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Research Article

Children's Response Bias and Identification of Misarticulated Words

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Purpose: The purpose of this study was to examine whether children's identification of misarticulated words as real objects was influenced by an inherent bias toward selecting real objects or whether a change in experimental conditions could impact children's selections.
Method: Forty preschool children aged 4 years 0 months to 6 years 11 months across 2 experiments heard accurate productions of real words (e.g., "leaf"), misarticulated words (e.g., "weaf" and "yeaf"), and unrelated nonwords (e.g., "geem"). Within the misarticulated words, the commonness of the substitute was controlled to be "common" or "uncommon." Using the MouseTracker software, children were asked to select between a real object (e.g., a leaf) and a novel object (Experiment 1) or between a real object (e.g., a leaf) and a blank square, which represented a hidden object (Experiment 2).
Results: Consistent with previous findings, children chose real objects significantly more when they heard accurate productions (e.g., "leaf") than misarticulated productions (e.g., "weaf" or "yeaf") across both experiments. In misarticulation conditions, real object selections were lower than in the previous study; however, children chose real objects significantly more in the common misarticulation condition than in the uncommon misarticulation condition.
Conclusions: The results of this study are consistent with previous findings. Children's behavioral responses depended upon the task. Despite these differences in the task, children demonstrated ease in integrating variability into their word identification.

In the development of children's language and phonological system, exposure to different speakers influences the development and interpretation of sounds, words, and linguistic structures. These experiences shape the development of the phonological system and acquisition of vocabulary. However, spoken language is phonetically and phonologically variable, and speech patterns are unique to each speaker. This variability introduces the potential for difficulty forming perceptual representations for phonemes. Despite this difficulty, previous research has shown that children readily accommodate variability and are able to interpret the communicative intent. However, some types of variability negatively impact processing and understanding. Therefore, children must integrate information from a variety of sources to understand the spoken message. These sources include the type of speech variability, commonness of the variability, available contextual cues, and perceptual similarity to the target production.

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Children's Response to Types of Speech Variability

Previous research suggests that children are flexible in their acceptance of variability in the speech signal in terms of dialectal differences and accented speech. For example, Best et al. (2009) found that toddlers at 19 months of age identified words spoken in Jamaican-accented English more accurately than 15-month-old children. This finding suggests that phonemic representations at 19 months of age are developed enough to allow some flexibility without impacting accurate interpretation of the message (Best et al., 2009). In older children, the establishment of abstract phonemic representations is further refined. Bent (2014) asked 4- and 7-year-olds to repeat words spoken by English speakers who produced accented speech. The researcher found that all children were able to complete the task accurately, and the child's vocabulary size positively correlated with word recognition ability along with the child's age, suggesting that known forms are a source of information that assists in understanding noncanonical speech (Bent, 2014).

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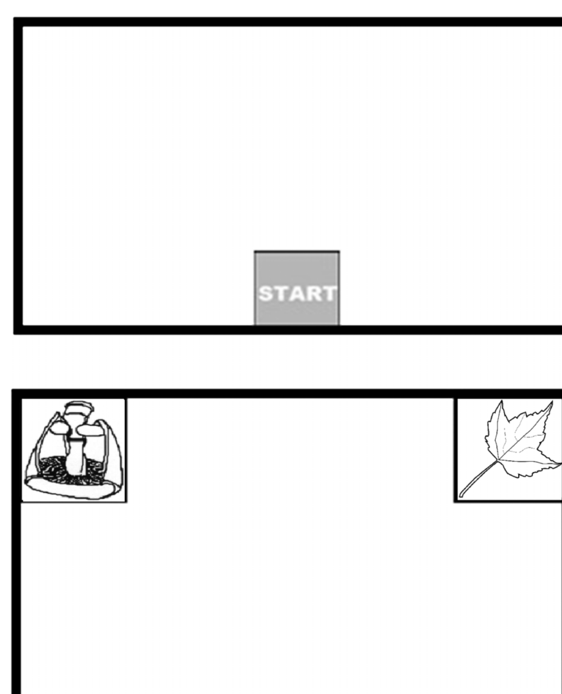
Children's interpretations of words must be flexible enough to assist them in strengthening their abstract phonological representations, while filtering out productions that deviate too far from the canonical production by native speakers. That is, canonical productions are often preferred over variable productions. In children aged 14–21 months, Swingley (2009) found that children visually fixated on real objects more than novel objects when hearing accurate productions than in misarticulations. If the phonemic substitute was in the onset position, fixations to the real object were reduced at onset and increased toward the real object as the rest of the word unfolded (Swingley, 2009). The results of this study indicated a sensitivity to deviation from the canonical production of the word at the phonemic level. In a study with older children, Swingley (2016) took this finding a step further to determine whether 24- to 30-month-old children would identify phonemic substitutions as real objects or novel objects. Across three experiments in which children were presented with words with substitutions, the real object referent was preferred (Swingley, 2016). Young children appeared to be flexible in their interpretation of words and had a bias toward known objects rather than identifying them as novel objects. Creel (2012) used phoneme substitutions in a similar paradigm with children aged 3–5 years. In this study, phonemes of words were systematically shifted to create "close" and "far" substitutions in terms of place–voice–manner features (Chomsky & Halle, 1968). Creel found that preschool children's acceptance of variability in words was reduced in conditions where two or more place–voice–manner features were changed as compared to conditions with only one feature changed. However, children in this study demonstrated a high preference for real objects over novel objects in each experimental condition. This result is consistent with previous research of children's acceptance of words—acceptability varies with the degree of variation from the target production but depends on the visual conditions as well.

Commonness of Variability

While previous researchers have explored the limits of children's understanding of words produced with phonemic variability, the influence of commonness has not been fully explored. Children who interact with others their age (e.g., in a day care or preschool setting) likely have extensive experience with another type of variability—developmentally appropriate speech sound misarticulations. Our previous study in this line explored the role of children's experience with speech sound variability and examined whether the commonness of the phoneme substitute (i.e., frequency of occurrence in typical development according to normative data) impacted children's identification of words as real objects or as novel objects (Krueger, Storkel, & Minai, 2018). To examine commonness, we conducted a series of three experiments in which children heard three types of tokens. Twelve words were accurately produced (e.g., [lif] for /lif/), 12 words contained a common misarticulation of the initial phoneme (e.g., [wif] for /lif/), and 12 words contained an uncommon misarticulation of the initial phoneme (e.g., [jif] for /lif/). The initial phoneme misarticulations were created by finding the most commonly occurring misarticulation for the accurate production and then finding a rarely occurring misarticulation that involved the same change in phonetic feature distance from accurate production to misarticulated production based on the error distributions analyzed in Smit (1993). For each trial, children were presented with a real object picture that represented the accurate word and with a novel object picture (see Figure 1).

Across three experiments using the MouseTracker software (Freeman & Ambady, 2010), or button presses, children were required to select either the real object or the novel object in response to each condition. Experiments were self-paced, and children could move from trial to trial by selecting a "start" button (see Figure 1). Across each of the three experiments in this study, preschoolers selected visual representations of real objects significantly more when they heard common misarticulations than when they heard uncommon misarticulations. Despite the consistent

Figure 1. Visual display from Krueger et al. (2018), used in this study. Clicking "start" initiates the trial, and children selected real objects or novel objects in response to auditory presentation of stimuli. The novel object picture (left) was reproduced from "Recognizing Words, Pictures, and Concepts: A Comparison of Lexical, Object, and Reality Decisions" by J. F. Kroll and M. C. Potter, 1984, *Journal of Verbal Learning and Verbal Behavior, 23,* pp. 61–63. Copyright 1984 by Elsevier. Reprinted with permission. The leaf (right) is licensed for public use under creative commons licensing (CC0).



significant difference between the two misarticulation conditions (common and uncommon), the proportion of real object selections was much higher than expected (i.e., greater than 60%) and much higher than that of variable conditions in other research (e.g., Creel, 2012). Like the findings of Swingley (2016) and Creel (2012), we found that preschoolers were accepting of variability in general, although children show a preference for real objects. Acceptance of phonemic variability in both Krueger et al. (2018) and Creel was dependent upon supralinguistic factors (e.g., commonness of the substitute). The results of Krueger et al.'s work extend these findings by demonstrating that preschoolers are much more accepting of variability in the context of a likely option (the real object) and a less likely option (the novel object). What is unclear is whether children's comprehension of words with misarticulations can be shifted when contextual clues are more obvious. This study intended to investigate the impact of context on children's identification of misarticulated words. In the prior study, children only heard accurate productions of real object words and related nonwords (misarticulations), and their response choices were always a real object pitted against a novel object. In the previous study, there was not a clear reason to select anything other than the real object. We identified that these factors could have biased the children to disproportionately select the real object. If supported by the results of the present inquiry, this finding would provide additional understanding about how contextual factors influenced children's identification of words containing misarticulations.

