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Do children's omissions leave traces?*

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ABSTRACT

When English-speaking two-year-olds begin producing polysyllabic words, they often omit unstressed syllables that precede syllables with primary stress (Allen & Hawkins, 1980; Klein, 1981; Gerken, 1994*a*). One proposed mechanism for these omissions is that children omit syllables at a phonological level, due to prosodic constraints that act on outputs. Under such accounts, it has been largely assumed that these syllables are simply missing, or deleted, from children's outputs. The present research consists of a pair of experiments that tested this assumption by investigating the acoustic properties of utterances manifesting or lacking weak initial syllable omissions. In the two experiments, 33 two-year-old children were asked to imitate sentences like 'He kissed *Lu*cinda' (often reduced as expected to a disyllabic trochaic form, e.g. 'He kissed _cinda') and 'He kissed Cindy'. Durations of each child's imitations were measured from the onset of the verb to the onset of the name, for each pair of sentences containing the reduced or unreduced disyllabic forms, for example, 'kissed _cinda' vs. 'kissed Cindy'. Our results yielded a significantly longer duration for the verb-onset to name-onset portion of sentences containing reduced '_cinda'-type names than for sentences with 'Cindy'-type names. This finding provides evidence that children do not completely delete weak syllables. Rather, the data from the phonetic analysis indicate that some prosodic trace exists of the omitted syllable.

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INTRODUCTION

Weak syllable omission is a well-studied property of child language (Allen & Hawkins, 1980; Klein, 1981; Gerken, 1991, 1994*a*, *b*, 1996; Peters & Menn, 1993; Wijnen, Krikhaar & den Os, 1994; Demuth, 1995, 1996; Demuth & Fee, 1995; Kehoe & Stoel-Gammon, 1997*a*, *b*). Young children between the ages of approximately 1;6 and 2;6 years often omit weak or unstressed syllables, especially those preceding primary stress, from monomorphemic words as well as from phrases. Examples of omissions are shown in 1a–b, below.

(1a) banána→nána
(1b) the mónkey→mónkey

What is the mechanism underlying these omissions? One possible mechanism concerns the acoustic and perceptual salience of syllables. For example, Echols and her colleagues have proposed that children have perceptual biases to notice stressed or word-final syllables in the input and to ignore pretonic weak syllables (Echols & Newport, 1992; Echols, 1993). Kehoe & Stoel-Gammon (1997*b*) also suggest that the phonetic content of some syllables cause them to be less salient and less robustly represented than other syllables. Under such salience proposals, weak syllables are omitted because they are less likely to be fully encoded in the first place. Thus, 'banana' is encoded as [nǽnə] or as an underspecified syllable plus [nǽnə].

Although a mechanism focusing on the acoustic or perceptual properties of syllables is consistent with the pattern of omissions observed, other properties of children's productions suggest that weak syllables are not entirely missing from early representations. First, individual variation is frequently attested, in which any given form may alternate between being produced in its entire lexical form and being reduced in some manner (e.g. [bənǽnə]∼[nǽnə]) (Wijnen *et al.*, 1994). This type of alternation often occurs in a short period of time (even within a few utterances). Second, Dutch and English data show that children omit portions of unstressed syllables from multisyllabic words and substitute them for or add them to the remaining syllables, as in [bǽnə] for 'banana', in which the vowel of the initial syllable is omitted, and the onset of the initial syllable is substituted for the onset of the second syllable (Allen & Hawkins, 1980; Fikkert, 1991; Echols, 1993). Third, research suggests that weak syllables occupying medial positions in utterances are omitted at different rates. For example, when children were asked to imitate the nonsense word in example 2, which has the same stress pattern as the English word 'cátamaràn,' they omitted the second weak syllable significantly more frequently than the first (Gerken, 1994*a*, *b*). Differential omissions of these syllables are not easily handled by perceptual accounts of omissions. Finally, comprehension studies show

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that children who fail to produce unstressed grammatical morphemes nevertheless perform better on the tasks when the utterances contain these morphemes (Shipley, Smith & Gleitman, 1969; Petretic & Tweney, 1977; Gerken, Landau & Remez, 1990; Gerken & McIntosh, 1993). Taken together, these results suggest that, although acoustic and perceptual properties of syllables may underlie some omissions, such a mechanism is not sufficient to account for the full range of omissions.

(2) zámpakasìs→zámpasìs

Another set of accounts for weak syllable omissions assumes that children have relatively adultlike representations of many of the words and phrases they attempt to produce. However, constraints on the phonological form of utterances prevent them from always achieving their intended targets. Phonological accounts generally focus on the concept of the prosodic foot. Specifically, it has been observed that while children are consistent in producing weak syllables that belong to a strong-weak, trochaic foot, they frequently omit weak syllables that do not belong to such a foot (Allen & Hawkins, 1980; Gerken, 1991, 1994*a*, *b*; Wijnen *et al.*, 1994; Demuth, 1995; Demuth & Fee, 1995; Kehoe & Stoel-Gammon, 1997*a*). Thus, the first weak syllable in example 2, above, belongs to a trochaic foot [zǽmpə], while the second weak syllable [kə] is unfooted (Gerken, 1994*a*, *b*; see Wijnen *et al.*, 1994 for similar examples in Dutch).

