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Children's Tolerance of Word-Form Variation

Paul Reeves Breuning
The Graduate Center, City University of New York

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By

Paul Reeves Bruening

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Date	Dr. Patricia J. Brooks Chair of Examining Committee
Date	Dr. Maureen O'Connor Executive Officer

Dr. Laraine McDonough

Dr. Deborah J. Walder

Dr. Sara E. Berger

Dr. Natalie A. Kacinik
Supervision Committee

THE CITY UNIVERSITY OF NEW YORK

Abstract

CHILDREN'S TOLERANCE OF WORD-FORM VARIATION

By Paul Reeves Bruening

Adviser: Dr. Patricia J. Brooks

This study compared children's (N=96, mean age 4;1, range 2;8-5;3) and adults' (N=96, mean age 21 years) tolerance of word-onset modifications (e.g., *wabbit* and *warabbit*) and pseudo affixes (e.g., *kocat* and *catko*) in a label extension task. Trials comprised an introductory phase where children saw a picture of an animal and were told its name, and a test phase where they were shown the same picture along with one of a different animal. For 'similar-name' trials, participants heard a word-form modification of the previously introduced name (e.g., introduced to a *dib*, they were asked, 'which animal is a *wib*?'). For 'dissimilar-name' trials, participants heard an entirely new word (e.g., introduced to a *dib*, they were asked, 'which animal is a *wuz*?'). Specific types of modifications were repeated within each experiment to establish productive inflectional patterns. Across all experiments, children and adults exhibited similar strategies: They were more tolerant of prefixes than onset-modifications involving substitutions of initial consonants, and they were more tolerant of suffixes than prefixes, which may reflect a statistical tendency for inflections to adhere to the ends of words. Additionally, participants parsed novel productive inflections from stems when choosing targets. These findings point to word learning strategies as being flexible and adaptive to morphological patterns in languages.

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Introduction

In language development, an important question is how young children go about the task of acquiring and correctly associating new words with their referents, a process sometimes referred to as word to world mapping. The debate about what learning strategies children use to identify the referents of new words will be explored. More specifically, this research paper will explore the question of how word morphologies may impact the interpretations of new words for novice language learners.

Children have been shown to have a strong bias toward mapping unfamiliar words onto unfamiliar objects (Graham, Poulin-Dubois & Baker, 1998). They also seem to be capable of learning new words after only a single exposure to the word (Carey & Bartlett, 1978). The rapid learning of a label from a single exposure is often called fast mapping. In perhaps the earliest study of fast mapping, Carey and Bartlett (1978) asked children to select a "chromium" tray (olive green in color) when given two choices, an object with a color that they already had a name for and one they did not. They found that children were highly biased to select the non-primary color item. To test if the child had actually learned the new color term, children were re-tested a year later and half of the children demonstrated retention. This fast-mapping tendency has proven to be a robust and reproducible phenomenon across many studies (e.g., Markman, 1990; Booth & Waxman, 2008; Markman, Wasow & Hansen, 2003). These studies have shown that, when given an object that is familiar and one that is unfamiliar, children will associate a new name with the unfamiliar object at levels far above chance. Markman and her colleagues have interpreted this bias as reflecting an innate word-learning constraint, the mutual exclusivity (ME) principle (Markman, 1989).

Other theorists have sought to explain this rather robust finding by proposing that children utilize a novel name for nameless category principle (N3C) (Golinkoff, Hirsh-Pasek, Bailey & Wenger, 1992) or utilize pragmatic reasoning to contrast the meanings of words in their developing vocabularies (Clark, 1990; Diesendruck & Markson, 2001). These theories all seek to define the strategies word learners use or adopt when faced with what must be a large number of new words that must be correctly associated with their referents.

The ME principle asserts that young children operate under the constraint that there is only one label per entity. The N3C principle is part of an emergentist coalition framework that views language learning as a series of developmental stages, with different biases emerging and supporting word learning at different stages (Hollich, Hirsh-Pasek, Golinkoff, Brand & Brown, 2000). The N3C principle leads the child to assume that the appearance of a novel name is a cue to create a new category. An alternative, pragmatic account posits that children make the assumption that a speaker's intent is to communicate effectively and that if the speaker had wanted the familiar object they would have asked for it by its mutually known name. Clark's (1990) principle of contrast (PoC) emphasizes that no two words are *exactly* synonymous so the child compares the new word to the other words he/she already has in his/her lexicon and creates a contrast between the two words. For example, if a child already knows the word *dog* and observes her father calling the animal a *mutt* she might create the contrast [*dog + what father calls it when he is unhappy*].

The above theories all seek to explain the fast-mapping tendency and suggest that children benefit from constraints or biases in word learning. Those who endorse ME and N3C would seem to make the prediction that children should reject any word-form variant as an alternative label for a familiar object, if a novel object is available as a possible referent to associate with the novel word form. Yet, given the dynamic nature of language and the variation in actual speech production and usage, these theories may not do an adequate job of explaining how the learning strategies interact with morpho-phonological processing.

All of these theories need to deal with the fact that in all languages there are word-form variation patterns that are readily tolerated by children. For instance, the diminutive derivation is quite common in child-directed speech across many languages (Jurafsky, 1996) and children appear to successfully map both *dog* and *doggie* onto the same entity with little confusion. Children’s tolerance of diminutives as alternative labels would seem to indicate that there is a limit to the extent with which children conform to the one-word-to-one-entity rule of ME.

The label extension task and children’s tolerance of word-form variants.

The label extension task involves presentation of an altered word-form to investigate whether the word-form variant is extended to a familiar object with a similar sounding name, or to a different object. That is, participants are first introduced to the name an object and are then presented a modification of that word, or a different word entirely. For example, Hupp, Sloutsky and Culicover (2009, Experiment 1) presented adults with a novel word (e.g., *ta-te*) as the name of an object (a heart), and then asked them to identify which of two objects would be a *ta-te-be*, with the choice being a heart or a star. They reported that adults selected the same object (the heart) only 17.5% of the time when given a word-form variant involving a suffix, and only 9.5% when it involved a prefix (e.g., *be-ta-te*). Thus, adults showed an overwhelming tendency to reject any word-form variant as an alternative label for a previously named object.

The label extension task contrasts with a more widely used procedure in which children are given a choice between a familiar and an unfamiliar object. Merriman and Schuster (1991) asked 2 and 4-year-old children to decide between a familiar or unfamiliar object after hearing a nonce word that sounded similar to the name of the familiar object. At both ages, children mapped the name-similar nonce word (e.g., *japple*) onto the familiar object (e.g., an apple) about 60% of the time. In contrast, when the nonce word (e.g., *firsh*) did not bear any similarity to the name of the familiar object, 4-year-olds (and to a much lesser extent 2-year-olds) engaged in the predictable fast mapping of the name to the unfamiliar object. Merriman and Schuster (1991) introduced a wide variety of word-form modifications across items, with some items having onset-consonant additions or substitutions (e.g., *japple* for *apple, sagon* for *wagon*, *bruck* for *truck*), other items with suffixes added (e.g., *cardle* for *car*, *housler* for *house*, *pantiffs* for *pants*), and others having word-internal changes (e.g., *firsh* for *fish*, *lote* for *light*, *colck* for *clock*). Merriman and Schuster failed to detect any difference in how children responded to the items with onset modifications versus the items with suffixes added (i.e., they selected the familiar object with the similar sounding name 70% of the time when the nonce noun had an onset-modification vs. 71% of the time when it had a suffix added). However, modifications that changed the rime (i.e., the items with word-internal changes) were less likely to be treated as meaning the same thing as a similar-sounding familiar noun.

Jarvis, Merriman, Barnett, Hanba & Van Haitsma (2004) explored whether training would alter how children treated word-form modifications similar to those used by Merriman and Schuster. They hypothesized that the children in Merriman and Schuster (1991) may have formed a response set that altered their pattern of responding over the course of testing. In particular, Merriman and Schuster's inclusion of trials with two familiar objects (e.g., an apple paired with a salamander) may have led the children to assume that *japple* referred to the apple as opposed to the salamander because *japple* sounded more like *apple* than *salamander.* Consequently, Jarvis et al. tested whether the inclusion of training trials with two familiar objects and a similar-sounding nonce word would lead children to be more accepting of word-form modifications in a post-test with a familiar object paired with an unfamiliar object. They found that prior to training (i.e., in a pre-test), the children were highly biased to treat any word-form modification as a new word, but were significantly more accepting of the similar-sounding words as alternative labels of familiar objects in the post-test. Adults, in contrast to children, did not alter their response patterns after training, and selected the familiar object on only 14% of post-test trials. This high degree of resistance to any word-form modification in adults mirrors the findings of Hupp et al. (2009).

Importantly, Jarvis et al.'s results confirmed Merriman and Schuster's (1991) finding that children did not treat all word-form modifications equivalently. However, the exact pattern of responding was not identical to that reported in Merriman and Schuster. In Jarvis et al. (2004, Experiment 1), word-form modifications involving replacements of word initial consonant(s) (e.g., *bruck* for *truck*) were associated with the familiar object (e.g., a truck) only 8% of the time in the pre-test, whereas, end modifications (e.g., *shoeler* for *shoe*) were associated with the familiar object (e.g., a shoe) 42% of the time. In both Merriman and Schuster (1991) and Jarvis et al. (2004) the word-ending modifications involved adding an unstressed final syllable to the word, whereas the word-onset manipulations did not involve prefixation; rather, they involved an addition or substitution of a consonant to alter the word onset. This leaves open the question of whether children would treat prefixed versus suffixed words differently.

The research reported in this paper explores whether children distinguish between inflectional derivations of words (i.e., word-form variants with prefixes or suffixes) and new words that are phonologically similar to existing words in the child's vocabulary. This issue is of importance both for understanding how the lexicon is organized throughout language development, and for understanding how words are processed phonologically. The research specifically tests (1) whether onset modifications involving prefixes are treated differently than onset modifications involving replacements of initial consonants, and (2) whether word-initial inflections (prefixes) have a different status for label extension than word-final inflections (suffixes).

The role of prefixes and suffixes in language learning.

Studies of the world's languages provide some clues regarding the distribution of morphological changes in words. Across human languages there appears to be a preference for suffixes over prefixes (Sapir, 1921). Of the world's languages, prefixing-only languages are rare in comparison to those with suffixing-only designs (Hawkins & Gilligan, 1988). However exceptions to this asymmetry can be found in some of the world's languages such as the Bantu languages that feature a variety of prefixes including a diminutive prefix (Grandi & Montermini, 2003).

Research into the statistical occurrences of inflections in modern languages is an often-discussed topic among linguists focused on morphology (Kuczaj, 1979; Mithum, 1989; Slobin, 1973). However, there are some key studies and theoretical works that point to not only distributional trends across languages, but also the differing impact that prefixation and suffixation can have on learning new words. For example, in addition to utilizing the label extension task described above, Hupp et al. (2009) asked adults to judge which word-form variant was most similar to a target word. Across several experiments, adults were much more likely to select a suffixed word (e.g., *ta-te-be*) as more similar to *ta-te* than a prefixed word (*be-ta-te*).

Marslen-Wilson's cohort model of word recognition (1987; Marslen-Wilson & Welsh, 1978) proposed that the initial phoneme(s) of a word activate an 'initial cohort' of words bearing the same sounds. As subsequent phonemes of the word are processed and a "uniqueness point" for the word is reached, the word is selected from the lexicon. Research on spoken word recognition in infants has demonstrated that the initial phonemes of word can successfully cue word recognition. Fernald, Swingley and Pinto (2001) tested infants of ages 18 and 21 months using partial information (i.e., first 300ms of a word) in a two-item forced choice task. They found that the children with the larger vocabularies were faster and more accurate in identifying the pictures, however all of the infants were able to use partial information from the beginnings of words to complete the task. Fernald et al. (2001) concluded that incremental speech processing was available to those children in their sample, even those that were of an age that put them prior to the vocabulary spurt.

A different line of research has contrasted the role of word-initial versus word-final information in spoken word recognition. Nooteboom (1981) presented Dutch speakers with fragments of the word *Kannibal*. The word Kannibal is special in Dutch because it has seven phonemes that are unique to this word in Dutch. Adults were given initial fragments or final fragments of the word. They succeeded 95% of the time in identifying *Kannibal* with the initial fragments versus 60% of the time with final fragments. In a very early study along the same lines, Bagley (1900) presented adults with word-initial and word-final mispronunciations of consonants and found word-initial mispronunciations to be more disruptive to word recognition.

Similar findings have been reported with 4- and 5-year-old children. Walley (1987) examined the influence of word initial input on children's recognition of spoken words through a mispronunciation detection task. She manipulated the position of the mispronounced phoneme (i.e., whether the word onset or offset was mispronounced) and, additionally, whether the word was presented within a sentence context (i.e., in a story) or was presented as an isolated word (with or without an accompanying picture). When the mispronounced word occurred within a story, children were more successful at detecting mispronunciations involving word onsets than offsets. However, the children did not show this position effect when the words were presented in isolation, without accompanying pictures. This led Walley to suggest that children may need more contextual support for word recognition than adults. Word-initial versus word-final positioning of phonemes has been shown to impact children's spoken word production as well as their spoken word recognition. Kirk and Demuth (2005) tested the production of word initial consonant clusters (nasal + /z/) versus word ending consonant clusters (/s/+nasal). They found that children had greater difficulty pronouncing word initial clusters and concluded that there are articulatory factors that create asymmetries in speech error rates.

All languages have systems for categorizing words into grammatical categories. Slobin's (1973) operating principle A_1 implied that "grammatical realizations in the form of suffixes of postpositions will be acquired earlier than realizations in the form of prefixes or prepositions." This, in addition to his operating principle A: "Pay attention to the ends of words", declared that the ends of words would be more salient to early language learners than the beginnings. St. Clair, Monaghan and Ramscar (2009) explored to what extent prefixes and suffixes are differentially helpful in cueing the grammatical categories of words. They conducted a corpus analysis of child directed speech in English using the CHILDES database. Scanning for usage of all prefixes and suffixes from a list of orthography (Fudge, 1984) they isolated all of the recorded inflections uttered by adults to children. For each affix they calculated a score based on the proportion of occurrences (type and frequency) in which a given affix pointed to a specific grammatical category. Most relevant to the current inquiry was their finding that suffixes contained more consistent category information than prefixes. In a subsequent experiment, they exposed adults to an artificial language, and found that adults were more accurate in identifying the grammatical categories of suffixed words than prefixed words. Based on this, St. Clair et al. concluded that there are multiple advantages in learning and in processing suffixes over prefixes, including faster processing time, greater facilitation and lower interference with category identification.

In sum, the literature seems to suggest that the initial segments of a word may facilitate word identification whereas the final segments of a word may facilitate grammatical categorization. This leads one to hypothesize that children would treat word-form modifications involving suffixes and prefixes differently in the label extension task.

Motivation for research.

Word learning strategies seem to play an important role in lexical acquisition (Markman, 1989; Golinkoff, Hirsh-Pasek, Bailey & Wenger, 1992; Clark, 1990; Diesendruck & Markson, 2001); however, it is not yet clear to what extent word-form variation affects word learning strategies. The research presented here tests the flexibility of language learners faced with different sorts of word-form variation. Experiment 1 tests whether children treat word-form variants with the replacement of word-initial consonants (e.g., *werper* for *jerper*) differently than word-form variants with prefixes (e.g., *wajerper* for *jerper*). Experiment 2 tests whether children treat prefixes differently than suffixes. The research uses a label extension task similar to that of Hupp et al. (2009). Following Jarvis et al. (2004), participants received some trials with two familiar objects in order to discourage a response set where the child selects the unfamiliar object on every single trial. In both experiments, adults as well as children were tested to provide a comparison group.

However, in contrast to the previous studies, all of which utilized non-productive word-form variation, our experiments used the same morpho-phonological modifications across items. This allows us to examine how children treat word-form variation that is systematic, as opposed to idiosyncratic. As noted above, the input to language learners includes many productive word form variations, such as diminutives. It should be noted that some languages, e.g., Russian, (Kempe, Brooks & Pirott, 2001), Spanish (Melzi & King, 2003), Dutch (Gillis, 1997), and Lithuanian (Savickienė, 2003), have an especially high rate of diminutive usage in child-directed speech. Diminutives appear to be the first morphological derivation that children acquire in the Baltic and Slavic languages (Savickienė & Dressler, 2007). Importantly, diminutives are not used primarily to mark a contrast between small and large objects in child-directed speech (Savickienė & Dressler, 2007), but are instead used to convey the intimate, affectionate and playful mood of child-focused interactions. Moreover, caretakers seem to flexibly alternate between the diminutive and simplex forms of a noun to refer to the same referent within a conversational interaction (Kempe, Brooks, Mironova, Pershukova & Fedorova, 2007; King & Melzi, 2004), and there is no evidence to suggest that this word-form variation negatively impacts on children's word learning.

Experiment 1 contrasts novel word-form variants (i.e., words with onset-substitutions or prefixes, as in *wurtle* or *waturtle* for *turtle*) with the English diminutive derivation (e.g., *turtley*). Due to its prevalence in natural language and CDS, we anticipated that children would readily tolerate the diminutive as an alternative name for the object. Thus, the inclusion of diminutives serves as a manipulation check that the task is making sense to the young participants. We used animate nouns to comply with the restriction that diminutive derivation applies most readily to animal names in American English.

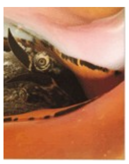
Experiment 1 – Tolerance of Different Types of Word-Onset Modification

Method

Participants. Sixty-four children (mean age 4;0, range 2;11-4;11, 38 boys and 26 girls) were recruited and tested at preschools in Staten Island, Cold Spring, and Garrison, NY. The children came from predominantly white, middle-class communities, and were monolingual speakers of English. Each child received a child-study t-shirt for their participation. Sixty-four adults (mean age 21 years, range 18-40, 21 males and 43 females) were recruited from psychology classes at a large public university and received research participation credits. Half of the participants in each age group were assigned to Experiment 1a (Onset-Substitution group) and half were assigned to Experiment 1b (Prefix group). These two groups varied only with respect to the manipulations of word onsets. For each age group, the numbers of male and female participants, and their ages, were matched across Experiments 1a and 1b.

Materials and Design. The visual stimuli were 6” x 4” pictures of novel and familiar animals. The pictures were collected from nature publications, websites, and other sources. Examples of stimuli for the novel animal trials are shown in Table 1. The pictures were arranged in binders to comprise 16 test trials, half with familiar animals and half with novel animals. Half of the trials involved monosyllabic animal names and half bi-syllabic names. This variation was required in order to construct a sufficiently large set of familiar animal names.

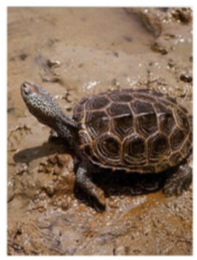
Table 1. Examples of stimuli for novel animal trials in Experiment 1a. Half of the participants were assigned to Experiment 1a and half to Experiment 1b.

		Onset Modification		Offset Modification
		Onset Substitution	Prefix	Diminutive
Picture	Simplex Name	Exp. 1a	Exp. 1b	Exp. 1a and 1b
	dib	wib	wadib	dibby
	stug	wug	wastug	stuggy

The label extension task was introduced as follows: Each trial consisted of an introduction page containing a single image of an animal and a second test page containing the first image along with one of a different animal (i.e., two novel animals or two familiar animals). An example set is depicted in Figure 1. Thus, as each animal was paired with another animal on the test page, for example a turtle and a giraffe. In each experimental group, half of the participants saw the picture of the turtle on the introductory page, and the other half saw the picture of the giraffe. This was accomplished by creating two binders: for each pair of animals, one binder had one animal of each pair on its introductory pages, and the other binder had the other member of each pair on its corresponding introductory pages. Positions of pictures were counterbalanced so that the image shown on the introductory page appeared on the right and left sides of the test page an equal number of times across conditions. The introductory page was used to establish the name of the animal, using its simplex form, by saying, for example “I call this animal a *turtle*”. The test page was used for the forced-choice probe described below. Appendix A provides the complete set of English stimuli. For each stimulus pair, the noun on top was used on the introductory page of one binder, and the noun on the bottom was used on the introductory page of the second binder.

Figure 1. Example of Familiar-Animal Trial for Experiment 1a with Onset Substitution

Introductory Page.



I call this a turtle.

Can you say turtle?

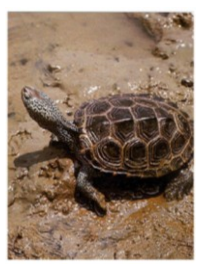
Test page

Now can you tell me

Which animal is a wurtle?

Figure 2. Example of Familiar-Animal Trial for Experiment 1b with Prefix

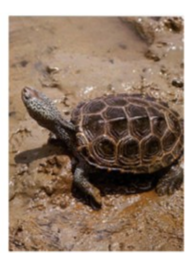
Introductory Page



I call this a turtle.

Can you say turtle?

Test page



Now can you tell me

Which animal is a

waturtle?

The 18 trials comprised two initial trials to ensure comprehension of the instructions and 16 test trials. The test trials involved the manipulation of two factors: noun type (novel versus familiar) and the type of morphological change (beginning versus end of word), with four trials per condition. Two trials per condition (i.e., 'similar' name trials) presented a word-form modification that sounded similar to the name of the animal presented on the introductory page, and two trials per condition (i.e., 'dissimilar' name trials) presented word-forms that were entirely unrelated to the name of the animal presented on the introductory page. Four lists were constructed to rotate the animal names assigned to each condition (similar vs. dissimilar animal names, word-form modifications at the beginning versus end of the word) across participants. The four lists were paired with the two binders to yield eight unique rotations of materials.

Experiments 1a and 1b contrasted two types of changes involving word onsets. In Experiment 1a (Onset Substitution group), participants heard word onset modifications that involved substitution of /w/ for the word onset (e.g., *wabbit* for *rabbit*). In Experiment 1b (Prefix group), onsets were altered through the addition of a prefix *wa-* (e.g., *warabbit* for *rabbit*). In both Experiments 1a and 1b, we included a diminutive condition as a manipulation check to ascertain whether children were detecting any relationship between the animal name provided on the introductory page and the test noun, and to discourage them from selecting the animal that had not yet been labeled on every test trial. For the diminutive trials we used the most productive diminutive derivation in English (i.e., the suffix /I/). All familiar animal names were selected to have rarely used diminutive forms (e.g., *toad-toady, giraffe-giraffey*), or 'frozen' diminutives such as *cat-kitten* that differed from the derived form used in the experiment, e.g., *cat-catty*.

Procedure. Each participant was tested individually in a single session of approximately 10 minutes duration. They were seated in front of a binder and were invited to play a game of pointing to the picture of the animal that was named. Participants were told that some of the animals might have made-up names they had never heard before and that they should try their best to figure out which animal might be called by the given name.

Two initial trials were used to ensure understanding of the task. Each trial began with the introduction of the first animal photo labeled using the simplex form of the animal name (e.g., "I call this animal a *horse*. Can you say *horse*?"). Children were asked to repeat the simplex name to confirm that they had heard it and were paying attention. This was followed by the presentation of the two photos on the test page and the probe (e.g., "Now can you tell me which animal is a *horsey*?'). Children were instructed to point to a picture, and their responses were recorded out of sight on a coded tally sheet.

The first two trials were used to train the participant on how the game was played. One of the initial trials probed for the same animal that was introduced on the initial page and the other trial probed for the other animal, with the order of ''similar-name' and 'dissimilar-name' trials counterbalanced. After these two initial training trials the experiment proceeded with the 16 test trials. The test trials were presented in a quasi random order, with no more than three 'similar-name' or 'dissimilar-name' trials occurring consecutively, and position of word-form modification (word beginning or ending) and noun type (familiar versus novel) randomized across trials. To illustrate the conditions: For 'similar-name' trials, children heard a modification of the previously introduced name (introduced to a *stug*, they were asked, 'which animal is a *stuggy*?' or 'which animal is a *wug* (Experiment 1a) or *wastug* (Experiment 1b)?'), and for 'dissimilar-name' trials, children heard an entirely different word (e.g., introduced to a *stug*, they were asked, 'which animal is a *mansy*?' or 'which animal is a *wance* (Experiment 1a) or *wamanse* (Experiment 1b)'). No corrective feedback was given during the test.

Results

Experiment 1a. Table 2 presents mean percentages of trials in which participants selected the same animal as the one previously labeled on the introductory page in Experiment 1a (Onset Substitution group). These data were submitted to a mixed-design ANOVA with three within-subjects factors: trial type (similar noun vs. dissimilar noun) x type of modification (onset substitution vs. diminutive) x noun type (novel vs. familiar) and one between-subject factor: age group (children vs. adults). This analysis yielded a significant main effect of trial type, $F(1, 62) = 452.7$, $p < 0.001$, $\eta 2 = 0.540$. Participants were more likely to select the same animal as on the introductory page when the noun was a modification of the previously used name (e.g., hearing *wug* or *stuggy* after being introduced to a *stug*) than when it was an entirely different word (e.g., hearing *wanse* or *mansy* after being introduced to a *stug*): 71.5% vs. 5.9%. The main effect of trial interacted significantly with age group, $F(1, 62) = 10.7$, $p < 0.01$, $\eta 2 = 0.013$. When presented with a modification of a previously introduced name, children were less likely than adults to select the animal from the introductory page: 62.1% vs. 78.9%. However, when the name was dissimilar to the previously introduced noun, participants across age groups only rarely selected the animal from the introductory page: 7.4% for children versus 4.3% for adults.

The ANOVA also showed significant main effects of the type of modification, $F(1, 62) = 37.1$, $p < 0.001$, $\eta 2 = 0.029$, and noun type, $F(1, 62) = 4.8$, $p < 0.05$, $\eta 2 = 0.001$. Both of these factors interacted with trial type: type of modification x trial type, $F(1, 62) = 76.0$, $p < 0.001$, $\eta 2 = 0.050$; noun type x trial type, $F(1, 62) = 18.2$, $p < 0.001$, $\eta 2 = 0.005$. Additionally, the three-way interaction of type of modification, noun type, and age group, $F(1, 62) = 4.0$, $p = 0.0504$, $\eta 2 = 0.001$, and the four-way interaction of trial type, age group, type of modification, and noun type approached significance, $F(1, 62) = 3.8$, $p < 0.06$, $\eta 2 = 0.001$.

To explore the interactions involving trial type, we analyzed responses for each trial type separately. In these analyses, position and noun type were within-subjects factors, and age group was a between-subjects factor. For trials involving word-form variants that were similar to the previously introduced name (e.g., hearing *wug* or *stuggy* after being introduced to a *stug*), there were significant main effects of age group, $F(1, 62) = 7.8$, $p < 0.01$, $\eta 2 = 0.048$, type of modification, $F(1, 62) = 66.9$, $p < 0.001$, $\eta 2 = 0.204$, and noun type, $F(1, 62) =$

14.7, $p < 0.001$, $\eta 2 = 0.016$. When presented with word-form modifications of previously introduced nouns, children selected the animal from the introductory trial somewhat less often than adults: 62.1% vs. 78.9%. Participants were less tolerant of the onset modifications that substituted *w-* for the word onset, i.e., they selected the same animal in only 53.1% of trials with onset substitutions in comparison to 87.9% of trials with diminutives. Participants were less accepting of word-form modification of novel nouns, i.e., they selected the same animal in 65.6% of novel animal trials vs. 75.4% of familiar animal trials. This analysis also showed a significant three-way interaction of age group, type of modification, and noun type, $F(1, 62) = 5.6$, $p < 0.05$, $\eta 2 = 0.007$. For trials involving onset-substitutions, children treated familiar and novel nouns similarly (42.2 vs. 40.6% selections of same animal, respectively), whereas adults were more accepting of onset-substitutions involving familiar animal names (71.9 vs. 57.8% selections of same animal). For trials involving diminutives, children were more accepting of diminutive derivations of familiar nouns than novel nouns (92.2% vs. 73.4%). Adults showed the same trend, but less strongly, with 95.3% and 90.6% same animal selections for familiar and novel diminutives, respectively.

Table 2. Mean percentages of selections of the same animal as on the introductory page, as a function of trial type (similar word versus dissimilar word) and condition (onset substitution vs. diminutive; novel/familiar nouns) in Experiment 1a. N=32 in each group. (Standard deviations in parentheses.)

		Onset Substitution		Diminutive	
		Novel Noun (e.g., wug)	Familiar Noun (e.g., wurtle)	Novel Noun (e.g. stuggy)	Familiar Noun (e.g., turtley)
Similar Word Trials	Children	40.6 (41.0)	42.2 (38.3)	73.4 (33.6)	92.2 (18.4)
Dissimilar Word Trials	Children	10.9 (21.0)	9.4 (23.5)	6.2 (16.8)	3.1 (12.3)
	Adults	92.2 (18.4)	95.3 (19.5)	4.7 (14.8)	0 (0)

For 'dissimilar-name' trials, in which the noun was entirely different from the name of the animal on the introductory page (e.g., hearing *wanse* or *mansy* after being introduced to a *stug*), there was only showed a significant effect of type of word form modification, $F(1, 62) = 5.0$, $p < 0.05$, $\eta 2 = 0.019$. Participants only rarely selected the animal from the introductory page on the 'dissimilar-name' trials; however, they were somewhat more prone to select this animal when the word-form modification affected the word onset (8.2% vs. 3.5% selections of 'same' animal for onset-substitution vs. diminutive trials). This suggests that altering the word onset sometimes made it difficult for participants to keep track of the names of the animals that had just been introduced.

Experiment 1b. Table 3 presents mean percentages of trials in which participants selected the same animal as the one previously labeled on the introductory page in Experiment 1b (Prefix group). These data were submitted to a mixed-design ANOVA with three within-subjects factors: trial type (similar noun vs. dissimilar noun) x type of modification (onset substitution vs. diminutive) x noun type (novel vs. familiar) and one between-subject factor: age group (children vs. adults). This analysis revealed a significant main effect of trial type, $F(1, 62) = 788.8$, $p < 0.001$, $\eta 2 = 0.738$. As in Experiment 1a, participants were much more like likely to select the animal from the introductory page on 'similar-name' trials than on 'dissimilar-name' trials, with 87.5% versus 7.4% selections of the same animal, respectively. This effect of trial type interacted with the type of word-form modification, $F(1, 62) = 7.5$, $p < 0.01$, $\eta 2 = 0.003$, and with noun type, $F(1, 62) = 17.1$, $p < 0.001$, $\eta 2 = 0.004$. None of the remaining effects were significant.

Table 3. Mean percentages of selections the same animal as on the introductory page, as a function of trial type (similar word versus dissimilar word) and condition (prefix vs. diminutive; novel/familiar nouns) in Experiment 1b. N=32 in each group. (Standard deviations in parentheses.)

		Prefix		Diminutive	
		Novel Noun (e.g., wastug)	Familiar Noun (e.g., waturtle)	Novel Noun (e.g. stuggy)	Familiar Noun (e.g., turtley)
Similar Word Trials	Children	82.8 (32.7)	82.8 (30.1)	85.9 (31.7)	92.2 (25.7)
	Adults	81.2 (30.5)	89.1 (24.5)	85.9 (22.8)	100 (0)
Dissimilar Word Trials	Children	15.6 (32.2)	10.9 (24.5)	10.9 (21.0)	4.7 (14.8)
	Adults	9.4 (19.8)	1.6 (8.8)	3.1 (12.3)	3.1 (17.7)

To tease apart the interactions involving trial type, we analyzed responses for each trial type separately. In these analyses, position and noun type were within-subjects factors, and age group was a between-subjects factor. For trials involving word-form variants that were similar to the previously introduced name (e.g., hearing *wastug* or *stuggy* after being introduced to a *stug*), there were significant main effects of type of modification, $F(1, 62) = 4.3$, $p < 0.05$, $\eta2 = 0.017$, and noun type, $F(1, 62) = 10.0$, $p < 0.01$, $\eta2 = 0.017$. Participants were less accepting of the word-forms with the prefix *wa-* in comparison to the English diminutive, i.e., selecting the 'same' animal on 84.0% of trials with *wa-* prefixed forms, in comparison to 91.0% of diminutives. Participants were more accepting of word-form variants of familiar nouns than novel nouns, 91.0% vs. 84.0%, respectively. No other effect was significant.

For 'dissimilar-name' trials, in which the noun was entirely different from the name of the animal on the introductory page (e.g., hearing *wamanse* or *mansy* after being introduced to a *stug*), there was only a significant main effect of noun type, $F(1, 62) = 5.4$, $p < 0.05$, $\eta2 = 0.013$. As in Experiment 1a, participants only rarely selected the animal from the introductory page, when presented with a dissimilar noun; however, they made slightly more 'same' animal selections for novel nouns than for familiar nouns, 9.8% vs. 5.1%.

Comparison of Experiment 1a and 1b. To directly compare the two onset-modification groups (onset substitution in Experiment 1a versus prefix in Experiment 1b), we conducted additional analyses with onset-modification group as a between-subjects factor. First, we conducted an omnibus mixed-design

ANOVA with three within-subjects factors: trial type (similar noun vs. dissimilar noun) x type of modification (onset modification vs. diminutive) x noun type (novel vs. familiar) and two between-subject factors: age group (children vs. adults), and onset-modification condition (onset substitution vs. prefix). As in the previous analyses, the dependent variable was the proportion of selections of the 'same' animal as the one on the introductory page. (We report here only the effects involving the between-subjects factor of onset-modification condition, as all other effects are redundant with previous analyses.) This analysis revealed a main effect of onset-modification condition, $F(1, 124) = 15.2$, $p < 0.001$, $\eta2 = 0.010$. Onset-modification condition interacted with trial type, $F(1, 124) = 13.7$, $p < 0.001$, $\eta2 = 0.007$, and type of modification, $F(1, 124) = 16.8$, $p < 0.001$, $\eta2 = 0.005$. The three-way interaction of onset-modification condition, trial type, and type of modification was significant, $F(1, 124) = 22.3$, $p < 0.001$, $\eta2 = 0.006$, and the four-way interaction of onset-modification condition, noun type, type of modification, and age group was marginal, $F(1, 124) = 3.8$, $p = 0.052$, $\eta2 = 0.001$.

Because onset-modification condition interacted with trial type, we analyzed responses for each trial type separately. For 'similar-word' trials, we obtained a significant main effect of onset-modification condition, $F(1, 124) = 19.2$, $p = 0.001$, $\eta2 = 0.061$, and a significant interaction of onset-modification condition and type of modification, $F(1, 124) = 26.0$, $p = 0.001$, $\eta2 = 0.041$. No other effects were significant. Overall, participants were much less tolerant of word-onset modifications involving onset substitutions than prefixes: They selected the 'same' object as on the introductory page for 53.1% of 'similar-noun' trials involving onset-modifications and 84.0% involving prefixes. Across Experiments 1a and 1b, participants showed similar levels of acceptance of the diminutive derivations (87.9% in Experiment 1a and 91.0% in Experiment 1b.

The only other effect to approach significance was a four-way interaction of onset-modification condition, type of modification, noun type, and age group, $F(1, 124) = 3.7$, $p = 0.056$, $\eta2 = 0.002$. In Experiment 1a, children showed a lower acceptance of the onset-substitutions than adults, especially for familiar nouns. In contrast, in Experiment 1b, there was no effect of age, with both age groups similarly showing high levels of acceptance of the prefixed word forms. Across Experiments 1a and 1b, children and adults responded similarly to the diminutive derivation, and accepted diminutives at higher levels than variants involving word onsets.

For 'dissimilar-word' trials, none of the effects involving onset-modification condition were significant. Participants showed similarly low levels of selecting the 'same' object for these trials across Experiments 1a and 1b.

Discussion

The main goal of Experiment 1 was to determine whether children would distinguish different types of word-onset modifications that involved (1) substitution of initial consonants or (2) the addition of a prefix. The children's performance was contrasted with adults to explore the extent to which learners of different ages show flexibility in adapting to morpho-phonological changes that are systematic in the sense that they apply across different nouns, as in the case of the English diminutive derivation. To the extent that children and adults show similar tolerance of a variety of word modifications, this suggests that they keep track of the productivity of morpho-phonological rules or patterns, and treat systematic variation differently from idiosyncratic changes.

Experiment 1 demonstrated that onset-modifications involving consonant substitution(s) are tolerated to a much lesser extent than onset-modifications involving novel prefixes. That is, *wastug* was a more acceptable variant of *stug* than is *wug*, and *waturtle* was a more acceptable variant of *turtle* than is *wurtle.* For the most part, children and adults responded similarly to the different experimental conditions. The largest effect of age was for the onset-substitution condition of Experiment 1a: Children seemed less capable of detecting the similarities across word forms such as *wug* and *stug*, *wurtle* and *turtle*, and were less likely to select the noun from the introductory page on these trials. Oddly, children, unlike adults, failed to shown an effect of noun type on the 'similar-name' trials with onset-substitutions. That is, the children were just as likely to select a giraffe when asked for the *wurtle*, as to select an entirely new animal when asked for a *wug.* In general, the children were less tolerant of the onset-substitutions than were adults. The effect of age was largest for the 'similar-noun' trials with familiar animals, where children made only 42.2% of 'same' animal selections in comparison to 71.9% for adults. Given this age effect, we conducted follow-up analyses to ascertain whether performance within the child group varied with age. In both Experiment 1a and 1b, there was no significant correlation between children's age in months and their willingness to accept the word-form variants (Experiment 1a: r (N=32) = 0.08, Experiment 1b: r (N=32) = -0.02).

Both types of onset-modifications were tolerated to a lesser extent than the familiar English diminutive. However, this comparison is confounded by the fact that the English diminutive derivation is a well-established pattern, whereas the onset-modifications were both entirely novel. Thus, there is a need to directly test the effect of position while holding constant the novelty of the morpho-phonological segment added to the beginning versus the end of a word.

Experiment 2 – Differential Effects of Prefixes Versus Suffixes

Method

Participants. Thirty-two children (mean age 4;3, range 3;2-5;1, 17 boys and 15 girls) were recruited and tested in the same schools as Experiment 1. All of the children were monolingual speakers of English, and none had participated in Experiment 1. Each child received a child-study t-shirt for their participation. Thirty-two adult native speakers of English (mean age 22 years, range 18-43 years, 12 men, 20 women) were recruited from psychology classes at a large public university and received research participation credits for their participation.

Table 4. Examples of stimuli for novel animal trials in Experiment 2.

		Word Form Modifications	
Picture	Simplex Name	Onset	Ending
	dib	kodib	dibko
	stug	kostug	stugko

Materials and Design. The materials and design of the experiment were identical to Experiment 1, with the exception that different novel word-form modifications were introduced. For the word onset modification, the nonce prefix *ko* was added to each noun, and for the word ending modification, the nonce suffix *ko* was added to each noun. Examples of stimuli for the novel animal trials are shown in Table 4. Appendix C provides the complete list of stimuli.

Procedure*.* The procedure was the same as Experiment 1.

Results

Table 5 presents mean percentages of trials in which participants selected the same animal as the one previously labeled on the introductory page. These data were submitted to a mixed-design ANOVA with three within-subjects factors: trial type (similar noun, dissimilar noun) x position of modification (onset/end) x noun type (novel/familiar) and one between-subject factor: age group (children, adults). This analysis yielded a significant main effect of trial type, $F(1, 62) = 185.6$, $p < 0.001$, $\eta 2 = 0.52$. When participants heard a modification of a previously introduced name, e.g., *kostug* or *stugko* having just been introduced to a *stug*, participants selected the 'same' animal only 74.8% of the time. In contrast, when participants heard a dissimilar word, e.g., *komanse* or *manseko* having just been introduced to a *stug,* they selected the 'same' animal only 8.6% of the time.

In addition to the main effect of trial type, there were significant interactions of trial type and position, $F(1, 62) = 4.3$, $p < 0.05$, $\eta 2 = 0.001$, and trial type and familiarity, $F(1, 62) = 4.2$, $p < 0.05$, $\eta 2 = 0.001$. Children and adults performed similarly: the only effect involving age to approach statistical significance was the interaction of trial type and age, $F(1, 62) = 3.3$, $p < 0.08$, $\eta 2 = 0.009$.

To explore the interactions involving trial type, we analyzed responses for each trial type separately. In these analyses, position and noun type were within-subjects factors, and age group was a between-subjects factor. For the trials involving word-form modifications of previously introduced nouns (e.g., *kostug* or *stugko* for *stug*), the main effects of position, $F(1, 62) = 5.7$, $p < 0.05$, $\eta 2 = 0.008$, and familiarity, $F(1, 62) = 6.1$, $p < 0.05$, $\eta 2 = 0.006$, were significant. Participants selected the 'same' animal more often when *ko* was a suffix (e.g., *dibko*) than when it was a prefix (e.g., *kodib*), 78.1% vs. 71.5%, and they were more likely to select the 'same' animal for modifications of familiar nouns than for novel nouns, 77.7% vs. 71.9%.

Table 5. Mean percentages of selections of the same animal as on the introductory page, as a function of trial type (similar word versus dissimilar word) and condition (onset/end modification; novel/familiar nouns) in Experiment 2. N=32 in each group. (Standard deviations in parentheses.)

		Onset Modification		End Modification	
		Novel Noun (e.g., kodib)	Familiar Noun (e.g., koturtle)	Novel Noun (e.g. dibko)	Familiar Noun (e.g., turtleko)
Similar Word Trials	Children	60.9 (41.6)	67.2 (45.1)	71.9 (38.0)	76.6 (38.1)
	Adults	73.4 (40.1)	84.4 (29.6)	81.2 (35.4)	82.8 (35.0)
Dissimilar Word Trials	Children	10.9 (27.6)	10.9 (27.6)	12.5 (28.4)	12.5 (28.4)
	Adults	6.2 (16.8)	4.7 (19.5)	6.2 (21.1)	4.7 (14.8)

Although children seemed to select the 'same' animal less often than adults (69.9% vs. 80.5%), the effect of age not reliable, $F(1, 62) = 1.7$, $p = 0.19$, $\eta2 = 0.023$, and age group did not interact with any other factor. Nonetheless, we conducted additional analyses to confirm the effects of position and familiarity in each age group, separately. For the children, only the main effect of position was reliable, $F(1, 31) = 5.5$, $p = 0.05$, $\eta2 = 0.016$. For the adults, only the interaction of position and familiarity was significant, $F(1, 31) = 5.1$, $p = 0.05$, $\eta2 = 0.005$. Adults showed a significant effect of position for trials with novel nouns, $F(1, 31) = 7.0$, $p = 0.05$ $\eta2 = 0.006$, but not for trials with familiar nouns, $F(1, 62) < 1$.

The analysis of responses to trials with dissimilar nouns (e.g., hearing *komanse* or *manseko* after being introduced to a *stug*) produced no significant findings. Both age groups rarely selected the 'same' animal for the 'dissimilar-name' trials.

Discussion

Experiment 2 contrasted children's tolerance of word-form modifications involving prefixes versus suffixes. As in Experiment 1, we used the same inflections (*ko-* vs. *-ko*) across nouns. These productive inflections were usually interpreted as referring to the same animals as the uninflected forms. Despite this overall bias to accept word-form modifications, participants were more accepting of *ko* when it was a suffix than when it was a prefix. This bias favoring suffixes matches the position effect reported by Hupp et al. (2009) despite the large differences in adults' tolerance of the word-form variants in the two studies.

In Hupp et al., each word was altered with a unique prefix or suffix, whereas we used the same affix across all items. Our participants picked up on the productive usage of the experimental affix seemingly right away, as we failed to find any effect of trial position in follow-up analyses. There are two possible reasons for this sensitivity to the productivity of the inflection: First, we had two 'training' trials that used the English diminutive derivation with familiar nouns, and, second, we used familiar animal names in 50% of the trials. Thus, hearing *koturtle* or *turtleko* and given a choice of a turtle or a giraffe, participants were biased to select the turtle, and they adopted a similar strategy for the novel animal trials.

Although Jarvis et al. (2004) also reported a position effect in a word-learning task, this study compared children's tolerance of word-form variants that had onset-substitutions (e.g., *japple*) with their treatment of suffixed nouns (*shoeler*). To our knowledge, our study is the first to test for a position effect, holding constant the complexity of the affixed material. Our results complement the word recognition studies of Walley (1987), showing that children are more sensitive to mispronunciations involving word onsets than word offsets.

Children and adults responded similarly in Experiment 2: There was no significant effect of age group and no interactions involving age. However, as in Experiment 1, we conducted follow-up analyses to examine whether child age in months correlated with word-learning strategies. In Experiment 2, unlike Experiment 1, children's age in months was negatively correlated with their tendency to accept the word-form variants, r (N=32) = -0.35, $p < 0.05$. That is, in this sample, older children were somewhat less likely than younger children to pick the 'same' animal as the one previously labeled on the introductory page. Unfortunately, a limitation of this study is that we do not have additional measures of language abilities from these children to ascertain what factors, besides age, might underlie this trend.

General Discussion

This research set out to examine the question of whether word-form variation can have an influence on children's ability to map words onto their referents. One question was whether children would treat words with onset replacements differently from prefixed words. A second question was whether children would treat prefixed words differently than suffixed words. The experiments used an established experimental framework, consisting of a forced choice label extension task, for the inquiry. To confirm that children understood the task a familiar word-form variation, the diminutive derivation common in child directed speech, provided the comparison condition for the first experiment. If the participants rejected the diminutives, it would suggest that the task was not making sense to them. Also, following Jarvis et al. (2004), on half of the trials, children heard a word totally dissimilar to the previously introduced animal name, in order to establish that the fast mapping mechanism was present. In this respect, the 'different' condition served as a task comprehension check. In the 'different' condition, children were observed to fast map novel word forms onto novel animals, thus confirming previous demonstrations of this phenomenon.

Previous research (Merriman & Schuster, 1991; Jarvis et al., 2004) suggested that children do not treat words with onset modifications as alternative labels of previously named objects (e.g., *japple* does not mean *apple*). Even with training (Jarvis et al., 2004), children seem to resist modifications of word beginnings. These previous studies, however, did not explore whether children would treat onset replacements or blends differently than prefixes. Experiments 1 provided new insights by addressing this question. The results clearly demonstrate that adding a separate syllable to the beginning of the word did not have the same effect as changing the initial consonant. The results for the two onset manipulation conditions were drastically different. Words with onset replacements in Experiment 1a (/w/) were treated as novel nouns, whereas in Experiment 1b, children showed the ability to parse the prefix /wa-/ from the word stem and treated the prefixed word as a word-form variant like the diminutives. In fact, in Experiment 1b, there was a relatively small difference in the level of acceptance of the words with the novel prefix in comparison to the diminutives.

In Experiment 2 the affix *ko* was added to both the beginning and end of words to allow a controlled comparison between word initial and word final inflections. Hupp et al. (2009) observed adults rigidly resisting mapping prefixed or suffixed word-form variations onto objects with similar-sounding names (e.g., *ta-te-be* was not treated as synonymous with *ta-te*). In contrast, Experiment 2 found considerable flexibility in adults, as well as children, in their willingness to parse a nonce inflection (prefix or suffix) from a word and map it onto a similar sounding object. Essentially, the systematic word-form variation presented to the participants in the experiments was treated very differently compared to the unnatural or random variation patterns presented by Hupp et al. (2009).

Importantly, in both Experiment 2 and Hupp et al. (2009), suffixed words were more likely to be accepted as word-form variants than prefixed words.

How this research furthers the literature on word learning

Regarding children's resistance to assign multiple labels to the same object, the results clearly show that the children readily treated the diminutives in Experiment 1 as referring to previously labeled objects, and they readily accepted the word-form variants with nonce prefixes and suffixes at levels comparable to the diminutives. This flexibility appears to violate the mutual exclusivity bias. In agreement with the general prediction of fast mapping, children appeared to fast map novel words onto previously unseen novel animals. This ability fits with the findings of Woodward and Markman (1998) and Golinkoff et al. (1992). However, in Experiment 1, the children mapped novel words onto familiar objects as well – a behavior not predicted by either ME or N3C. That is, the children often mapped familiar words with onset modifications (e.g., *wiraffe*) onto familiar objects (e.g., a turtle). Together these two findings would indicate that theories such as ME and N3C may be over-reaching and that the children do show some tolerance for multiple words referring to the same object/category. Swingley and Aslin (2007) have postulated that it is children's over-riding interest in expanding their lexicon that pushes them to assume that new forms of existing words represent new words all together. This openness to new labels may have made them particularly vulnerable to the words with onset replacements used in Experiment 1a.

Jarvis et al. (2004) presented a wide variety of word-form variants to 2 and 4 year olds (i.e., all stimuli had unique word-form modifications). Experiment 1a replicated their general finding that children were more likely to choose an alternative familiar object when the initial phoneme was altered versus when the word-form involved the addition of an unstressed syllable to the end of the word. The stimuli used in Jarvis et al. (2004) experiments, as mentioned above, used a wide variety of word-form modifications. Thus, unlike the research reported here, there was no systematic comparison of the effects of types of modification. Their most important finding was that the children changed their word learning strategies as a function of training. Thus, they demonstrated that children are flexible word learners capable of adapting to meet the demands of input characteristics. This view of children's word learning strategies as flexible is supported by the reported findings. Children drastically altered their word-learning strategies to distinguish prefixed word-form variants from words with onset replacements. They were able to adjust the overall strategy rather quickly in the presence of novel affixes and use them effectively. Future research should test further the limits of children's flexibility by contrasting the two types of onset-modification in the context of a within-subjects design.

Processing of affixes

As described in the introduction, there is an overall tendency among the world's languages to favor suffixing over prefixing to modify the grammatical or semantic properties of words. Hawkins and Gilligan (1988) and St. Clair et al. (2009) pinned the suffixing preference to an observation that the end location was useful for determining the category of words. This was corroborated by Clark’s work (2007) showing that children learn suffixes more easily and earlier than prefixes. She attributed this suffix bias as due to greater complexity of forms and associated meanings for prefixes than for suffixes. Frequency of occurrence could also play a role in this delayed acquisition of prefixes. There are fewer prefixes in English and they can be applied to a smaller set of word types in comparison to the broader productivity of suffixes. Cutler, Hawkins and Gilligan (1985) put forth a processing account to explain the asymmetry. In their analysis there was a processing advantage to have the word identified as soon as possible in continuous speech. This prediction aligns with the Marslen-Wilson (1987) cohort based model that emphasizes the competition between active candidates until a ‘uniqueness point’ is reached. The new word forms generated by the consonant replacements in Experiment 1a could have activated lexical items for participants that were quite distant from the actual target. For example, the stimuli word *weetle* could have activated a number of lexical items (e.g., *weed, wheat, wheel,* etc.) that may have distracted the child from the target *beetle*. Recovery from this broad search may have proved too difficult, leading children to a default selection of the alternative animal.

According to the cohort model, the same disruption would have been applicable to the experimental prefixes used in this research. However, there was no disruption in the *wa*- or *ko*- conditions where children appeared to have been able to parse the prefixes from the word stems. Though I did not systematically examine the uniqueness points for the stimuli used in the experiments, Marslen-

Wilson (1987) hypothesized that the uniqueness point would be pushed later in prefixed words because it would take longer to cull the cohort. Perhaps only by isolating the prefix from the word stem, were children able to identify the similar sounding word in the prefix condition.

Suffixes may create more acceptable word-form variants than prefixes due to a tendency for suffixes to provide grammatical cues for word classes, such as noun genders. St. Clair et al. (2009) conducted corpora analyses to test whether prefixes or suffixes better supported learning of grammatical categories in the CDS speech stream. In their analysis of the CHILDES database they found more reliable categorical information present in suffixes than prefixes in English. St. Clair et al. (2009) also used an artificial language containing equal amounts of prefix and suffixation to study how readily subjects picked up the category cues based on the prefix or suffix condition. What they found was a strong advantage for suffixing in terms of accuracy for determining category membership.

Hupp et al. (2009) in research with adults also found a small advantage for prefixes over suffixes. In the label extension tasks, the adults in Hupp et al. exhibited a strong tendency to reject any word form variants. This is possibly because our word modifications were systematic or perhaps it is because the previous study employed only nonce syllables whereas we included familiar as well as novel nouns. In Hupp and colleagues' word-similarity judgment task, adults were strongly biased to judge suffixed word-form variants as more similar the target word than prefixed word-form variants (e.g., *ta-te-be* was judged more similar to *ta-te* than *be-ta-te*). The current research only looked at children's tolerance for word form variation in the label extension task, so future work is needed to ascertain whether the results would replicate in the word-similarity judgment task.

The present results do not allow any determination of whether the observed preference for suffixed over prefixed word-form variants is a product of learning or whether it represents a universal word-learning bias. The universal 'operating principles' that guide early language learners (Slobin, 1973) proposed that the ends of words were more salient than the beginnings. This proposal was supported with observation that case marking seems to be learned earlier in languages that use suffixes versus those that used articles to mark case. An alternative to a universal bias is the proposal that children's experience with the distributional characteristics of a language may allow them the opportunity to adapt their word-learning strategies to the morphological and grammatical properties of the language input.

Limitations of the current research

The findings from this current research would benefit from some key additional research comparisons. First of all a cross-linguistic comparison is recommended. English is strongly skewed toward suffixation (56 prefixes and 181 suffixes; Fudge, 1984). Therefore, a comparison with a language containing a different distribution of prefixation versus suffixation (e.g., a Bantu language) would shed light on whether the suffix bias stem is influenced by the distributional characteristics of the input language, or whether it stems from processing factors, as suggested by the Cohort model, or reflects a universal bias to attend to word endings. Additionally, future work should explore how exposure to a morphologically rich language, such as Lithuanian or Russian, in comparison a morphologically impoverished language such as English of Chinese, affects the word-learning strategies of children. Preliminary data from Lithuanian (Dabašinskienė, unpublished data), using a similar methodology to the present study, showed no evidence of an effect of trial type across two experiments. This suggests that children learning more richly inflected languages may have less of a bias to select the novel picture whenever there is a novel word-form modification than children learning English.

An additional limitation of this research is that I failed to collect any measures of language skills in the children, which might help to explain the lack of an effect of age in Experiment 1, and the negative correlation with age in Experiment 2. Jarvis et al. (2004) used pre-test measures of vocabulary size and phonological awareness and found correlations in opposite directions between these two measures and word learning strategies. Whereas larger vocabulary size was associated with greater resistance to any word-form modification, greater phonological awareness was correlated with a larger shift in word learning strategy following training. Lacking these measures, I was unable to explore individual differences in task performance due to age-correlated increases in vocabulary size and/or phonological awareness.

Finally, to test the generality of these findings, future studies should utilize a larger set of noun inflections to control for response set effects. Thus, it is important to determine whether children can isolate novel prefixes and suffixes from words under conditions of increased task complexity due to greater variability in the inflections used. Usage of a greater variety of inflections would also facilitate comparison of the present results to those of Merriman and Schuster (1991) as well as Jarvis et al. (2004).

Conclusions

Three experiments exposed children to different word forms that varied as a function of the position and type of modification. Even though English is a morphologically impoverished language, the children in this study appeared to readily accept both familiar and novel morphological variants. In contrast, the children were much less accepting of modifications that involved replacements of word-initial consonants. These findings suggest that language learners are able to track morphological variation across words, and adjust their word-learning strategies to accommodate recurring affixes. How much repetition of a novel inflection is needed to trigger a shift in children's word-learning strategies, and the extent to which language typologies impact word-learning strategies are topics for future research.

Appendix

Appendix A: Stimulus Words for Experiment 1a.

		Same Picture Trials		Different Picture Trials	
Pair #	Introductory Picture	End Modification	Onset Modification	End Modification	Onset Modification
1 initial	horse	horsy		doggy	
	dog	doggy		horsy	
2 initial	pig	piggy		fishy	
	fish	fishy		piggy	
1 fam	goat	goaty	woat	owly	wowl
	owl	owly	wowl	goaty	woat
2 fam	toad	toady	woad	catty	wat
	cat	catty	wat	toady	woad
3 fam	goose	goosey	woose	apey	wape
	ape	apey	wape	goosey	woose
4 fam	hawk	hawky	wawk	mousey	wouse
	mouse	mousey	wouse	hawky	wawk
5 fam	camel	camelly	wamel	hippoey	wippo
	hippo	hippoey	wippo	camelly	wamel
6 fam	beetle	beetley	weetle	chickeny	wicken
	chicken	chickeny	wicken	beetley	weetle
7 fam	turtle	turtley	wurtle	giraffey	wiraffe
	giraffe	giraffey	wiraffe	turtley	wurtle
8 fam	rabbit	rabbitty	wabbit	tigery	wiger
	tiger	tigery	wiger	rabbitty	wabbit
1 novel	geck	gecky	weck	kazy	waze
	kaze	kazy	waze	gecky	weck
2 novel	tuz	tuzzy	wuz	dibby	wib
	dib	dibby	wib	tuzzy	wuz
3 novel	terp	terpy	werp	vikey	wike
	vike	vikey	wike	terpy	werp
4 novel	stug	stuggy	wug	mansy	wanse
	manse	mansy	wanes	stuggy	wug
5 novel	pabble	pabbley	wabble	rutchery	wutcher
	rutcher	rutchery	watcher	pabbley	wabble
6 novel	dappo	dappoee	wappo	chitoffy	witoff
	chitoff	chitoffy	witoff	dappoee	wappo
7 novel	burble	burbley	wurble	spirteny	wirten
	spirten	spirteny	wirten	burbley	wurble
8 novel	hacket	hackety	wacket	jerpery	werper
	jerper	jerpery	werper	hackety	wacket

Appendix B: Stimulus Words for Experiment 1b.

		Same Picture Trials		Different Picture Trials	
Pair #	Introductory Picture	End Modification	Onset Modification	End Modification	Onset Modification
1 initial	horse	horsy		doggy	
	dog	doggy		horsy	
2 initial	pig	piggy		fishy	
	fish	fishy		piggy	
1 fam	goat	goaty	wagoat	owly	waowl
	owl	owly	waowl	goaty	wagoat
2 fam	toad	toady	watoad	catty	wacat
	cat	catty	wacat	toady	watoad
3 fam	goose	goosey	wagoose	apey	waape
	ape	apey	waape	goosey	wagoose
4 fam	hawk	hawky	wahawk	mousey	wamouse
	mouse	mousey	wamouse	hawky	wahawk
5 fam	camel	camelly	wacamel	hippoey	wahippo
	hippo	hippoey	wahippo	camelly	wacamel
6 fam	beetle	beetley	wabeetle	chickeny	wachicken
	chicken	chickeny	wachicken	beetley	wabeetle
7 fam	turtle	turtley	waturtle	giraffey	wagiraffe
	giraffe	giraffey	wagiraffe	turtley	waturtle
8 fam	rabbit	rabbitty	warabbit	tigery	watiger
	tiger	tigery	watiger	rabbitty	warabbit
1 novel	geck	gecky	wageck	kazy	wakaze
	kaze	kazy	wakaze	gecky	wageck
2 novel	tuz	tuzzy	watuz	dibby	wadib
	dib	dibby	wadib	tuzzy	watuz
3 novel	terp	terpy	waterp	vikey	wavike
	vike	vikey	wavike	terpy	waterp
4 novel	stug	stuggy	wastug	mansy	wamanse
	manse	mansy	wamanse	stuggy	wastug
5 novel	pabble	pabbley	wapabble	rutchery	warutcher
	rutcher	rutchery	warutcher	pabbley	wapabble
6 novel	dappo	dappoee	wadappo	chitoffy	wachitoff
	chitoff	chitoffy	wachitoff	dappoee	wadappo
7 novel	burble	burbley	waburble	spirteny	waspirten
	spirten	spirteny	waspirten	burbley	waburble
8 novel	hacket	hackety	wahacket	jerpery	wajerper
	jerper	jerpery	wajerper	hackety	wahacket

Appendix C: Stimulus Words for Experiment 2.

		Same Picture Trials		Different Picture Trials	
Pair #	Introductory Picture	End Modification	Onset Modification	End Modification	Onset Modification
1 initial	horse	horsy		doggy	
	dog	doggy		horsy	
2 initial	pig	piggy		fishy	
	fish	fishy		piggy	
1 fam	goat	goatko	kogoat	owlko	koowl
	owl	owlko	koowl	goatko	kogoat
2 fam	toad	toadko	kotoad	catko	kocat
	cat	catko	kocat	toadko	kotoad
3 fam	goose	gooseko	kogoose	apeko	koape
	ape	apeko	koape	gooseko	kogoose
4 fam	hawk	hawkko	kohawk	mouseko	komouse
	mouse	mouseko	komouse	hawkko	kohawk
5 fam	camel	camelko	kocamel	hippoko	kohippo
	hippo	hippoko	kohippo	camelko	kocamel
6 fam	beetle	beetleko	kobeetle	chickenko	kochicken
	chicken	chickenko	kochicken	beetleko	kobeetle
7 fam	turtle	turtleko	koturtle	giraffeko	kogiraffe
	giraffe	giraffeko	kogiraffe	turtleko	koturtle
8 fam	rabbit	rabbitko	korabbit	tigerko	kotiger
	tiger	tigerko	kotiger	rabbitko	korabbit
1 novel	gep	gepko	kogep	kazeko	kokaze
	kaze	kazeko	kokaze	gepko	kogep
2 novel	tuz	tuzko	kotuz	dibko	kodib
	dib	dibko	kodib	tuzko	kotuz
3 novel	terp	terpko	koterp	vikeko	kovike
	vike	vikeko	kovike	terpko	koterp
4 novel	stug	stugko	kostug	mansko	komanse
	manse	mansko	komanse	stugko	kostug
5 novel	pabble	pabbleko	kopabble	rutcherko	korutcher
	rutcher	rutcherko	korutcher	pabbleko	kopabble
6 novel	dappo	dappoko	kodappo	chitofko	kochitoff
	chitoff	chitofko	kochitoff	dappoko	kodappo
7 novel	burble	burbleko	koburble	spirtenko	kospirten
	spirten	spirtenko	kospirten	burbleko	koburble
8 novel	hacket	hacketko	kohacket	jerperko	kojerper
	jerper	jerperko	kojerper	hacketko	kohacket

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