Response Bias: Lack of Unrelated Nonwords

In the previous experiment, for every misarticulated word the children heard, they also heard an accurate production. In response to these accurate productions, children selected the real object rapidly and with certainty—response times were lowest in this condition. No forced-choice condition for the novel object existed because children never heard a word that was completely dissimilar to the real word. It is possible that children were uncertain about the novel object being a viable response option because there was not a clear condition that encouraged children to select the novel object. As previously discussed, these findings mirror those of Creel (2012) and Swingley (2016). More specifically, Swingley (2016) showed that kids did not find that introducing the idea that the examiner was familiar with the novel words (Experiment 1) nor by teaching the words to children ahead of time (Experiment 3) influenced their preference for real objects in the face of phonemic variability. As in Krueger et al. (2018), children tended to select the most likely option for them—the real object picture. This theory may explain the high level of real object selections across both accurate and misarticulation conditions. This is explored in this study by presenting accurate productions of the target item, which should require selection of the real object, and presenting unrelated nonwords, which may require selection of the novel object, potentially shifting children's judgment through the change in task and visual context. In this context, we once again examine how children respond to common and uncommon misarticulations to determine whether the prior results will be replicated and extended.

Response Bias: Use of Nonobjects

In a similar vein, children may have been reluctant to identify a misarticulated production as a novel word even though they recognized that the misarticulated production was not a "good" production of the target. If the context was altered to present children with an ambiguous response, they may be less accepting of phonemic variability. Previous research has explored potential methods for changing the context to reduce potential response bias. Gelman, Croft, Fu, Clausner, and Gottfried (1998) explored the nature of children's overextensions in terms of "object shape, taxonomic relatedness, and prior lexical knowledge." Gelman et al. noted that, in examining children's lexical knowledge, there are some methodological issues that may measure children's errors rather than measuring their underlying lexical or phonological knowledge. In other words, if a child is shown two pictures but the auditory stimulus does not match either picture, children may feel pressured to select one of the pictures despite not actually identifying either as "correct" (Gelman et al., 1998). Gelman et al. overcame this issue through a novel experimental paradigm. The researchers aimed to provide children with a selection that left their identification ambiguous. That is, rather than being required to identify an object in response to auditory stimuli, the researchers allowed children an opportunity to say, "It's not that." The design was changed so that, instead of two objects, children were trained to understand that, if the target object was not present, then it would be "hiding" under a blank piece of paper (Gelman et al., 1998). The results of this study found that even very young children (aged 2 years) reduced the number of receptive overextensions as compared to an expressive task (Gelman et al., 1998). This paradigm was used in Experiment 2 to explore the possibility of response bias due to the forced-choice task. We once again examine how children respond to common and uncommon misarticulations to determine if the prior results will be replicated in this potentially less biased context.

Purpose

The purpose of this study was to examine the possibility of response bias in children's identification of words containing misarticulations. In Experiment 1, we addressed the possibility that children did not have an opportunity to select the nonobject unambiguously, which may have increased their uncertainty. To test this possibility, we added an additional auditory condition in which children heard an unrelated nonword (e.g., [gim] alongside a picture of a leaf and a novel object), which was intended to provide children with two anchors by introducing two unambiguous conditions—canonical = real object; unrelated nonword = novel object—and then testing the two ambiguous conditions: the common and uncommon speech sound substitutions. Through anchoring the selection of the visual stimulus types, children's real object responses in misarticulation conditions may be reduced. In Experiment 2, we addressed the response bias introduced by the forced-choice task and the visual context of the experiment (real object and nonobject). To address this possibility, we removed the novel object visual display and, instead, trained children to know that, if the object they were seeking was not on the screen, it was "hiding" underneath a blank white square. This method allowed children to be less specific about the labels they used for these objects and instead allowed them to indicate the word they heard was not the real object without providing another label. This change allowed for an examination of whether response bias could be reduced through minimizing the requirement of certainty and/or confidence in the response.

Experiment 1

Experiment 1 explored the possibility that participants in Krueger et al. (2018) chose visual representations of real objects at a high rate in misarticulation conditions due to a lack of unrelated nonwords forcing selection of the novel object. To explore the possibility of response bias, we aimed to answer the following research questions.

Research Questions

When children are presented with an equal number of accurate productions and unrelated nonwords to anchor equivalent unambiguous selection of real object pictures and novel object pictures:

1. Do children select real object representations more often for accurate versus misarticulated versus unrelated nonword productions?
2. Within misarticulation conditions, do children select real objects more often for commonly misarticulated words than uncommonly misarticulated words?

Through addressing Question 1, we explored whether children's acceptance of misarticulated speech was influenced by response bias, rather than a response to the misarticulated stimuli in general. Our hypothesis for Question 1 was that children's real object responses would be reduced in misarticulation conditions more so than in accurate conditions, but not as low as in the nonword condition. The purpose of Question 2 was to determine whether the change of experimental paradigm changed the difference in real object selections between common and uncommon misarticulation conditions. Our hypothesis was that, although we expected the real object selections to decrease for both common and uncommon conditions, we expected the proportion of real object responses to common misarticulations to be significantly higher than real object responses to uncommon misarticulations.

Method

Participants

This study was approved by the University of Kansas internal review board for the protection of human subjects. Twenty-five monolingual preschoolers (M = 4;7 [years; months], SD = 0;8, range: 3;0–5;9; 12 boys, 13 girls) were recruited from local preschools and through fliers distributed to community boards. Twenty-four participants were identified as Caucasian, non-Hispanic, and one was identified as American Indian/Asian Pacific Islander, non-Hispanic. In order to be included in the experimental portion of the study, participants were required to be between the ages of 4 and 6 years and to have no known neurological conditions (e.g., attention-deficit/hyperactivity disorder, autism spectrum disorder), as reported by a questionnaire completed by parents. Additional inclusionary criteria were based on results of articulation, vocabulary, and hearing assessments. Participants were required to score within normal limits on the Goldman-Fristoe Test of Articulation–Second Edition (Goldman, 1986) and the Peabody Picture Vocabulary Test–Fourth Edition (Dunn & Dunn, 2007) and to pass a hearing screening at 20 dB HL at 1000, 2000, and 4000 Hz (American Speech-Language-Hearing Association, 1997). In addition to the Goldman-Fristoe Test of Articulation–Second Edition, a probe of participants' articulatory skills on late-acquired sounds (/θ, ð, s, z, l, ɹ, ʃ, tʃ/) was taken using a subset of the Phonological Knowledge Protocol (PKP; Dinnsen & Gierut, 2008). This probe was administered via live voice of the examiner and served to measure preschoolers' production of sounds in a variety of vowel contexts. The probed sounds were the onset sounds of the accurate misarticulation condition in the experimental stimuli. Of the 25 preschoolers recruited, one was excluded for a pre-existing diagnosis of a neurological condition (as reported on the parent questionnaire), and three were excluded for being younger than 4 years old. (Note: The experimental condition was attempted with children younger than 4 years of age, but these participants were unsuccessful at using the mouse reliably and in completing the task in general.)

Therefore, 21 participants were included in the current analysis. Standard score means, standard deviations, and ranges are reported in Table 1. All participants scored within normal limits on these assessments. Overall, participants were highly accurate on the PKP speech probe, but 14 of 21 participants misarticulated at least one of the phonemes in the experimental auditory stimuli.

Materials

Auditory Stimuli

Auditory stimuli (see Table 2) consisted of 12 real words and common and uncommon misarticulations from Krueger et al. (2018). What is novel to the present experiment

Table 1. Experiment 1 participant scores on preliminary assessments.

Assessment	Mean standard score	*SD*	Range
GFTA-2	112	7	97–120
PPVT-4	116	15	89–145

Note. $n = 21$. GFTA-2 = Goldman-Fristoe Test of Articulation–Second Edition; PPVT-4 = Peabody Picture Vocabulary Test–Fourth Edition.

is the addition of 12 unrelated nonwords. The 12 real words were picturable and frequent in the child's lexicon. Additionally, these words were selected to begin with late-acquired sounds to increase the likelihood that children had received exposure to misarticulations associated with these phonemes. From these 12 accurately produced real words, 12 common misarticulations were created by selecting the most frequently occurring phoneme substitution for the initial consonant in each accurate word. The frequency of occurrence for these phonemes was identified based on data from Smit (1993) for the 4.5- to 5-year age range (Smit, Hand, Freilinger, Bernthal, & Bird, 1990). Substitute phonemes were selected only if the resulting misarticulated word was not a real word. Uncommon substitutes were chosen by examining the number and type of feature change from accurate production to common misarticulation. Then, the same feature change in terms of distinctive features was completed to ensure consistency in difference of substitution between common and uncommon from the original accurate production. If the resulting misarticulated word was a real word, the next most frequently used substitute was selected. For example, the uncommon substitute for "thumb" should have been a voiceless fricative to match the accurate to common substitute feature change, "thumb" to "fumb." Therefore, possible candidates were "sum" and "shumb." Since "sum" (or "some") is a real word, "shumb" was selected instead. The confusability of the substitutes from accurate to common and accurate to uncommon was compared using the procedures in Han, Storkel, Lee, and Cox (2016) from data found in Wang and Bilger (1973). No difference between conditions was observed, and these results are reported in Krueger et al. In addition, 12 nonwords were developed to serve as the unambiguous "match" to the novel objects. These nonwords were designed to represent a variety of consonants and vowel contexts, while maintaining similar features (e.g., phonotactic probability) as the experimental stimuli.

Table 2. Auditory stimuli.

Accurate	Common	Uncommon	Unrelated
"chick"	ʃɪk	fɪk	θɛp
"leaf"	wif	jif	ruʃ
"thumb"	fʌm	ʃʌm	sɛn
"comb"	toʊm	poʊm	baŋ
"jar"	dɑɹ	gɑɹ	bul
"safe"	teɪf	peɪf	koʊʃ
"van"	bæn	dæn	kæθ
"shirt"	sɝt	fɝt	θʌp
"clock"	kwɔk	kjɔk	treɪp
"rope"	woʊp	joʊp	luk
"fish"	pɪʃ	tɪʃ	kɛs
"girl"	dɝl	bɝl	pʌm

Note. Auditory stimuli: accurate condition in American English orthography as well as misarticulated and unrelated nonwords in phonetic transcription.

The first author, who is a female native speaker of a midwestern dialect of English, recorded the nonword auditory stimuli. The stimuli were recorded in an anechoic chamber on a Marantz PMD-671 solid-state digital recorder. Each nonword was recorded multiple times in one session using a carrier phrase "Look at the____." The carrier phrase was used to control for listing effects and to control the intonation for each nonword. These words were extracted from the carrier phrase using Praat phonetics software, and 250 ms of silence was embedded at the onset and offset of each word (Boersma & Weenink, 2013). The nonword tokens were transcribed phonetically by a blinded undergraduate research assistant to ensure the intended phonemes were produced. Additionally, the duration of each nonword was measured to ensure the mean and standard deviation of the nonword category duration were within the same range of each accurate and misarticulated category. Word durations of each type were compared using a one-way analysis of variance (ANOVA) with Word Type (accurate, common, uncommon, unrelated) as a factor. The results demonstrated no significant difference between word types, $F(3, 44) = 0.05$, $p = .98$, $\eta_p^2 = .004$.

Visual Stimuli

Visual stimuli were the same as those used in Krueger et al. (2018). Each word in the auditory stimuli was matched with a picture of a real object and a picture of a novel object. The real object pictures were 12 black-and-white line drawings selected from Microsoft Clipart and from Snodgrass and Vanderwart's (1980) collection of standardized pictures. Each misarticulated version was assigned a novel object picture, so 24 novel objects were used. These novel object pictures were chosen from the Kroll and Potter (1984) picture set. These pictures were also black-and-white line drawings of objects that do not exist. Each novel object picture was selected to have a rating of 5 or below on a 7-point scale of "object likeness" (where 1 = *nothing like a real object* and 7 = *looks like a real object*) as determined by children's ratings from Storkel and Adlof (2009). They were also balanced across conditions by semantic set size and semantic strength of the first neighbor (Storkel & Adlof, 2009).

All pictures were sized at 144 × 144 pixels to maintain a consistent selection area for the mouse-tracking software. Pictures were paired with common and uncommon substitutions, and the picture assignment for each misarticulated word was counterbalanced across blocks and across participants. These pictures were matched with each misarticulation to ensure that children had a unique choice for each condition.

Experimental Design

Experimental Control

Audio tokens were aligned into sets of three for the purpose of counterbalancing the visual displays. The sets are as follows: accurate–common–nonword and accurate–uncommon–nonword. These sets were matched with a visual display of a real object (e.g., "chick") and a novel object picture (e.g., "nonobject 75") to create three trials for each "set." This means that children heard each accurate word and each nonword twice, once in the common misarticulation visual display condition and once in the uncommon misarticulation visual display condition. This ensures that every visual display offered an unambiguous opportunity to select the real object (i.e., accurate production trial) and the novel object (i.e., nonword trial), anchoring selection of each response choice. These six trials for each set were distributed across two experimental blocks so that the dual repetitions of the accurate and nonwords only occurred once in each block. Misarticulated words (common and uncommon) were counterbalanced across the two blocks. Each aural presentation of these nonwords only occurred once per block (two blocks in total). Eight versions of the experimental design were created to ensure that children's responses were not due to recency effects or due to preference for one side of the screen or other. The position of visual stimuli was counterbalanced across the left and right sides of the screen, as well as in the initial and final blocks (see Appendix).

Procedure

Testing was conducted in a quiet room in each participant's preschool building. Each child participated in one or two sessions; the number of sessions depended on each child's attention and disposition in completing all testing and experimental tasks. Children were seated in front of a Dell Latitude D610 PC laptop with external speakers, a 17.25″ × 13.25″ mousepad, and a single-button, corded optical mouse. Verbal assent from the child was obtained prior to beginning the experimental procedures.

Children heard the following instructions: "You are going to hear some words, use this mouse to click on the picture that matches what you hear." Children completed five practice trials to acclimate them to mouse use. The practice trials were the same as experimental trials, except no nonwords or nonobjects were presented. Instead, children were presented with two real object pictures and with accurately produced real words in the training. If the child did not appear to have knowledge of mouse use, the examiner would demonstrate its use by hand over hand, guiding the child to the correct stimuli. Experimental procedures were the same across all versions (see Appendix for sample counterbalanced versions).

First, a "start" button appeared. Children clicked on the "start" button with the mouse, and the two visual stimuli appeared immediately in the upper right- and left-hand corners of the screen. After an interval of silence of 500 ms in duration, children heard a single stimulus word from the external speakers. The child then selected the picture by using a mouse click. This ended the trial, and the "start" button appeared once again to prompt the child to begin the next trial. As this was a self-paced task, the duration of the task differed from child to child. Overall, the presentation of the 72 trials took approximately 10 min. The proportion of real object selections (accuracy), response time, and mouse trajectories were recorded through the MouseTracker experimental software (Freeman & Ambady, 2010). The findings of Krueger et al. (2018) demonstrated that response time and mouse trajectories were not consistent with accuracy results; therefore, these data were not analyzed in this study. This software was used because it is a free, portable method for data collection and mouse movements have been shown to be successful in measuring children's processing and responses (Berteletti, Lucangeli, & Zorzi, 2012; Cargill, Farmer, Schwade, & Spivey, 2007; Crook, 1992).

Data Analysis

Children's proportion of real object selections was compared using a 3 Similarity (accurate, substitute, unrelated) × 2 Typicality (common, uncommon) repeated-measures ANOVA. The critical alpha level of this analysis was at the $p < .05$ level. Effect size was measured through calculating a partial eta squared (η_p^2).

Children's selections of real objects were scored as "correct" responses in order to examine how children's bias toward or against real objects changed in response to the change in each accurate, misarticulation, and nonword stimuli conditions. Statistically significant interactions were explored further through planned post hoc testing. These analyses were planned as a series of five comparisons using paired-samples *t* tests comparing accurate responses to each of the misarticulation conditions, as well as the misarticulation conditions to one another, and misarticulation differences to nonwords.

These comparisons allowed us to identify factors that were driving these interactions. The alpha level of these paired-samples *t* tests was corrected to account for Type I error using the Bonferroni method of multiple comparisons. Since we planned five comparisons, the predetermined *p* value for these tests was set at $p < .01$ ($\alpha_{critical} = .05/5$).

Since this experiment was an extension of Krueger et al. (2018)—particularly for Experiment 1 of Krueger et al.—the charts from that study will be reproduced for visual comparison. Furthermore, each condition that is consistent across the two experiments (accurate, common, uncommon) will be compared using a one-way ANOVA with Experiment as a factor.

Results

A significant interaction between typicality and similarity was observed, $F(2, 40) = 24.93$, $p < .001$, $\eta_p^2 = .56$. This interaction was supported by significant main effects of both typicality, $F(1, 20) = 23.82$, $p < .001$, $\eta_p^2 = .54$, and similarity, $F(2, 40) = 182.55$, $p < .001$, $\eta_p^2 = .90$. Overall (see Figure 2), children chose real objects significantly more when they heard accurate productions (93% common visual display condition, *SD* = 9%, range: 67%–100%; 94% uncommon visual display condition, *SD* = 5%, range: 83%–100%) than when they heard substitutions (63% common, *SD* = 24%, range: 25%–100%; 40% uncommon, *SD* = 23%, range: 17%–83%) and more when they heard substitutions than when hearing unrelated nonwords (13% common visual display condition, *SD* = 13%, range: 0%–50%; 12% uncommon visual display condition, *SD* = 9%, range: 0%–33%). These findings suggest that both main factors and the interaction of these factors produced significant differences. To explore this interaction further, we conducted planned, post hoc paired-samples *t* tests.

The results of post hoc testing (see Table 3) showed that children chose real objects significantly more for accurate productions (93%) than common misarticulation stimuli (63%). Children chose real objects significantly more in accurate productions (94%) than in uncommon misarticulation conditions (40%). Additionally, children chose real objects significantly more in common misarticulation conditions (63%) than when hearing uncommon misarticulations (40%), replicating our prior results. Finally, these tests showed that children chose real objects significantly more for common misarticulations (63%) than unrelated nonwords (13%) and significantly more for uncommon misarticulations (40%) than unrelated nonwords (12%). These results confirm that children's selection of the real object varied by stimulus type, with the most real object selections occurring for accurate productions, followed by common misarticulations, followed by uncommon misarticulations, and followed by nonwords.

The results of the one-way ANOVA with Experiment as a factor to compare each condition between Experiment 1 of this study and Experiment 1 of Krueger et al. (2018) showed significant differences in both the common and uncommon misarticulation conditions. As shown in Table 4, in the common misarticulation condition, children chose real objects significantly more in Krueger et al. (78%) than in the present analysis (63%), $F(1, 38) = 4.28$, $p = .045$, $\eta_p^2 = .10$. In the uncommon misarticulation conditions, children chose real objects significantly more in Krueger et al. (70%) than in the present analysis (40%), $F(1, 38) = 12.98$, $p = .001$, $\eta_p^2 = .25$. These results suggest that the addition of the unrelated condition significantly reduced the response bias toward selecting real objects in misarticulation conditions.

Figure 2. Children's real object selections in response to real object and novel object visual stimuli for each auditory condition. The left panel contains data from Krueger et al. (2018), which are replotted to match the data from the current study in the right panel to facilitate comparisons across data sets. The black horizontal line indicates chance at 50%.

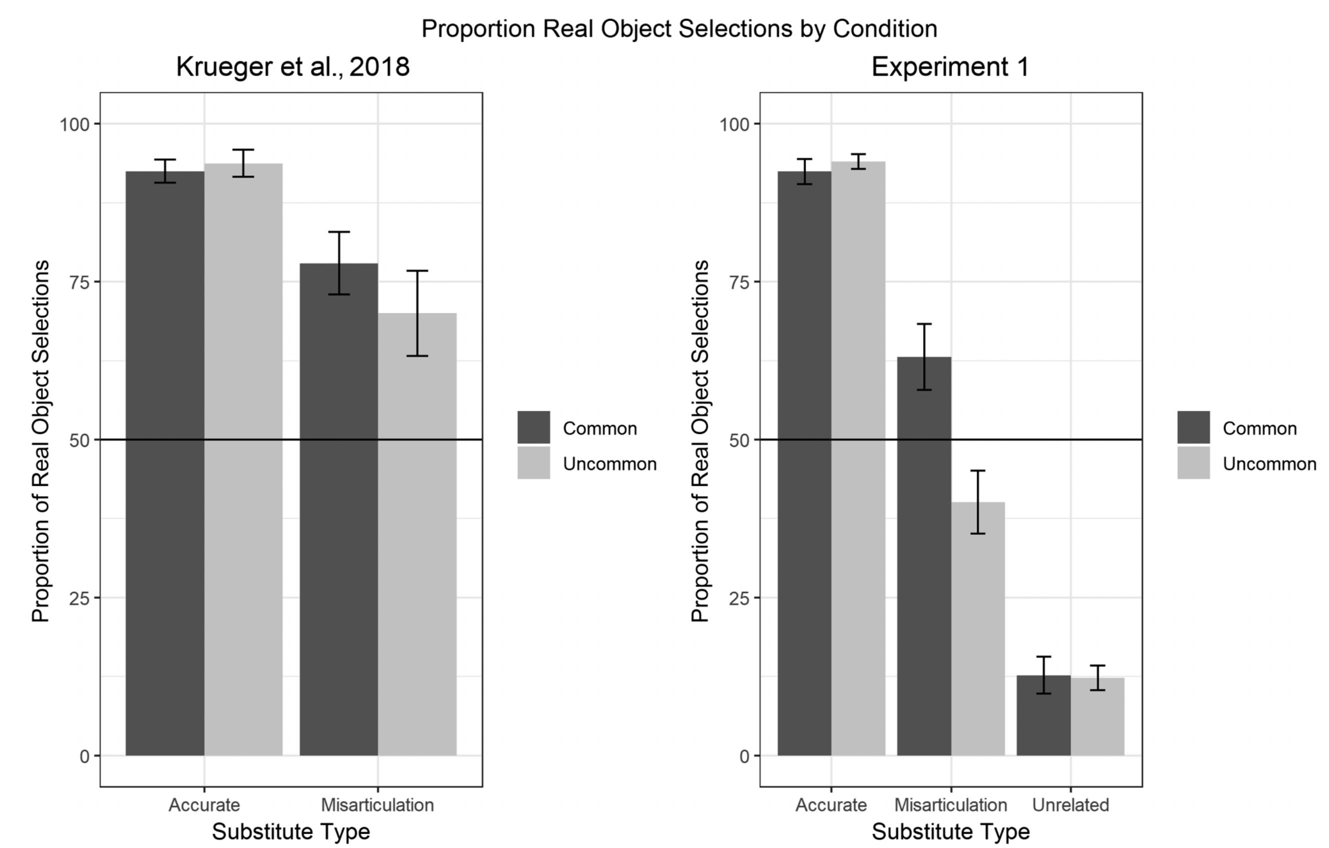


Table 3. Post hoc testing between conditions.

Comparison	$t(20)$	p ($\alpha < .01$)
Accurate vs. common	5.09	< .001
Accurate vs. uncommon	11.59	< .001
Common vs. uncommon	7.2	.001
Common vs. unrelated nonwords	9.11	< .001
Uncommon vs. unrelated nonwords	5.89	< .001

Discussion: Experiment 1

The purpose of Experiment 1 was to examine the impact of misarticulations on children's word identification with a reduced likelihood of response bias. Recall that we sought to determine whether children chose real objects more in the presence of accurate conditions than in misarticulation conditions and whether, within misarticulation conditions, children chose real objects more in common misarticulation conditions than in uncommon misarticulation conditions. The results of Experiment 1 were very similar to those found in Krueger et al. (2018) in that children chose real objects more in accurate conditions than in misarticulation conditions and more in common misarticulation conditions than in uncommon misarticulation conditions. The results extend those of Krueger et al. by showing that children demonstrated gradient performance when contextual changes occurred. It is possible that including the unrelated nonword shifted the criteria for what constitutes an acceptable label for a real object or a novel object. Therefore, Experiment 2 will explore this possibility by creating an ambiguous response choice and removing the pressure to pick between a known object and a novel object. This possibility was explored in Experiment 2.

Experiment 2

The data collection method for Experiment 2 was approved by the internal review board for the protection of human subjects at the University of Kansas. Experiment 1 required children to select either a known or novel object. To overcome this embedded methodological pressure, for Experiment 2, we removed the requirement of identifying a misarticulated word as a specific item. Based on the findings of Gelman et al. (1998), we altered our paradigm to offer children the choice between a real object and a "hiding object." In Experiment 2, children were trained to understand that, if the word they heard as auditory stimuli was not present as a real object on the screen, then it was "hiding" under a blank white square. This allowed children to generally identify the misarticulated words as "not the real object" rather than specifically naming an unknown novel object, as in Experiment 1.

Research Questions

The unrelated nonword condition used in Experiment 1 was utilized in Experiment 2 to maintain anchor conditions. When children are presented with the opportunity to select a "hiding object" to reduce methodological pressure:

1. Do children select real objects more often for accurate versus misarticulated versus unrelated nonword productions?
2. Within misarticulation conditions, do children select real objects more often for commonly misarticulated words than uncommonly misarticulated words?

Based on the results of Experiment 1, we expected the difference in real object selections between accurate and misarticulation conditions to remain consistent. In answering Question 2, we predicted that children's proportion of real object selections would be reduced in both misarticulation conditions but that the difference between common and uncommon misarticulation conditions would remain consistent with Experiment 1 and Krueger et al. (2018). The novel visual display condition allowed children to provide responses without the pressure of incorrectly naming an unknown object. Our predictions reflect those of our previous findings and those found in Gelman et al.

Method

Participants

Twenty-four preschoolers (M = 4;6, SD = 0;5, range: 3;10–5;7; 14 boys, 10 girls) were recruited from local preschools and through fliers to participate in this study. Twenty-two participants were identified as Caucasian, non-Hispanic;

Table 4. Comparison of conditions between studies.

Experiment/condition		F	df	p ($\alpha_{critical} = .05$)	η_p^2
Krueger et al. (2018) Experiment 1	Accurate common	0.001	39	.98	< .001
Krueger et al. (2018) Experiment 1	Accurate uncommon	0.03	39	.86	.001
Krueger et al. (2018) Experiment 1	Misarticulation common	4.28	39	.05	.1
Krueger et al. (2018) Experiment 1	Misarticulation uncommon	12.98	39	.001	.25

Note. Comparison of accuracy conditions between Krueger et al. (2018) and Experiment 1.

one was identified as American Indian/Asian Pacific Islander, Hispanic; and one was identified as Black/African American, non-Hispanic. Of these, one was excluded for a low articulation score, one was excluded for a low vocabulary score, and two were excluded for speaking a second language. Therefore, 19 participants were included in the current analysis. Inclusionary criteria for Experiment 2 are the same as those in Experiment 1. Results of testing (mean standard score, standard deviation, and range) are reported in Table 5. Overall, participants were highly accurate on the PKP speech probe, but 14 of 19 participants misarticulated at least one of the phonemes in the experimental auditory stimuli.

Materials

Auditory Stimuli

The auditory stimuli used in this experiment were the same as those used in Experiment 1, including the nonword stimuli.

Visual Stimuli

Experiment 2 employed a different paradigm from what was conducted in Experiment 1 to further examine the visual condition's impact on response bias. The real object pictures from Experiment 1 were included in Experiment 2, but instead of having a second alternative to choose from (e.g., a novel object), children were shown a real object and a "blank" white square (see Figure 3).

Experimental Design

Experimental Control

Due to the findings of Experiment 1, we continued to use the accurate, misarticulated, and nonword auditory stimuli recorded and used in Experiment 1. This provided children with an equal opportunity to select the real object and the blank square to ensure that any real object bias was not due to an increased selection of real objects in general. The experimental control for Experiment 2 was consistent with Experiment 1.

Procedure

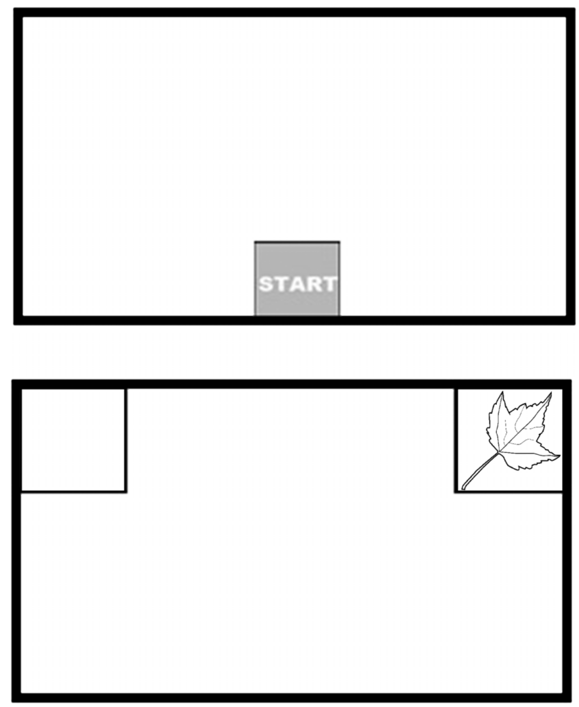
Experimental procedures were the same as those in Experiment 1, in terms of the delivery of stimuli. Children used the MouseTracker to make their selections in response to single-word stimuli. The experiment was self-paced, and children's mouse click responses moved them from trial to trial. Auditory and real object visual stimuli were the same as those in Experiment 1 and made up 72 trials. The only difference between Experiment 1 and the present experiment is that the nonobject visual stimuli were replaced with a white blank, and children received a course of training prior to the experiment to acclimate them to the "hiding object" visual stimuli.

Table 5. Experiment 2 participant scores on preliminary assessments.

Assessment	Mean standard score	*SD*	Range
GFTA-2	114	5	103–122
PPVT-4	121	13	101–143

Note. *n* = 19. GFTA-2 = Goldman-Fristoe Test of Articulation–Second Edition; PPVT-4 = Peabody Picture Vocabulary Test–Fourth Edition.

Figure 3. Visual display for Experiment 2. Children were trained to select the blank box if they believed the correct response picture was not present or "hiding" beneath the blank white box. The leaf (right) is licensed for public use under creative commons licensing (CC0).



Hidden Object Training

Immediately prior to the experimental task, children received a brief course of training from the examiner (six trials in total). In this training, participants were presented with a Microsoft PowerPoint presentation that visually and behaviorally simulated the operation of the MouseTracker software. On the first slide, children saw a "start" button and were asked to select it using the mouse. They then saw a picture of a real object (e.g., a zebra) and a white square on a black background (the "blank"). First, children were asked to select the "zebra" using the mouse. Once the zebra picture was selected, the child received positive feedback (e.g., "That's right, you clicked on the 'zebra,' good job!"). Next, participants were asked to point to a "ball" while seeing the same visual display of a "zebra" and a "blank," but there was no ball shown on the screen. If the child clicked on the blank, the blank was animated to move away and reveal a ball underneath the blank square.

If they clicked on the picture of the zebra, they then received feedback saying, “No, that’s not a ball.” The child would then either click on the blank (the only other option) to see the ball revealed or be prompted to click on the blank to see the animation. On the second slide, children saw a real object (“flower”) and a blank white square. For this slide, the white square was not animated. They were then asked, “point to the flower” and “point to the horse.” Children were again provided with corrective feedback to point to the flower when hearing “flower” and the blank when hearing “horse.” The final slide displayed a real object picture and an unanimated blank white square. This time, children heard the real object label and an unrelated nonword and were provided corrective feedback to select the real object when hearing the real object label and to select the blank when hearing the nonword. In this way, children were trained to understand that the real word and nonwords served as anchors for each condition (as in Experiment 1), and this also trained their understanding of the blank square.

Data Analysis

The data analysis procedure for Experiment 2 was the same as for Experiment 1. Children’s proportion of real object selections was calculated based on data recorded by the MouseTracker software. Comparisons, alpha levels, and error adjustments were the same as those in Experiment 1. The results of Experiment 2 will be compared to the results of Experiment 1 of Krueger et al. (2018) in the same way as for Experiment 1 of this study.

Results

Children’s identification of words as real objects was impacted by the stimulus conditions (see Figure 4). Recall that real object selections were analyzed using a 2 Typicality (common, uncommon visual displays) × 3 Similarity (accurate, substitute, nonword) repeated-measures ANOVA. A significant interaction between typicality and similarity was observed, $F(2, 36) = 9.20$, $p = .001$, $\eta_p^2 = .34$. This interaction was supported by a significant main effect of similarity, $F(2, 36) = 89.13$, $p < .001$, $\eta_p^2 = .83$, but the main effect for typicality did not reach significance, $F(1, 18) = 3.73$, $p = .07$, $\eta_p^2 = .17$. The lack of main effect of typicality suggests that the difference between common and uncommon visual display conditions (across all three similarity conditions) did not impact children’s responses. Overall, children chose real objects significantly more when they heard an accurate production (*M* = 89% common visual display, *SD* = 10%, range: 67%–100%; *M* = 91% uncommon visual display, *SD* = 11%, range: 50%–100%) than when they heard substitutions (common: *M* = 48%, *SD* = 30%, range: 8%–100%; uncommon: *M* = 36%, *SD* = 30%, range: 8%–92%). Additionally, children selected real objects more when hearing substitutions than when hearing unrelated nonwords (common: *M* = 15%, *SD* = 23%, range: 0%–67%; uncommon: *M* = 16%, *SD* = 24%, range: 0%–75%).

Planned post hoc paired-samples *t* tests, with Bonferonni correction ($\alpha_{critical} = .01$), were conducted to examine the relationship between the variables driving the significant interaction (see Table 6). The results of post hoc testing showed that children chose real objects significantly more for accurate productions (89%) than common misarticulation conditions (48%). Children chose real objects significantly more in accurate productions (91%) than in uncommon misarticulation conditions (36%). Within the misarticulation condition, children chose real objects significantly more in common misarticulation conditions (48%) than when hearing uncommon misarticulations (36%). Finally, these tests showed that children chose real objects significantly more for common misarticulations (48%) than unrelated nonwords (15%) and more for uncommon misarticulations (36%) than unrelated nonwords (16%). These results are consistent with those found in Experiment 1, which suggests that children’s identification of misarticulated words as common or uncommon is robust enough that the change in experimental and methodological conditions does not have a significant influence.

In comparing Experiment 2 to Experiment 1 of Krueger et al. (2018), a significant difference was found in the misarticulation conditions (see Table 7). Using a one-way ANOVA with Experiment as a factor, children chose real objects significantly more in common misarticulations in Experiment 1 of Krueger et al. (78%) than in Experiment 2 (48%), $F(1, 37) = 12.69$, $p = .001$, $\eta_p^2 = .26$. Furthermore, children selected real objects significantly more in Krueger et al. (70%) than in Experiment 2 (36%) when hearing uncommon misarticulations, $F(1, 37) = 12.86$, $p = .001$, $\eta_p^2 = .26$.

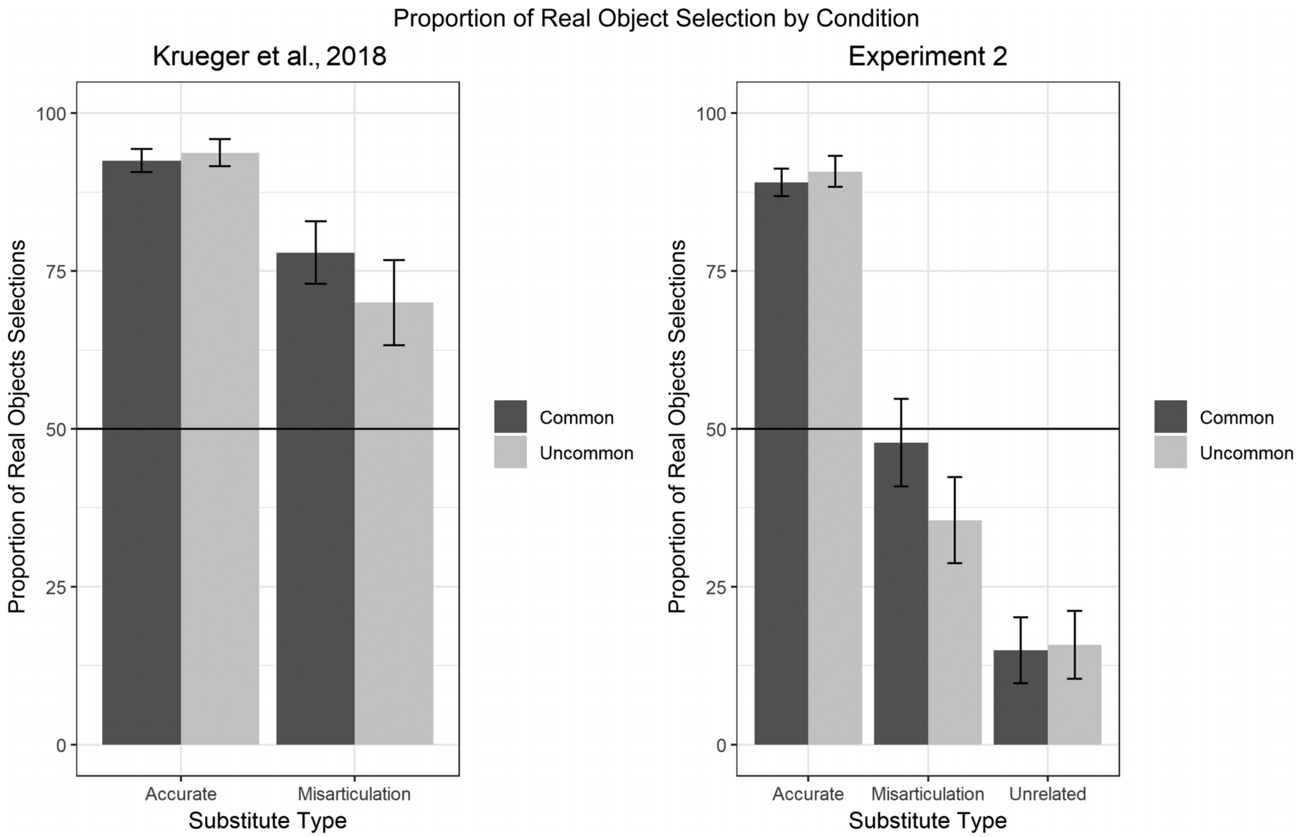
Discussion: Experiment 2

The purpose of Experiment 2 was to explore whether children’s identification of words was influenced by response bias due to the pressured nature of forced-choice tasks. The first question we addressed was the following:

1. Do children select real objects more often for accurate versus misarticulated versus unrelated nonword productions?

The results of Experiment 2 revealed that children selected real objects significantly more in accurate conditions than in misarticulation conditions and more in misarticulation conditions than in unrelated nonword conditions. In contrast to the findings of Experiment 1, children selected real objects at a much lower rate in the common misarticulation condition, suggesting that they were not as certain about the identity of the common substitutes as they were in other stimulus conditions, given the opportunity to express this through the selection of the blank object. This finding leads to our second question regarding comparisons within misarticulation conditions:

Figure 4. Proportion of real object selections in each condition comparing data from Krueger et al. (2018; left panel) to this study. Krueger et al. data are replotted for accurate visual comparison to the present data set. Black horizontal line indicates chance at 50%.



2. Within misarticulation conditions, do children select real objects more often for commonly misarticulated words than uncommonly misarticulated words?

Our findings revealed that the results of Experiment 1 and those in Krueger et al. (2018) remained consistent—children's experience with common substitutes influenced their selection of real objects over "something else" or a novel object more often than when hearing uncommon substitutes. There was no difference between Experiments 1 and 2 for any condition. This finding suggests that children use multiple sources of experience and context to decide whether a misarticulated word is a real object or a novel object. Recall that, in each of these studies, preschoolers selected real objects significantly more when hearing common misarticulations than when hearing uncommon misarticulations. Although the proportion of real object selections in misarticulation conditions was reduced relative to the findings in Krueger et al., there remains a difference between common and uncommon misarticulation conditions. This suggests that children may use supralinguistic factors, such as commonness of the speech sound substitute, in conjunction with contextual factors, such as visual displays.

Table 6. Post hoc testing between conditions.

Comparison	$t(18)$	p ($\alpha_{critical} < .01$)
Accurate vs. common	5.78	< .001
Accurate vs. uncommon	8.12	< .001
Common vs. uncommon	3.20	.005
Common vs. unrelated nonwords	5.49	< .001
Uncommon vs. unrelated nonwords	4.17	.001

Between-Experiments Comparison

Due to the methodological similarities between Experiments 1 and 2 (same auditory stimuli, both have added an unrelated nonword anchor condition), we conducted a comparison of conditions across the two experiments to examine whether one was significantly different than the other in either condition through a one-way ANOVA with Experiment as a factor. This analysis was intended to demonstrate whether the addition of the unrelated nonword alone or the difference in task made an impact on children's real object selections in misarticulation conditions. As shown in Table 8, there were no significant differences observed between the two experiments within conditions. This finding suggests that, overall, the addition of the

Table 7. Comparison of conditions between studies.

Experiment/condition		F	df	p ($\alpha_{critical}$ = .05)	η_p^2
Krueger et al. (2018) Experiment 2	Accurate common	1.42	37	.24	.04
Krueger et al. (2018) Experiment 2	Accurate uncommon	0.70	37	.41	.02
Krueger et al. (2018) Experiment 2	Misarticulation common	12.69	37	.001	.26
Krueger et al. (2018) Experiment 2	Misarticulation uncommon	12.86	37	.001	.26

Note. Comparison of accuracy conditions between Krueger et al. (2018) and Experiment 2.

unrelated nonword and the addition of the ambiguous condition had a significant influence on children's selection of real objects.

General Discussion

The results of the current study were consistent with what was found in Krueger et al. (2018). Overall, children across both studies selected real objects significantly more in accurate production conditions than in misarticulation conditions. Furthermore, within misarticulation conditions, children selected real objects more in common misarticulation conditions than in uncommon misarticulation conditions. Children's identification of misarticulations as real objects in general supports the finding that early word learning relies on accepting some degree of variability to allow for refinement of lexical and phonological representations. However, in this study, children selected real objects less often in both Experiments 1 and 2 than in Krueger et al. This suggests that the manipulations to the paradigm replicated the finding that children's interpretation of words is flexible. The current findings extend the findings of Krueger et al. to demonstrate what may occur in differing contexts. That is, the addition to the "game" of identifying unrelated nonwords provided an anchor to each visual alternative and lowered children's acceptance of misarticulated productions as real objects.

Anchors in the Visual Context

The real word stimuli and the introduction of the unrelated nonword in Experiment 1, and kept in Experiment 2, provided children with an anchor to each visual selection. These anchors provided a context in which children could reliably treat misarticulated words (common and uncommon) as either real words or new words. This comparison to the anchors, therefore, reduced the tendency of children to default to the real object selection because it was "known" to the child and the novel object was not. Recall that Gelman et al. (1998) similarly found differences in behavior patterns in response to the differentiated tasks. Despite demonstrated overacceptance of misarticulated or accented speech in previous work, these responses were likely influenced by contextual factors. The influence of context may provide some insight into how children learn words from misarticulating peers in real-world scenarios. In other words, if the context for learning is present (e.g., a spoken item is physically present), then children's understanding of misarticulations is greater than if no context was present (e.g., no object referent). Words with common misarticulations, for example, were interpreted similarly to accurate productions of words—as real objects (Experiment 1). On the other hand, uncommon

Table 8. Comparison of conditions between experiments.

Experiment/condition		F	df	p ($\alpha_{critical}$ = .05)	η_p^2
Experiment 1 Experiment 2	Accurate common	10.37	38	.25	.04
Experiment 1 Experiment 2	Accurate uncommon	10.45	38	.24	.04
Experiment 1 Experiment 2	Misarticulation common	30.17	38	.08	.08
Experiment 1 Experiment 2	Misarticulation uncommon	0.30	38	.59	.01
Experiment 1 Experiment 2	Unrelated common	0.15	38	.70	.004
Experiment 1 Experiment 2	Unrelated uncommon	0.39	38	.54	.01

Note. Comparison of accuracy conditions between experiments of this study.

misarticulations were interpreted in a similar way as the unrelated nonwords—not as real objects (Experiments 1 and 2). Within this overall response pattern, children still differentiated between accurate and common words and between uncommon words and nonwords. Children demonstrated a gradient interpretation across these conditions. Therefore, children's responses were influenced by the contextual condition, as well as the commonness of the substitution.

Interpretation of Common Misarticulations

Although the two experiments were consistent with one another in terms of the pattern of responses to each of the word conditions, children's treatment of the common misarticulation condition varied between Experiments 1 and 2 and the findings of Experiment 1 of Krueger et al. (2018), which warrants further consideration. In Experiment 1 of Krueger et al., children more clearly interpreted common misarticulations as real objects than in the present experiments. This difference is attributed to the change in visual context and the experimental task or "game" that children were playing. The difference in behavior among the two studies provides a glimpse into the methods children employ when hearing misarticulations from their peers. Previous work on acceptance of speech variability (e.g., Bent, 2014; Creel, 2012) suggests that children integrate several modalities when learning new words (e.g., commonness of the substitution, available visual stimuli). The use of these modalities differs depending on the availability of information while interpreting the words they hear in the world around them. Since the stimuli in this study were late-acquired sounds and since the participants were recruited from preschools, there was an increased likelihood that children would be exposed to typical, developmentally appropriate speech sound substitutions. Children clearly used this experience to support their decision making in Experiments 1 and 2 of this study.

Children's Flexibility and Common Misarticulations

Contextual factors, such as visually presenting known objects alongside a commonly misarticulated word, affected children's proportion of real object selections. This finding demonstrates a level of flexibility that is very important in children's word learning. This flexibility is a necessary part of the acquisition process, according to previous research, and this study further strengthens that argument (Bent, 2014; Best, Tyler, Gooding, Orlando, & Quann, 2009; Rost & McMurray, 2009). It is important to examine how contextual factors influence interpretation of the common misarticulations because it demonstrates children's use of supralinguistic and nonlinguistic information. The evidence suggests that children's decisions about words can be shifted by manipulating their access to additional information. In terms of common misarticulations, children's interpretation is flexible enough to allow for the acquisition of varied forms of the same word or for the acquisition of a new word entirely. Among other factors, the interpretation of phonemically similar words is dependent upon the context at the time of exposure to the word.

Conclusion

Children's flexibility in the perception of variability is a well-established phenomenon that assists children in learning new words. However, previous work did not consider contextual variables that may influence children's identification of words. The research questions of this study not only considered the auditory experience of children (commonness of the substitute) but also considered the context in which the word is learned. In Experiments 1 and 2, we found that, if we normalized the selection of the novel object or blank option as much as we did the real object, then a better representation of children's experience with misarticulations could be found. That is, children take into account contextual factors (e.g., an implied "game" in which new words are being learned). Although real object selections were reduced, the difference between common and uncommon substitutes remained. This demonstration of flexibility between the two experiments highlights the major differences observed in language learning situations. The context in which a word is learned may have implications for how well it is acquired or how receptive a child will be to accepting that word as a novel object.

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Appendix (p. 1 of 2)

Counterbalancing of Stimuli

Table A1 demonstrates the presentation of stimuli for each word and picture type. This is an example of one set of words and pictures presented. There were 12 sets in total. Each "accurate" and "nonword" production was heard twice by children. Each real object picture (e.g., "chick") was seen six times (Picture A). Each novel object picture (e.g., "nonobject 75," "nonobject 82") was seen three times (Picture B).

Table A1. Presentation of stimuli for each word and picture type.

Word type	Auditory stimuli	Picture A	Picture B
Accurate	[tʃɪk]	"Chick"	"Nonobject 75"
Common	[ʃɪk]	"Chick"	"Nonobject 75"
Nonword	[gim]	"Chick"	"Nonobject 75"
Accurate	[tʃɪk]	"Chick"	"Nonobject 82"
Uncommon	[fɪk]	"Chick"	"Nonobject 82"
Nonword	[gim]	"Chick"	"Nonobject 82"

Appendix (p. 1 of 2)

Counterbalancing of Stimuli

Since the MouseTracker software randomizes trials, it is possible that the dual occurrence of the accurate or nonwords could occur simultaneously. To remove this possibility, stimuli were balanced across two blocks, and the MouseTracker software was set to randomize within blocks only. Table A2 demonstrates the balancing of the set across two blocks.

Table A2. Balancing of the set across two blocks.

Word type	Auditory stimuli	Picture A	Picture B
Block 1			
Accurate	[tʃɪk]	"Chick"	"Nonobject 75"
Common	[ʃɪk]	"Chick"	"Nonobject 75"
Nonword	[gim]	"Chick"	"Nonobject 75"
Block 2			
Accurate	[tʃɪk]	"Chick"	"Nonobject 82"
Uncommon	[fɪk]	"Chick"	"Nonobject 82"
Nonword	[gim]	"Chick"	"Nonobject 82"

Figure A1 provides an example of how trials were organized and counterbalanced across blocks. The first column displays the International Phonetic Alphabet transcription of the auditory stimuli, and the second column represents the condition. The third column in each table represents the picture that appeared on the left of the screen, and the fourth column in each table represents the picture that appeared on the right side of the screen. As Figure A1 demonstrates, each accurate production and each nonword occurred once in each block. The nonobject pictures were counterbalanced between blocks across conditions and were counterbalanced on the side of the screen.

Figure A1. Example of how trials were organized and counterbalanced across blocks.

Block 1			
[tʃik]	Accurate	"chick"	"nonobject 75"
[fik]	Uncommon	"nonobject 75"	"chick"
[θɛp]	Nonword	"chick"	"nonobject 75"
Block 2			
[tʃik]	Accurate	"nonobject 79"	"chick"
[ʃik]	Common	"chick"	"nonobject 79"
[θɛp]	Nonword	"nonobject 79"	"chick"
Block 1			
[tʃik]	Accurate	"nonobject 79"	"chick"
[fik]	Uncommon	"chick"	"nonobject 79"
[θɛp]	Nonword	"nonobject 79"	"chick"
Block 2			
[tʃik]	Accurate	"chick"	"nonobject 75"
[ʃik]	Common	"nonobject 75"	"chick"
[θɛp]	Nonword	"chick"	"nonobject 75"
Block 1			
[tʃik]	Accurate	"chick"	"nonobject 79"
[ʃik]	Common	"nonobject 79"	"chick"
[θɛp]	Nonword	"chick"	"nonobject 79"
Block 2			
[tʃik]	Accurate	"nonobject 75"	"chick"
[fik]	Uncommon	"chick"	"nonobject 75"
[θɛp]	Nonword	"nonobject 75"	"chick"
Block 1			
[tʃik]	Accurate	"nonobject 75"	"chick"
[fik]	Uncommon	"chick"	"nonobject 75"
[θɛp]	Nonword	"nonobject 75"	"chick"
Block 2			
[tʃik]	Accurate	"chick"	"nonobject 79"
[ʃik]	Common	"nonobject 79"	"chick"
[θɛp]	Nonword	"chick"	"nonobject 79"

Block 1			
[tʃik]	Accurate	"nonobject 75"	"chick"
[fik]	Uncommon	"chick"	"nonobject 75"
[θɛp]	Nonword	"nonobject 75"	"chick"
Block 2			
[tʃik]	Accurate	"chick"	"nonobject 79"
[ʃik]	Common	"nonobject 79"	"chick"
[θɛp]	Nonword	"chick"	"nonobject 79"
Block 1			
[tʃik]	Accurate	"chick"	"nonobject 79"
[ʃik]	Common	"nonobject 79"	"chick"
[θɛp]	Nonword	"chick"	"nonobject 79"
Block 2			
[tʃik]	Accurate	"nonobject 75"	"chick"
[fik]	Uncommon	"chick"	"nonobject 75"
[θɛp]	Nonword	"nonobject 75"	"chick"
Block 1			
[tʃik]	Accurate	"nonobject 79"	~"chick"
[ʃik]	Common	"chick"	~"nonobject 79"
[θɛp]	Nonword	"nonobject 79"	~"chick"
Block 2			
[tʃik]	Accurate	~"chick"	~"nonobject 75"
[fik]	Uncommon	~"nonobject 75"	~"chick"
[θɛp]	Nonword	~"chick"	~"nonobject 75"
Block 1			
[tʃik]	Accurate	~"chick"	~"nonobject 75"
[fik]	Uncommon	~"nonobject 75"	~"chick"
[θɛp]	Nonword	~"chick"	~"nonobject 75"
Block 2			
[tʃik]	Accurate	~"nonobject 79"	~"chick"
[ʃik]	Common	~"chick"	~"nonobject 79"
[θɛp]	Nonword	~"nonobject 79"	~"chick"