From this basic observation about the vulnerability of unfooted syllables, researchers have made a variety of specific proposals. Gerken (1991, 1994*a*, *b*) has proposed that young children apply a trochaic metrical template to their intended utterances, especially when utterance complexity is high. Demuth & Fee have proposed that children at the early stages of language attempt to produce minimal words, one form of which is a trochaic foot (Demuth & Fee, 1995; Demuth, 1996; Fee, 1996). This account was formalized by Demuth (1995) using Optimality Theory (Prince & Smolensky, 1993), in which well-formedness conditions act upon output representations of a word to yield the most optimal candidate, which is then produced.

Another Optimality Theoretic approach to weak syllable omissions was proposed by Pater & Paradis (1996) to account for weak syllable omissions both in w-S-w words as well as S-w-w words, the latter of which has come to be known as the 'elephant problem' for templatic theories. This analysis begins with Demuth & Fee's minimal word constraint and adds a maximum word and anchoring constraint favouring disyllabic words in which the final syllable is preserved. A third Optimality Theoretic account was proposed by Massar & Gerken (1998). This account addresses syllable omissions from phrases as well as from multisyllabic words. A key component of the Massar & Gerken model is its inclusion of zero syllables in the output

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representation. These syllables serve as placeholders in a prosodic representation, but they do not license segments. Finally, Kehoe & Stoel-Gammon (1997*b*) propose an account in which metrical templates and segmental factors of syllable structure work together to determine which syllables are omitted or retained in children's productions (also see Gerken, 1994*a*).

What all of the phonological accounts have in common is that they explain omissions at the level of phonology. In other words, these accounts assume that syllables not appearing in a phonetic transcript are missing from the child's linguistic output. For example, phonological accounts assume that there is no difference between an utterance like 3a, from which a determiner has been omitted, and one like 3b, in which a determiner was never intended.

(3a) Fido chased the cats.→Fido chased cats.
(3b) Fido chased cats.→Fido chased cats.

The present research tests this assumption by examining the acoustic properties of children's utterances exhibiting or not exhibiting weak syllable omissions. That is, we ask whether an utterance from which a weak syllable has been omitted is phonetically identical to one in which a weak syllable in the same phonetic environment was not in the target utterance in the first place. In particular, we consider two hypotheses.

The first we will call the STRUCTURE REDUCTION HYPOTHESIS, which is consistent with the assumption just outlined. For this discussion and to narrow the focus of the paper, let us consider simple trisyllabic words such as 'banána', which contain an unfooted syllable that is frequently omitted. Under the Structure Reduction Hypothesis, children impose a reduced prosodic structure on the lexical representation that structurally obeys a trochaic foot. In other words, children simplify their productions by deleting the entire unfooted syllable (the segmental content as well as the syllable structure encompassing it). If children do delete the entire syllable, then their representations of weak-strong-weak (w-s-w) words are at some point in production identical to the forms perceived by adult listeners. The template account proposed by Gerken, the minimal word accounts (both structural and OT) proposed by Demuth & Fee, and Pater & Paradis' size restriction and content preservation account are all variants of the hypothesis that children delete the entire syllable.

The second hypothesis to consider is that children do not entirely delete the unfooted syllable in question. Rather, they leave behind some measurable trace of the syllable. We will refer to this as the TRACE HYPOTHESIS. Under the Trace Hypothesis, children simplify their productions by omitting the segmental material of the unfooted syllable, in effect producing a form that

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is perceived to be identical to a s-w form. However, under this account, the syllable structure of the internal representations of w-s-w words is still manifest in the output, and it can be acoustically measured in the output of the form, perhaps as some type of compensatory lengthening of elements surrounding the omitted segmental content.

A useful tool we can draw on in discussing the Trace Hypothesis to explain the omission of segments but retention of the manifestation of the syllable structure is Autosegmental theory and the concept of phonological tiers (Goldsmith, 1976). Originally developed within phonology as an account for the correspondence between tones and segments that is not necessarily one-to-one, the main tenet of this theory is that different tiers exist in the prosodic hierarchy, including segments, syllables, feet, and prosodic words. For example, syllables reside on one tier and segmental content on another. In our model, a separation of levels in the phonology could possibly account for the omission of segments but the retention of the syllable structure governing those segments.

The idea of separate tiers has already been proposed to account for children's utterances (Menn, 1978; Stemberger, 1988; Echols, 1993). Echols (1993) suggested that young children's underlying representations may be fully specified at the level of the syllable tier, but only partially specified at the level of the segmental tier, in order to explain the phenomenon of substitutions such as [*b*ǽnə] for 'banana', which were noted as problematic for a perceptual account. A second piece of evidence for the separation of segmental and prosodic tiers in children's productions is the use of filler syllables by children. In Gleitman & Wanner's (1982) discussion of children's emerging ability to produce stressless syllables, they note that the first attempts usually take an undifferentiated form such as a schwa [ə]. For example, they showed that children produce the compound noun 'report card' as [ə- port kɑrd], replacing the unstressed, tense-vowel syllable 're' [ri] with a schwa [ə]. The prosodic structure of this word is retained, although the segmental content has been replaced.

The phenomenon of syllable omissions in these unfooted positions might very well be similar to filler syllables or substitutions in that the prosodic structure of the underlying representation remains despite the deletion of segmental content. Of the phonological accounts given above, the zero-syllable account proposed by Massar & Gerken (1998) and the integrated account of Kehoe & Stoel-Gammon (1997*b*) are consistent with the concept of a separation between suprasegmental and segmental representations. If the Trace Hypothesis is correct, we might expect to find some phonetic evidence for syllables that appear to be omitted based on transcription data. The experiments reported below were designed to further test the Trace Hypothesis through the collection of phonetic data.

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EXPERIMENT 1

Experiment 1 is a first attempt at exploring the possible existence and nature of a trace of omitted syllables. In order to compare the Structure Reduction Hypothesis to the Trace Hypothesis, we performed an instrumental phonetic analysis on sentences from which syllables were omitted from a trisyllabic word. By examining the phonetic durations of the reduced disyllabic forms and the elements in the surrounding sentential context, and comparing these durations to similar disyllabic forms with true trochaic stress patterns in their sentential context, we attempted to compare the Trace and Structure Reduction Hypotheses. If no difference were found between the two types of utterances, the Structure Reduction Hypothesis would be supported, whereas if a difference were found, the Trace Hypothesis would be supported. The main goal of Experiment 1 was to compare the predictions of these two hypotheses.

If the Trace Hypothesis is supported, we will need to consider rejecting or modifying the range of existing phonological accounts of weak syllable omissions. If these accounts are inadequate, what is the omission mechanism? In an attempt to explore that puzzle, we manipulated two additional variables to address two more minor hypotheses. First, if there is a difference in duration of the phonetic material surrounding the omission site, does it mirror a change in duration of the trace of the omitted syllables? More specifically, there are intrinsic duration differences between consonants with distinct manners of articulation and between vowels with different tense and stress assignments (Lehiste, 1970; Klatt, 1975, 1976). Therefore, would an inherent length difference in the syllable to be omitted be reflected in the trace of that omitted syllable? Second, do differences in the types of phonetic material surrounding the omission site influence the robustness of the trace of the omitted syllable? In particular, it has been noted that stressed syllables undergo a greater degree of contextually determined duration modification than unstressed syllables (Lehiste, 1970). Thus, if the syllable preceding the likely omission site is stressed, any phonetic modification of that syllable may be more robust than if the preceding syllable is unstressed. The experiment described below was designed to address these two exploratory questions as well.

METHOD

Participants

Fifty-one English-speaking children were recruited from the Tucson, Arizona community, but only twenty participated for reasons noted below. All participants were identified from archival records of birth announcements and ranged in age from 2;1 (year;months) to 2;7, with a mean age of 2;3. Each participant's mean length of utterance (MLU; Brown, 1973) was

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calculated based on the spontaneous speech that he or she produced during the experimental session. MLUs ranged from 1·30 to 3·51, with a mean of 2·28 morphemes. Data from 31 children were not included in the final analysis due to: bilingualism ($n=1$), failure to produce forms resembling the target stimuli in more than half of the trials ($n=1$), failure to speak at an audible volume ($n=1$), failure to imitate more than half of the sentences ($n=3$), failure to imitate in sentence form ($n=15$), and failure to imitate or speak at all ($n=10$). Children who were unable to imitate in sentence form or to speak at all tended to be the younger participants.

Stimulus materials

Children were asked to produce sentences with the structure *He+verb+name*. The names comprised two trisyllabic proper names with a w-s-w stress pattern ('Lucinda' and 'Cassandra') and two disyllabic s-w names ('Cindy' and 'Sandy'), such that the second syllable of a trisyllabic name was the same as the first syllable of the paired disyllabic name.[1] In addition to being near minimal word pairs, the proper names were chosen with one other issue in mind. The onsets of the stressed syllables in both the trisyllabic name and the disyllabic name must have phonetic characteristics that make it easy to identify in the waveform or spectrogram. No proper name minimal pairs could be found which contained a voiceless stop or affricate onset in the stressed syllable; therefore, the voiceless alveolar fricative /s/ was chosen as the stressed syllable onset of all four of the proper names. In this way also, both stressed onsets of the reduced forms were identical, which reduced the risk of any duration difference being affected in some way by the name onset.[2]

Each of the four names occurred with four different verbs, for a total of 16 sentences. The verbs were chosen to meet two criteria. First, they must be familiar to children as attested in various experiments by Gerken (1994*a*, *b*, 1996). Second, as with the proper names, verb onsets must be easily

[1] During testing, parents filled out a questionnaire asking whether any of the four proper names were familiar to the children. Sixteen of the parents answered none were familiar, two answered 'Sandy' was familiar, and one each answered that 'Cassandra' and 'Cindy' were.

[2] Although the name 'Cassandra' has the counterpart nickname 'Sandra' in addition to 'Sandy', it was decided that the disyllabic name 'Sandy' was preferable, for three reasons. First, 'Sandy' is minimally distinct from the anticipated reduced form '_sandra', thereby insuring that children would not simply be substituting the reduced name '_sandra' for the full disyllabic name 'Sandra'. Second, a form was chosen with an '-y' final syllable as children are adept at producing words ending in this syllable, thereby insuring their production of it. Finally, by using the two disyllabic nicknames 'Sandy' and 'Cindy', results for each would be more comparable than if one disyllabic name were identical to the reduced form and one were not.

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recognizable on a digitized waveform. To meet the latter criterion, each of the four verb onsets consisted of a voiceless stop or voiceless affricate ('push', 'kiss', 'touch', and 'chase'). Our main prediction was that, if children simply delete unfooted syllables and their segmental content, as predicted under the Syllable Reduction Hypothesis, the duration of the constant portion of the sentence (the verb onset to the name onset) should be equivalent in each member of the sentence pair. If, however, the omitted syllable has some phonetic status, as predicted by the Trace Hypothesis, the utterances containing the unpronounced weak syllable (e.g. '_cinda') should show a longer verb-to-name duration than those containing the original trochaic form (e.g. 'Cindy').

Recall that, if the Trace Hypothesis is supported, we can ask two supplementary questions. First, does the trace of an omitted syllable mirror the duration of the syllable? We included the two trisyllabic names and their disyllabic counterparts in an attempt to address this question. The initial syllable of 'Lucinda' contains a sonorant onset and a tense vowel, whereas the initial syllable of 'Cassandra' contains an obstruent onset and an unstressed schwa. Lax vowels, and specifically schwa, are inherently shorter than tense vowels. Likewise, an obstruent consonant such as /k/ is inherently shorter in duration than a sonorant consonant such as /l/ (Klatt, 1975, 1976). Given the likelihood therefore of a duration difference between these syllables when actually produced, we can also ask whether the difference in verb-to-name duration between '_cinda' and 'Cindy' is larger than the difference between '_sandra' and 'Sandy'. If it is, we would have evidence that the trace children leave is correlated with the duration of the syllable for which the trace exists.

The second question that is raised by support for the Trace Hypothesis concerns the prosodic domain in which traces are realized, or in other words, the locus of any compensatory lengthening. As a first pass at investigating this question, we were interested in knowing whether the domain of lengthening is the syllable that precedes the omitted syllable in these productions. In particular, sentences in which omission sites are preceded by stressed syllables might be more likely to reveal a trace of the omitted syllables than sentences in which the site is preceded by a weak syllable. To examine this possibility, one group of children ($n=8$) produced sentences in which the verb inflection was present tense '-es' and syllabic, while another ($n=12$) produced sentences with the non-syllabic past tense inflection '-ed.'

For each inflection condition, there were two different randomly ordered lists, such that eight of the sixteen sentences appeared in the first half of each list. This manipulation was made so that, if children became fatigued before completing the entire study, we would have productions of the sentences across the entire set. Examples of the stimulus sentences are given in Table 1.

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TABLE 1. *Sample stimuli sentences for disyllabic and trisyllabic proper names*

	Disyllabic target names	Trisyllabic target names
Monosyllabic verbs	He pushed Sandy.	He pushed Cassandra.
	He pushed Cindy.	He pushed Lucinda.
Disyllabic verbs	He pushes Sandy.	He pushes Cassandra.
	He pushes Cindy.	He pushes Lucinda.

To review, there were three factors of interest. The first and main factor was name prosody, that is, whether the target proper name was reducible ('Cassandra', 'Lucinda') or non-reducible ('Sandy', 'Cindy'). The second factor was name type, that is, whether the target name contained a tense vowel in the projected omitted syllable ('Lucinda', or '_cinda' once reduced) or a reduced vowel ('Cassandra', or '_sandra' once reduced). The third factor was verb syllable number, that is, whether the target verb was monosyllabic (non-syllabic '-ed' inflection) or disyllabic (syllabic '-es' inflection).

Procedure

Each child was brought into a quiet room of the University of Arizona Language Acquisition Lab by his or her caregiver(s) for one test session, which lasted approximately 45 minutes. The experimenter began by introducing toys and playing with the child until he or she appeared to feel comfortable. The experimenter proceeded to ask the child if he or she would like to play a game. If the child agreed, the experimenter introduced him/her to a stuffed animal bear puppet and four dolls, each corresponding to one of the four proper names of interest. Then the experimenter explained that in this game, the child would help make up stories to act out with the bear and dolls. If the child imitated the experimenter's story, then the bear would act it out. Once the child indicated that s/he understood the game, the experimenter began to produce the test sentences in the context of a story. For example, after an appropriate preamble, the experimenter would say, 'He kisses Cassandra. Can you say that? He kisses Cassandra.'

An independent transcription judge listened to a random sample of the recordings and determined that the experimenter produced consistent and audible weak initial syllables for each trisyllabic stimulus name. In addition, the duration measurements that were made on the experimenter's weak initial syllable portions of the trisyllabic names independently indicate that the experimenter consistently produced audible weak syllables. Furthermore, the independent judge measured the durations of a random sample of the verbs in the four different name contexts, and found no difference in the

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durations of each verb. These acoustic and perceptual measures indicate stability in the live-voice presentation of the stimuli.

If the child imitated the target sentence, then the bear puppet carried out the task, and the experimenter moved on to the next sentence. If the child did not respond, the experimenter would repeat the request up to two times and then move on to a new sentence. Missed items were presented again at the end of the game. Each child received all 16 items, unless it was clear that he or she would not complete the task.[3] Upon leaving the lab, each child was given a small book or puzzle.

RESULTS

Both transcription and acoustic data will be reported. All sessions were audiotaped in their entirety using a Sony DAT recorder (TCD-D8), which served as the basis for all acoustic analyses. Some children were also filmed with a Sony video recorder (Handycam CCD TR93 8mm). All responses to the test sentences were transcribed during the session by the experimenter. After the session, the sentences were transcribed from the audio or video record by the experimenter and checked by a second coder naïve to the purpose of the experiment. Ninety-three percent of the item transcriptions were agreed upon, and any disagreements about the transcriptions were discussed and resolved between the experimenter and the second coder.

Transcription data

Transcribed responses were coded as falling into one of five possible response categories. For disyllabic target names ('Sandy', 'Cindy'), responses were coded into Disyllabic Target Produced (the child correctly imitated the simple disyllabic trochaic name, 96%), and Other (4%). For trisyllabic target names ('Cassandra', 'Lucinda'), responses were coded into Trisyllabic Target Produced (the child correctly imitated the trisyllabic proper name, retaining the initial syllable, 15%), Initial Syllable Omitted (the child omitted the initial weak syllable from the trisyllabic target, 66%), and Other (19%). Each of the Other categories contained response failures and responses that resembled neither the target name nor the predicted initial syllable omission pattern. Specifically, forms in the Other categories differed from the target by two or more phonemes (e.g. [ʊsǽnət], [lúsə], [súnə]). The only exception was with cases of medial consonant-cluster reduction (e.g. [lusínə], [sǽndə]), which were included in their relevant categories. The categories on which this experiment focused are Disyllabic

[3] For three of the subjects, only eight utterances (half of the stimulus set) were collected due to the fact that they tired of the task or became reticent to continue.

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TABLE 2. *Percent of initial syllables omitted, by name type* (*tense vowel vs. schwa in omitted syllable*) *and verb syllable number* (*monosyllabic vs. disyllabic*) *for Experiments* 1 *and* 2

Name type	% Monosyllabic verbs	% Disyllabic verbs	Total (%)
Experiment 1			
% Lucinda (tense vowel)	16	20	36
% Cassandra (schwa vowel)	32	32	64
Total (%)	48	52	
Experiment 2			
% Lucinda (tense vowel)	14	22	36
% Cassandra (schwa vowel)	27	37	64
Total (%)	41	59	

Target Produced and Initial Syllable Omitted, because responses falling into these two categories form the near-minimal pairs that were relevant to the acoustic analysis.

A more detailed examination of the Initial Syllable Omitted category (Table 2) was performed to tease apart any effects of syllable number preceding the omitted syllable, or of name type, on omission rates. This analysis revealed that children omitted the initial syllable from 'Cassandra' (64%) more frequently than from 'Lucinda' (36%). A (2) verb syllable number × (2) name type ANOVA (with verb syllable number as the between-subjects factor and with name type as the within-subjects factor) showed a main effect of name type ($F(1, 18) = 13{\cdot}59$, $p < 0{\cdot}01$). This finding suggests that the difference between the two initial syllables 'Ca-' and 'Lu-' does affect the omission rate of the syllable. An examination of omission patterns within each child was also consistent with this observation. Thirteen of the twenty participants showed this pattern, while only two showed the reverse (and five omitted the initial syllable equally frequently).

The ANOVA, however, showed no main effect of verb syllable number ($F(1, 18) = 1{\cdot}63$, $p = 0{\cdot}22$). In fact, the percent of omissions was nearly equal between monosyllabic (48%) and disyllabic (52%) verb contexts. This may suggest that the number of syllables has no effect on responses. However, it might only suggest that the number of syllables has no effect on responses if the difference is morphological in nature. This issue will be addressed in Experiment 2.

Acoustic analysis

Acoustic analyses using the Macintosh software packages Signalyze (version 3.11) and SoundEdit 16 (version 2) were performed on the

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categories Disyllabic Target Produced and Initial Syllable Omitted. Each subject's sentences were digitized directly into computer sound files. A series of duration measurements was then taken from the onset of the verb to the onset of the proper name (including the pause if one existed). The rationale for taking duration measurements from the verb onset to the name onset was that the verb represents the constant element in each sentence pair, and by measuring the duration of the constant element between the minimal pairs, any difference in its duration is attributable to the omitted syllable. Reliability coding of the duration measurements yielded 86% agreement by a second coder within 25 msec. Any measurement differences greater than 25 msec. were resolved through replay and discussion with a third coder.

Since each of the four verbs contained either a voiceless stop or affricate onset, the phonetic burst was readily noticeable for most of the verbs in the waveforms. If the burst was not visible on the waveform, the experimenter counted the point at which the burst was auditorily detected as the onset. The onset of the proper name, which in the cases of both the non-reduced disyllabic forms ('Cindy', 'Sandy') and the reduced disyllabic forms ('_cinda', '_sandra') was /s/, was highly visible as energy in the waveforms of the utterances. For a portion of the participants in the disyllabic verb group, no silence existed between the verbs and the onsets of the proper names. In these cases, the word juncture was defined in one of two ways. Either the voicing contrast between the offset of the verb and the onset of the proper name was evident, or the midpoint of the consonant sequence was taken as the critical juncture between words.

Three analyses were performed on the verb-to-name durations between reduced ('_sandra', '_cinda') and non-reduced ('Sandy', 'Cindy') utterances. The first examined the prediction of the Trace Hypothesis that children would produce longer verb-to-name durations for utterances containing reduced names than for utterances containing non-reduced names. The second examined the possibility that any trace found in the first analysis would be more robust when the syllable preceding the omitted one was stressed (monosyllabic condition). The third analysis tested the possibility that the trace left for the first syllable in 'Lucinda' would be longer than the one left for the first syllable of 'Cassandra'.

In the first analysis, data from all 20 children were included. Seventeen of these 20 showed a longer verb-to-name duration for sentences containing the reduced '_cinda' and 'sandra' forms than for those containing the non-reduced 'Cindy' and 'Sandy' forms. Results are shown in Table 3. A (2) verb syllable number × (2) name prosody ANOVA (with verb syllable number as the between-subjects factor and with name prosody as the within-subjects factor) showed a main effect of name prosody ($F(1, 18) = 8{\cdot}84$, $p < 0{\cdot}01$). As predicted by the Trace Hypothesis, children's verb-to-name

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TABLE 3. *Mean verb-to-name durations (in msec.) and standard error for reduced and non-reduced names in monosyllabic and disyllabic verb contexts, for all 20 subjects*

	Reduced names (_sandra & _cinda)		Non-reduced names (Sandy & Cindy)	
	Mean duration	SE	Mean duration	SE
Monosyllabic verbs	480·91	32·63	399·19	20·24
Disyllabic verbs	627·31	52·64	555·60	34·05

durations were longer for reduced '_cinda' and '_sandra' forms (mean duration = 554·11 msec.) than for non-reduced 'Cindy' and 'Sandy' forms (mean duration = 477·40 msec.). The ANOVA also showed a main effect of verb syllable number ($F(1, 18) = 13·22$, $p < 0·01$). Verb-to-name durations were longer when the verbs contained two syllables (mean duration = 591·46 msec.) than when they contained one (mean duration = 440·05 msec.). Importantly, no interaction was found between name prosody and verb syllable number ($F(1, 18) = 0·04$, $p = 0·84$), indicating that children left traces of the omitted syllable regardless of whether verbs were monosyllabic or disyllabic.

Recall that we had predicted that children might leave a longer or more consistent trace when the preceding syllable was stressed (i.e. in sentences with monosyllabic verbs), a prediction that would have been manifest in a significant name prosody × verb syllable number interaction. It is possible that our verb syllable number manipulation was not effective because children frequently omitted the unstressed verb inflection on disyllabic verbs. To examine this possibility, we carried out a second analysis: a (2) verb syllable number × (2) name prosody ANOVA (with verb syllable number as the between-subjects factor and with name prosody as the within-subjects factor) on all of the data from the monosyllabic group (12 children) and the subset of data from the disyllabic group in which disyllabic verbs were produced with both syllables intact (seven children). There was no main effect of either name prosody ($F(1, 17) = 1·03$, $p = 0·33$) or verb syllable number ($F(1, 17) = 1·94$, $p = 0·18$) and no interaction ($F(1, 17) = 1·94$, $p = 0·18$). Although the interaction between verb syllable number and name prosody was not significant, we wanted to know whether the main effect of prosody could be found in each group of children separately. Therefore, we separated the data from the two groups (monosyllabic verbs and disyllabic verbs) and performed two different 1-way ANOVAs: name prosody (2). The ANOVA on the data from the 12 children in the monosyllabic group revealed a significant effect of name prosody ($F(1, 11) = 10·27$, $p < 0·01$), consistent with the original 2-way ANOVA. The ANOVA

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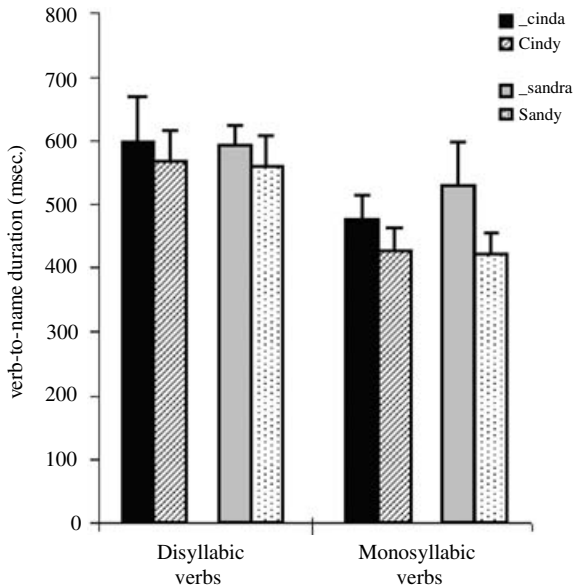


Fig. 1. Mean verb-to-name durations (in msec.) between reduced and non-reduced forms separated by name type and verb syllable number, for 14 subjects who omitted syllables from both name and verb contexts. Error bars shown represent standard error.

on the subset of data from the seven children in the disyllabic group who preserved the full disyllabic forms showed no main effect of name prosody ($F(1, 6) = 0{\cdot}03$, $p = 0{\cdot}88$). This pattern of results suggests that traces of omitted syllables may in fact be more observable when the preceding syllable is stressed. However, the fact that we could only examine a reduced subset of the data for disyllabic verbs makes this interpretation very tenuous. We will return to the possible effect of verb syllable number below.

The third analysis consisted of a (2) verb syllable number × (2) name prosody × (2) name type ANOVA (with verb syllable number as the between-subjects factor and with name prosody and name type as the within-subjects factors) that was performed on the verb-to-name duration data from just the 14 children who omitted syllables from both names. Results are shown in Figure 1. Consistent with the first analysis, there was a significant main effect of name prosody ($F(1, 12) = 6{\cdot}12$, $p < 0{\cdot}05$), and a marginal main effect of verb syllable number ($F(1, 12) = 4{\cdot}34$, $p < 0{\cdot}06$). However, there was no main effect of name type ('cinda' vs. '_sandra'). That is, there was no significant verb-to-name difference between '_cinda', in which the omitted syllable had a sonorant onset and a tense vowel, and '_sandra', in which the omitted syllable contained an obstruent onset and a schwa vowel. None of the interactions were significant (all F's < 1).

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DISCUSSION

In summary, Experiment 1 yielded three results of interest. In the analysis of the transcription data, children omitted the initial syllable of 'Cassandra' more frequently than of 'Lucinda'. The reason for this difference may concern some phonological aspect of the weak initial syllables of these two names. For example, the vowel in 'Lu-' carries secondary stress, whereas the schwa in 'Ca-' is a reduced, unstressed vowel. Such a factor may make 'Ca-' a more likely candidate for omission than 'Lu-', since it is possible that the tense vowel of 'Lu-' may provide an easier phonological target for young children to reproduce in their phonetic output than a schwa. However, while a significant difference was found in the omission rates of the two initial syllables, the acoustic analysis failed to show any difference in verb-to-name durations between forms with the omitted syllables 'Ca-' and 'Lu-'. The issue of a difference in rate of omissions, as well as the disjunction of transcription data and acoustic data, will be addressed in the General Discussion.

The second, and most important, finding was the significant difference in the verb-to-name duration that we found between sentences containing reduced disyllabic names ('_sandra', '_cinda') and non-reduced disyllabic names ('Sandy', 'Cindy'). This difference suggests that children did in fact leave a phonetic trace of the syllables coded as omitted in the transcription data. The trace was found regardless of whether verbs were monosyllabic or disyllabic. This finding refutes the Structure Reduction Hypothesis, and supports the Trace Hypothesis.

Third, when we looked at only complete productions of the verb by children in the disyllabic group and performed separate ANOVAs on the monosyllabic and disyllabic group data, the effect of name prosody was present for the monosyllabic group but was absent for the disyllabic group. This result suggests that traces may be more observable when the preceding syllable is stressed. However, it is difficult to determine whether there was in fact an effect of verb syllable number because many of the inflections were omitted, yielding only 60% of the children's productions that could be examined in the follow-up analysis. Experiment 2 was designed to examine the possibility of such an effect, using less problematic materials.

EXPERIMENT 2

The results from Experiment 1 created the basis for further study of weak syllable omissions. The first purpose of Experiment 2 was to replicate the main result of Experiment 1, that is, the effect of name prosody. The second goal was to determine if the effect of name prosody really is attenuated in utterances with disyllabic verbs, given the tenuous nature of the verb syllable number results reported in Experiment 1. Two changes were made

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to the design in order to address this goal. First, disyllabic and monosyllabic verb stimuli were presented to each subject in order to compare the results directly within each child, as opposed to across groups. In addition, the monosyllabic and disyllabic verbs were monomorphemic, in order to decrease the chance of inflection deletion and to rule out any confound from morphology.

METHOD

Participants

Thirty English-speaking children were recruited from the Tucson, Arizona community, but only thirteen participated for reasons noted below. The children ranged in age from 2;3 to 2;10, with a mean age of 2;5. We targeted slightly older participants in Experiment 2 than Experiment 1, due to the more frequent failure of children under 2;3 to imitate some or all of the sentences in the earlier experiment. MLUs ranged from 1·65 to 3·70, with a mean of 2·24 morphemes. Data from 17 participants were not included in the final analysis due to: bilingualism ($n=1$), evidence of a language or speech disorder ($n=2$), production of only complete forms (i.e., no syllable omissions, $n=7$), failure to imitate more than half of the sentences ($n=1$), and failure to imitate or speak at all in the experiment ($n=6$).

Stimulus materials

Stimuli in this experiment were 32 randomly ordered sentences similar in form to those in the first study. The sentence list was expanded in Experiment 2 to comprise eight verbs, each used with the four proper names from Experiment 1 ('Cassandra', 'Sandy', 'Lucinda', 'Cindy'). Half of the verbs were monomorphemic and monosyllabic (e.g. 'pat') and half were monomorphemic and disyllabic (e.g. 'carry'). Verbs were chosen on the basis of frequency (high frequency), familiarity to children (as young as two years of age), and the following phonetic properties. First, the verbs each must contain a stop or fricative onset in order to facilitate recognition in the waveform for proper duration measurements. Second, each verb must also contain a stop, sonorant or tense vowel offset, in order to be maximally distinct from the following strident proper name onset. The form of the carrier phrase was simplified from a three-word declarative sequence to a two-word sequence of an imperative verb followed by a proper name.[4]

[4] This change was due to the nature of the original dissertation study: individuals from two clinical populations participated in a similar task. In a pilot probe, a subset of the participants with aphasia were unable to repeat more than two-word combinations, therefore, the sentences were shortened in order to keep the task identical between population conditions.

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Similar to Experiment 1, the three within-subjects factors we manipulated were name prosody (reducible versus non-reducible), verb syllable number (monosyllabic versus disyllabic) and name type (tense vowel versus reduced vowel in the projected omitted syllable).

Procedure

This study was performed in the same manner as Experiment 1, with one small difference. To make the increased number of test items more interesting to the children, five different stuffed animals were introduced to the child and were used in place of the single bear puppet. Also, in order to elicit the imperative forms of the verb, the experimenter told each participant that in order to act out the story, the participant and experimenter would direct the animals to carry out their relevant tasks. For example, after an appropriate preamble, the experimenter would say 'Tell the zebra to pat Cassandra. Can you say that? Pat Cassandra.' Each child received all 32 items, and upon leaving the lab, each child was given a small book or puzzle.[5]

RESULTS

All sessions were audiotaped in their entirety using a portable Sony DAT recorder (TCD-D8) and a Sony video recorder (Handycam CCD TR93 8mm). As in Experiment 1, all responses to the test sentences were transcribed during the session by the experimenter. After the session, the sentences were transcribed from the audio or video record by the experimenter and a second coder. Ninety-eight percent of the item transcriptions were agreed upon, and any disagreements about the transcriptions were resolved between the experimenter and the second coder.

Transcription data

Transcribed responses were coded as falling into one of the five possible response categories identical to those in Experiment 1. For disyllabic target names, responses were coded into Disyllabic Target Produced (94%) and Other (6%). For trisyllabic target names, responses were coded into Trisyllabic Target Produced (23%), Initial Syllable Omitted (52%), and Other (25%).

A detailed examination of the Initial Syllable Omitted category was performed as in Experiment 1 with the factors name type (tense vowel versus schwa in the projected omitted syllable) and verb syllable number (monosyllabic vs. disyllabic). Results are shown in Table 2. A (2) name

[5] For two of the subjects, only 16 utterances (half of the stimulus set) were collected.

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type × (2) verb syllable number ANOVA with name type and verb syllable number as within-subjects factors revealed a significant main effect of name type, consistent with Experiment 1 ($F(1, 13) = 7{\cdot}74$, $p < 0{\cdot}05$). Consistent with Experiment 1, children omitted the initial syllable from 'Cassandra' (64%) more frequently than from 'Lucinda' (36%). Nine of the thirteen participants showed this pattern, compared to one who showed the reverse (and three who omitted the initial syllable equally frequently).

With regard to verb syllable number, children omitted the initial syllable in disyllabic verb contexts (59%) more frequently than in monosyllabic verb contexts (41%). The 2-way ANOVA revealed this difference to be significant ($F(1, 12) = 8{\cdot}14$, $p < 0{\cdot}05$). An effect of verb syllable number was not found in Experiment 1, however, this finding in Experiment 2 is consistent with previous studies, in which syllable number has been shown to affect omission rate (Blasdell & Jensen, 1970; Valian, 1991; Gerken, 1996). