders. The toddlers tested did not produce any past tense verbs — correct or not. This was determined by a past tense questionnaire designed in-house. Parents/guardians were asked to indicate if their child produced any verb forms, including the root form, past tense form, and overregularized form (e.g. *catch*, *caught*, **catched*). An additional twelve toddlers were excluded for the following reasons: fussiness ($n = 5$), the participant's mean looking time was more than 2.5 standard deviations above the mean ($n = 2$) or three or more trials had looking times under 2 sec. (based on the standards of our lab; $n = 1$), equipment or experimenter error ($n = 3$), and parental interference (i.e., the mother pointed; $n = 1$). The number of excluded toddlers is comparable to studies using the same procedure with toddlers of the same age (Höhle et al., 2004; Soderstrom et al., 2007).

2.1.2. Stimuli

The stimuli were the 8 overregularized irregulars sentences and the nonce verbs + *–ed* sentences found in Table 2. The eight verbs were selected from the 'Action Words' section of the MacArthur Communicative Development Inventory: Toddler (CDI: Toddler; Dale & Fenson, 1996).[1] A female native speaker of American English produced auditory stimuli in child-directed speech in a sound-attenuated recording booth. All stimuli were recorded during the same recording session. The sentences were combined into blocks and edited, controlling for duration, using Praat software (Boersma & Weenink, 2014). The relative speech rate of the verb to the rest of the sentence was the same. The shorter sentences were adjusted to have the same duration as their longer counterparts. The sentences were separated by pauses of 1000 msec. The sentences had a duration of 2.125 s and each trial had a duration of 24 s. Two versions of each block were created with different orders of the sentences to ensure that toddlers who did not listen to complete trials would be exposed to the entire range of stimuli. Each toddler was seen for one experimental session. All toddlers heard the same four blocks two times each.

2.1.3. Procedure

We used the Headturn Preference procedure (HPP; Kemler Nelson et al., 1995) in the way it was originally developed – to test toddlers' preference for language patterns that conform to their native language versus language patterns that do not conform (e.g., Jusczyk, Luce, & Charles-Luce, 1994). That is, as noted above, our study does not include a familiarization phase. Instead, the toddlers' linguistic environment

[1] The phonotactic probabilities of each target verb were calculated using an online phonotactic probability calculator (Vitevitch & Luce, 2004). There were no significant differences between the blocks of stimuli.

serves as the familiarization. Any significant difference in looking times for the two types of test trials would indicate discrimination of the test stimuli. Our hypothesis was that toddlers would listen longer to over-regularized English verbs than the phonotactically-matched nonce verbs + *–ed*. That is, toddlers would discriminate between the two types of stimuli and interpret the past tense morpheme as correctly co-occurring with the irregular verb stem (e.g., **breaked*) and attend longer to these forms because they are familiar.

Each toddler was tested individually while seated on the caregiver's lap in a soundproof booth. The booth contained an amber light directly in front of the toddler and two red lights above speakers to the toddler's right and left. The caregiver listened to masking music through headphones in order to avoid inadvertently influencing the toddler. An experimenter outside the test booth viewed the session on a video monitor with the sound off and recorded the toddler's looking behavior using a button box connected to an Apple Power Macintosh computer. The experimental control program initiated trials and scored head-turn responses. During test, each trial began with the light blinking at center. When the observer, unable to hear the stimuli, indicated that the toddler was looking at the light, a light on the left or right began flashing. When the toddler turned toward the flashing side light, one of the randomly selected lists of auditory stimuli played from the corresponding speaker. The toddlers' looking times were recorded by the experimenter pressing a button on the computer when the toddler changed their gaze direction, turning their head at least 30 degrees toward the side light. The assignment of sentences was randomized via the lab computer in order to avoid confounding stimuli with a particular side (Kemler Nelson et al., 1995). The session was complete when the toddlers received all eight test trials. The side presentation (left or right) was randomized by the program. Each trial ended when the toddler turned his or her head away from the light for more than two seconds or when the end of the file was reached. The dependent measure was amount of time a toddler oriented toward the light on each trial type. In keeping with standard procedures using the HPP, looking times shorter than two seconds were excluded from the analyses (Kemler Nelson et al., 1995).

2.2. Results and discussion

A paired sample *t*-test was conducted to compare mean looking times for overregularized irregular verbs vs. nonce verbs + *–ed*. There was a significant difference in looking times for overregularized ($M = 11.69$, $SD = 2.32$) and nonce ($M = 9.65$, $SD = 2.47$) blocks ($t(15) = 2.93$, $p = 0.01$; See Fig. 1.) 14 out of 16 toddlers listened longer to the overregularized stimuli. Post-hoc power analyses indicated that the statistical power for this study was 0.84 for detecting a large effect size (0.8, as defined by Cohen, 1992) with the alpha level set at $p < 0.05$ (two-tailed).

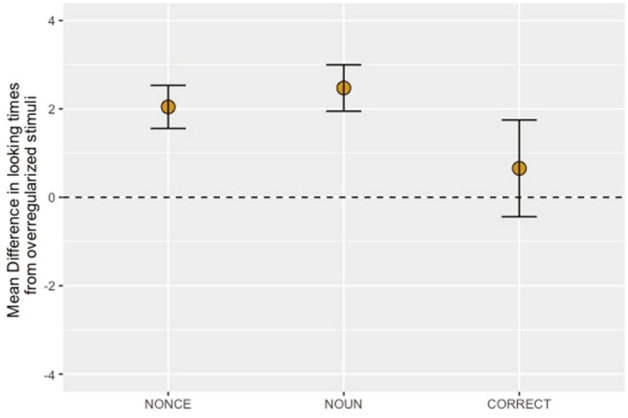

Fig. 1. Mean difference in looking times for each experiment from the overregularized stimuli with bars for standard error. The mean difference was calculated from the participants' listening times for the overregularized stimuli and the test stimuli (i.e., nonce, noun, or correct).

This pattern of results is consistent with at least two possible interpretations: (1) Our hypothesis is correct and the toddlers are displaying a familiarity preference for the forms that follow their knowledge of the distributional properties of the *–ed* morpheme and their interpretation of the past tense formation rule, i.e., add *–ed* to English verbs without exception. (2) Toddlers are responding to the combination of a familiar word + familiar morpheme. The latter interpretation at least implies that toddlers can separately perceive familiar words and the past tense morpheme, but it does not entail toddlers having tacit knowledge that *–ed* is added to verbs as we hypothesized. Exp. 2 was designed to tease apart these two hypotheses.

3. Experiment 2

Exp. 2 used the same recordings of overregularized verbs from Exp. 1 and contrasted them with familiar English nouns + *–ed*. As noted above, toddlers in Exp. 1 may have used the confluence of cues from the presence of a familiar verb and a familiar morpheme and focused their attention on this combination. This could drive them to prefer the overregularized form, but not because they have tacit knowledge of the English past tense rule, as we propose. By including another familiar form (nouns) with the same familiar morpheme (*–ed*) the two types of stimuli should be equally familiar and we should not see a difference in listening times. However, if toddlers are responding based on their tacit knowledge of the distributional properties of the *–ed* morpheme as we propose, we should again see a listening/familiarity preference for the overregularized stimuli.

3.1. Methods

3.1.1. Participants

Sixteen toddlers contributed data in Exp. 2 (8 female, *M* age = 16.26). All toddlers met the same criteria as in the Exp. 1. An additional 10 toddlers were excluded for the following reasons: fussiness ($n = 7$) and technical difficulties ($n = 3$). Again, the number of excluded toddlers is comparable to studies using the same procedure with toddlers of the same age (Höhle et al., 2004; Soderstrom et al., 2007).

3.1.2. Stimuli

The same overregularized verb stimuli from Exp. 1 were used (Table 2). The only difference between the two blocks was the target verb/noun + *–ed*. The nouns were taken from the 'Common Nouns' section of the CDI: Toddler. These words are candidates for words understood by learners under 16 months, based on previous research (Dale & Fenson, 1996). Like Soderstrom et al. (2007), we chose words that would be 'unicategorical' based on a toddler's experience. That is, although nouns can be 'verbed', these particular nouns are much more likely to appear in the children's linguistic input as nouns and in noun contexts. Using Adam's corpus again, plus the other two children's corpora from Brown (1973), Sarah and Eve, we searched for any instances of the nouns being used as verbs in the children's surrounding linguistic input and there were none. A paired sample *t*-test found no significant difference between the phonotactic probabilities of the overregularized and the English nouns + *–ed* forms. The stimuli were recorded by the same speaker as in the previous experiment. As in Exp. 1, the sentences were combined into blocks and edited, controlling for duration, using Praat software (Boersma & Weenink, 2014). The relative speech rate of the verb to the rest of the sentence was the same. The shorter sentences were adjusted to have the same duration as their longer counterparts. The sentences were separated by pauses of 1000 msec. The sentences had a duration of 2.125 s and each trial had a duration of 24 s. Two versions of each block were created with different

orders of the sentences to ensure that toddlers who did not listen to complete trials would be exposed to the entire range of stimuli. Each toddler was seen for one experimental session. All toddlers heard the same four blocks two times each.

3.1.3. Procedure

The procedure was identical to that used in Exp. 1.

3.2. Results and discussion

As in Exp. 1, toddlers showed a listening preference for the overregularized real verbs. A paired sample *t*-test comparing looking times was conducted and there was a significant difference between the overregularized verb blocks ($M = 10.77$, $SD = 3.61$) and English noun + *–ed* blocks ($M = 8.30$, $SD = 2.79$; $t(15) = 3.00$, $p = 0.01$; See Fig. 1). As in Exp. 1, 14 out of 16 toddlers listened longer to the overregularized stimuli. Post-hoc power analyses indicated that the statistical power for this study was 0.84 for detecting a large effect size (0.8, as defined by Cohen, 1992) with the alpha level set at $p < 0.05$ (two-tailed).

Exp. 2 eliminated a potential confound of Exp. 1 and nevertheless replicated the effect that toddlers preferentially listened to overregularized verb stimuli. The inclusion of familiar words (i.e., English nouns) allowed us to assess whether discrimination of the familiar VERB + *–ed* morpheme is based on familiarity or if the preference is a reflection of toddlers' tacit understanding of the distributional properties of the *–ed* morpheme (e.g., Gerken & McIntosh, 1993; Golinkoff, Hirsh-Pasek, & Schweisguth, 2001; Mintz, 2013). Toddlers have never heard either the nouns or the verbs with *–ed* endings, so the nouns and the verbs should be equally familiar (or unfamiliar) to them. In fact, if toddlers in either Exp. 1 or 2 were responding based on familiarity alone, they should have listened longer to the noun stimuli in Exp. 2. Over the course of development, nouns have a distributional advantage over verbs (Willits, Seidenberg, & Saffran, 2014), and toddlers recognize nouns months before they recognize verbs (e.g., Jusczyk & Aslin, 1995; Marquis & Shi, 2008). Therefore, the listening preference for the overregularized verb forms provides strong evidence against a simple familiar stem plus morpheme response in Exps. 1 and 2 and is therefore consistent with our hypothesis that 16-month-olds have tacit knowledge of the distributional properties of the *–ed* morpheme.

It is very unlikely that 16-month-olds are responding to a violation of English word order/sentence-level distributional information (i.e., the sentences with nouns create a NOUN-NOUN + *–ed*-NOUN word order). We know from studies examining children's ability to learn the meaning of a novel noun or verb that 16-month-olds are very unlikely to be able to do this. For example, Soderstrom et al. (2007) found that 16-month-olds displayed knowledge of the correct placement of the third person singular *–s* marker when it co-occurred with familiar verbs and nouns, but they were not sensitive to the word order of these same verbs and nouns. 16-month-olds were presented with grammatical and ungrammatical passages that either manipulated morphosyntactic morphemes and word order together, e.g., "They used to *sing* in the *chairs* on the porch" became "They used to *chairs* in the *sing* on the porch"), or manipulated each independently, e.g., the word order condition became "They used to chair in the sings on the porch." and the morpheme condition became "They used to sings in these chair on the porch." (*the* was changed to *these* to make sure the cue for the appropriate morpheme was not ambiguous). Only the 16-month-olds who heard the morpheme violations preferred to listen to grammatical passages. Further, Ferguson, Graf, and Waxman (2014) found that 19-month-olds, and not 15-month-olds, were able to assign a proto-meaning to a novel noun serving as an argument to a known verb. Additional work shows that 25- and 22-month-olds have the ability to use sentence-level distributional information to infer the meaning of novel verbs given the verb's arguments (Gertner, Fisher, & Eisengart, 2006; Messenger, Yuan, & Fisher, 2015; Yuan, Fisher, & Snedeker, 2012); however, 19-month-olds do this only if the experiment is simplified by adding more repetitions of test items and giving them more time to process the corresponding (or not) visual event (Yuan et al., 2012). Based on the current literature, there is no compelling evidence that the 16-month-olds in our study are responding to sentence-level distributional information.

One additional interpretation of Exps. 1 and 2 concerned us since the preferred stimuli in both experiments were physically identical. We considered the possibility that there was something about the sound properties of the stimuli themselves that drove toddlers' preferences. Exp. 3 was designed to rule out this hypothesis by pitting the overregularized verb stimuli from Exps. 1 and 2 against stimuli that toddlers might find equally attractive.

4. Experiment 3

To rule out the possibility raised above that something about the sound properties of the overregularized forms in Exps. 1 and 2 drew toddlers' attention, Exp. 3 used the overregularized verbs from Exps. 1 and 2 and contrasted them with their correct irregular counterparts (e.g., *breaked/broke;* see Table 2). Our reasoning was as follows: We hypothesize that toddlers have heard verb stems like *break* as well as inflected versions like *breaks* and *breaking* in their environment (see Table 1). Because verbs that occur with *–s* and *–ing* inflections also typically occur with *–ed* in toddlers' experience, we suggest that toddlers anticipated overregularized forms like *breaked*. The anticipation that such forms *should* exist is the basis on which toddlers in Exps. 1 and 2 preferred them. However, toddlers have actually heard the correct past tense forms of irregular verbs like *broke*. Thus, these forms should compete with the putatively anticipated overregularized forms. Therefore, we predict that toddlers will either prefer the correct forms because they have actually heard them, or they may show no preference for the correct versus overregularized forms, because they have experience with the former, but they also have strong reason to tacitly believe (based on the distribution of verbs and inflections in their environment) that the latter should occur. Thus, Exp. 3 pits experience with actual forms against experience with verbal morphosyntactic paradigms. Given that the irregular verbs included in this study were all less common in spoken language than their uninflected, root form, with the exception of *caught* (Davies, 2008), the pitting of experience with a particular form vs. an entire paradigm might well end in a tie. However, a preference for correct irregulars or no preference at all would indicate that it was not the physical stimuli used in the overregularized conditions in Exps. 1 and 2 that were responsible for the toddlers' preference.

4.1. Methods

4.1.1. Participants

18 toddlers contributed data to this experiment (6 female, *M* age = 16.25). Participants met the same criteria as in Exps. 1 and 2. An additional seventeen toddlers were excluded for the following reasons: fussiness ($n = 14$), the participant's mean looking time was more than 2.5 standard deviations above the mean ($n = 1$), equipment or experimenter error ($n = 1$), and parental interference (i.e., the mother pointed; $n = 1$). As in Exps. 1 and 2, the number of excluded toddlers is comparable to studies using the same procedure with toddlers of the same age (Höhle et al., 2004; Soderstrom et al., 2007).

4.1.2. Stimuli

The stimuli were the overregularized stimuli and the correct irregular counterparts in Table 1.[2]

[2] The phonotactic probabilities of each target verb were calculated using an online phonotactic probability calculator (Vitevitch & Luce, 2004). There were no significant differences between the blocks of stimuli.

The stimuli were recorded by the same speaker as in the previous experiments. All stimuli were recorded during the same recording session. As in the two previous experiments, the sentences were combined into blocks using Praat software (Boersma & Weenink, 2014). The relative speech rate of the verb to the rest of the sentence was the same. The shorter sentences were adjusted to have the same duration as their longer counterparts. The sentences were separated by pauses of 1000msec. The sentences had a duration of 1.875 s and each trial had a duration of 22 s. Two versions of each block were created with different orders of the sentences to ensure that toddlers who did not listen to complete trials would be exposed to the entire range of stimuli. Each toddler was seen for one experimental session. All toddlers heard the same four blocks two times each.

4.1.3. Procedure

The procedure was identical to that used in Exp. 1 and Exp. 2.

4.2. Results and discussion

A paired sample *t*-test did not show a significant difference in looking times between overregularized ($M = 10.16$, $SD = 4.83$) and correct ($M = 9.71$, $SD = 3.27$) forms ($t(17) = 0.48$, $p = 0.63$; See Fig. 1). 9 out of 18 toddlers listened longer to the overregularized verbs. A non-parametric test also showed no significant differences in looking times: Post-hoc power analyses indicated that the statistical power for this study was 0.89 for detecting a large effect size (0.8, as defined by Cohen, 1992) with the alpha level set at $p < 0.05$ (two-tailed). A Wilcoxon signed-rank test indicated that overregularized and correct looking times were not statistically different $Z = 75$, $p = 0.67$. Fig. 1 shows the difference in mean looking times across the three experiments. The fact that toddlers showed no preference for the overregularized forms in Exp. 3 suggests that there is not something about the sound properties of these stimuli that was driving their responses in Exps. 1 and 2. The difference between Exp. 1 vs Exp. 3 and Exp. 2 vs. Exp. 3 were significant using non-parametric statistics ($\chi^2(4) = 17.44$, $p = 0.004$).

5. General discussion

The three experiments presented here ask when children acquire abstract grammatical categories, and does production or perceptual discrimination data give us a better answer? Production data that bear on the *when* question have focused almost exclusively on how children treat gaps in their experience, both syntactically-motivated gaps like *breaked* and accidental gaps in which a particular determiner does not co-occur with a particular noun. There is evidence from children's productions that they fill in gaps in morphosyntactic paradigms at around 2–3 years. At this time, they both fill linguistically motivated gaps like *breaked* (Brown, 1973; Cazden, 1968; Kuczaj, 1977; Marcus et al., 1992) and produce the range of determiners with the range of nouns that they know (Meylan et al., 2017; Pine et al., 2013; Pine & Lieven, 1997; Pine & Martindale, 1996; Tomasello, 1992, 2000a, 2000b).

On the perceptual discrimination side, previous research has suggested that 16-month-olds have the prerequisite sensitivities for abstract grammatical category formation – primarily sensitivity to co-occurrences between grammatical morphemes and content words (e.g., Golinkoff et al., 2001; Kedar et al., 2006; Mintz, 2013; Santelmann & Jusczyk, 1998; Shady, 1996; Soderstrom et al., 2007). These prerequisites should allow them to discern the relationship between the VERB protocategory + *–ed*. However, knowing that 16-month-olds have the prerequisites for grammatical category formation do not tell us how they reconcile the fact that *walk* can appear with *–ing*, *–s*, and *–ed*, while *break* can only appear with a subset of those morphemes (i.e., *–ing* and *–s*). These linguistically-motivated, non-accidental gaps in the distributional paradigms of forms like *walk* versus *break* are a result of language-based inconsistencies in the grammar. Meanwhile, children are also exposed to accidental, chance-based gaps in distributional paradigms, such as the gap in Adam's experience with the verbs *cried*, *danced* and others (Table 1). There is also evidence from experiments on receptive language that toddlers at around 16–17 months discriminate legal versus illegal experiential gap fillers, supporting earlier acquisition of grammatical categories (Gerken et al., 2005; Höhle et al., 2004; Shi & Melançon, 2010). However, none of these studies of perceptual discrimination have provided evidence for the category VERB. The current work addressed a missing piece of data in the literature by looking at how 16-month-olds treat experiential gaps in the morphosyntactic paradigm of the category VERB.

Across three experiments, we manipulated past tense overregularizations to examine whether 16-month-olds anticipate how experiential gaps should be filled across the entire VERB paradigm. We specifically tested the hypothesis that toddlers tacitly expect that previously heard irregular verbs should occur with the English grammatical morpheme *–ed*. We reasoned that, if 16-month-olds indeed are filling in gaps in morphosyntactic paradigms and can predict the existence of past tense forms like *breaked* and *catched*, they should, at the very least, discriminate these paradigm-completing yet never-heard-forms from other similar forms which do not complete a paradigm. Using a preferential listening task, we found that toddlers exhibited a familiarity preference for overregularized real verbs over (1) nonce verbs marked with *–ed* (Exp. 1) and (2) familiar nouns marked with *–ed* (Exp. 2). Exp. 3 rules out the possibility that performance in Exps. 1 and 2 was due to something about the sound properties of the overregularized verbs in those experiments and not due to toddlers tacitly anticipating the overregularized forms as filling gaps in their experience. Because children had almost certainly heard at least some of the correct irregulars in Exp. 3, they failed to show a significant preference for overregularized forms that we suggest they tacitly anticipate versus forms that they actually had experienced.

Exps. 1 and 2, in which toddlers preferentially listened to overregularized past tense forms, suggest that, based on their experience with English, they associate the members of the set of frequent verbal morphemes (e.g., *–ing*, *–s*, *–ed*), and they do so earlier, rather than later. This strong association has the consequence that, if they have encountered one or more of these morphemes attached to a word (outside of the lab), they expect that the associated morphemes should also attach to that word. Exp. 2, in which toddlers discriminated overregularized verbs from English nouns marked with *–ed,* further suggests that toddlers treat the set of words that linguists label VERB as distinct from the set labeled NOUN. Only the former set of words can co-occur with the *–ed* inflection. Based on previous research with 16-month-olds, specifically the work of Soderstrom et al. (2007) that shows that children at this age do not show evidence of a sensitivity to the word order properties of familiar verbs and nouns, our results in Exp. 2 strongly suggest that 16-month-olds are responding to the co-occurrence of VERB + *–ed* (and not based on the illegal sequence NOUN-NOUN + *–ed*-NOUN). That is, consistent with the earlier account of grammatical category acquisition, the toddlers in our study are behaving as though they have acquired a proto-VERB category, to which a variety of inflections including *–ed* can be added.

Our data suggest that children partition content words into proto-grammatical categories earlier, rather than later, answering the question of *when* children learn grammatical categories. Recall there are three theoretical accounts of when children learn grammatical categories: Constructivist, Semantic Bootstrapping, and Distributional. Our data rule out the *Constructionist* view, which is a later account of grammatical acquisition (Tomasello, 1992, 2000a, 2000b). This account relies mainly on what children say, not on their receptive language abilities. We have shown here through a perceptual, gap-filling study that toddlers at 16-months-old anticipate the type of endings with which content verbs are able to co-occur months before a Constructivist account proposes. The two earlier accounts of grammatical category

acquisition, *Semantic Bootstrapping* (Pinker, 1984) and ***distributional*** accounts (Gerken et al., 1990; Gerken & McIntosh, 1993; Maratsos & Chalkley, 1980; Mintz et al., 2014; Moran et al., 2018), both predict that toddlers should perform as they have in the studies presented here. Unfortunately, there is no way to tease apart these two accounts with the data at hand. Some *distributional* accounts, unlike Semantic Bootstrapping, argue that the only ability that is innate is a predisposition to discern distributional patterns and form generalizations based on these patterns (e.g., Maratsos & Chalkley, 1980). However, we have not directly tested this aspect of Semantic Bootstrapping, so it cannot currently be ruled out.

What kind of learners are 16-month-olds who appear to be willing to fill linguistically-motivated gaps like *breaked* in their input? We suggest that the toddlers in our experiments treat the grammar, or at least the VERB category of the grammar, as relatively uniform (gapless). This view that children are willing to (over)generalize over gaps is consistent with evidence that older children initially form robust, general grammatical categories and clean up the exceptions later (Hudson, Kam and Newport, 2005). Hudson et al. (2005) taught 5- to 7-year-old children an artificial language with built-in inconsistencies in the appearance of determiners within the noun phrase to create accidental gaps in the input. For example, the non-word /lædnʌ/ appears with a determiner 44% of the time, while /flɛɹbɪt/ appears with a determiner 78% of the time. The researchers found that the children, in the face of inconsistent input, would either systematically use determiners everywhere or systematically omit them everywhere. That is, children overregularized the pattern with which they were presented.

Such a willingness to treat the grammar as relatively uniform would allow children to initially form robust general categories and to anticipate the fillers for accidental gaps like *cried* and *danced* in the corpus in Table 1. Perhaps given that accidental gaps may be more frequent than linguistically-motivated gaps, this solution is a good one. But is it better than performing the approximation to Bayesian inference that we outlined in the Introduction? Recall that on the Bayesian approach, children would weigh how frequently a form *should* occur, given that it is part of the grammar versus how often it actually occurs. In our illustration of this approach, we used the verbs *take* and *dance*, both of which occurred zero times with the inflection *–ed* in the corpus we examined. Given the rates at which other forms of *take* and *dance* occurred, *taked* should have occurred about 10 times, whereas *danced* should have occurred only about 3 times. We suggested that children might use such differences, especially over large input sets, to determine that some highly unlikely gaps in their input are linguistically-motivated and some more likely gaps are accidental. We noted that there is some evidence that even 9-month-olds are able to engage in such Bayesian inference over very small data sets (Gerken, 2006, 2010). However, over the large data set that constitutes the English VERB morphosyntactic paradigm, this approach would be very computationally demanding. Importantly, it also risks providing evidence for the wrong inferences about which gaps are motivated by the grammar. The risk is illustrated by the forms of *finish* in Table 1, which should occur in the present tense about 21 times (0.3 × 71), yet it never occurs in the corpus under consideration, no doubt because the meaning of the verb makes it more amenable to talking about past actions. Thus, even though the distribution of particular verbs and particular inflections might provide some evidence about which experiential gaps should be filled and which should not, the likelihood of serious errors, coupled with the computational demands of this kind of statistical inference for real language makes the Bayesian inference solution less advantageous that it might initially seem. Indeed, treating the grammar as relatively uniform until more information can later provide explanations for persistent gaps and other statistical anomalies might be a better solution.

What information might children ultimately use to decide that verbs like *breaked* are not grammatical in English? The most frequently suggested solution has been that, as children become more adept at sentence interpretation, they might realize that there is a word *broke* that is used in the same semantic contexts where the child previously expected *breaked* (Kuczaj, 1977; Marcus et al., 1992). Our study did not specifically address the question of whether 16-month-olds associate meaning to the tested forms, but if they do, then our data would suggest a *semantic* gap in the children's lexicon since they do not seem to associate *broke* with *break*. This remains an open issue that we are currently exploring.

Note that our explanation of the current pattern of results is very similar to the explanation offered for older children's past tense overregularization in production. On the production account, children begin to incorrectly attach *–ed* to irregular verbs because they have discovered the past tense rule, and, importantly, because they are treating irregular verbs as members of the larger class of VERB (e.g. Brown, 1973; Marcus et al., 1992). The only difference is that we have found evidence for such expectations about grammatical categories and their likely distributional contexts six or more months earlier. Therefore, the production data may reflect some process other than one of grammatical categorization. Indeed, data from our lab suggest that past tense overregularization may reflect limitations on phonological production, since, depending on the child's developmental stage, irregular past tense forms that are more phonotactically and lexically frequent than the overregularized versions are less likely to be overregularized (Figueroa, Fisher, & Gerken, 2018, under review).

The question of linguistically-motivated gaps versus accidental gaps in distributional paradigms frequently plagues computational models of distributionally-based grammatical category learning, because it is not clear what number of categories should be distinguished. For example, Chemla et al. (2009) investigated the categorization efficacy of *frames*—the distributional environment consisting of two context words with an intervening target word, i.e., [A × B]—in child-directed French. Using the Champaud (1994) corpus from the CHILDES database (MacWhinney, 2000), the researchers found that frames in the mothers' speech were accurate in their grammatical categorization of French content words significantly above chance. However, *completeness*—the degree to which the analysis put together words that belong to the same grammatical category—decreased when the number of different frames increased. That is, several frames capture nouns (e.g., *la* × *de*, which captures feminine nouns, and *le* × *de* which captures masculine nouns, etc.), and each frame creates a new, separate grammatical category for NOUN. The current data suggest that toddlers solve the gap problem in two steps – first opting for a solution that maximizes completeness followed by fine-tuning to achieve greater accuracy, perhaps through the use of semantic and pragmatic information.

Our data speak to an observed asymmetry between apparent early knowledge of NOUN vs. VERB morphosyntax that was noted in the Introduction. Recall that previous perceptual gap-filling studies examining 14- to 16-month-olds' tacit knowledge of the co-occurrence associations of grammatical morphemes and pseudowords showed the ability to generalize from familiarization to test with nouns, but not verbs (Höhle et al., 2004; Shi & Melançon, 2010). Our experiments contradict the verb finding of these studies. As noted earlier, the asymmetry in the pattern of results across studies might indicate that different grammatical morphemes in different languages may be more or less reliable predictors of the category membership of co-occurring nouns and verbs. Consistent with the reliability account, the current results suggest that verb contexts such as *–ed* are discovered at about the same time as noun contexts (somewhere between 14-16 months). This could be because the *–ed* morpheme appears in a fixed position in English — it is always proceeded by a verb stem. Since this morpheme is stable in speech, its properties may be more salient if infants and toddlers are searching for repeated patterns or co-occurrences, as we have argued. This view reinforces the idea that toddlers generalize liberally across morphosyntactic paradigms that are reliable. Interestingly, children do not need much information to extract category information. According to Wordbank, a database of developmental

vocabulary data (Braginsky, Yurovsky, Marchman, & Frank, 2016), half the 16-month-olds whose data were contributed to Wordbank know 19 verbs. Of those, nine are regular verbs (three of them end in a vowel or a voiced consonant, and six end in a voiceless consonant). The Wordbank data indicate that children are getting the full range of information needed for the past tense rule, but not much of it.

In sum, evidence reported here supports the conclusion that 16-month-olds exhibit an early expectation that English verbs, and not nouns, co-occur with the *–ed* morpheme. This knowledge suggests relatively early grammatical categorization of verbs and illustrates a relatively uniform application of *–ed* to all members of the category of VERB. How children ultimately determine that verbs like *breaked* are not grammatical in English remains an unanswered question.

Acknowledgments

The authors would like to thank Heidi Harley and Rebecca Gómez for helpful feedback on this project. This research was supported by NSF Grant DDIG 1729862 awarded to MF and NSF Grant BCS 1724842 awarded to LAG.

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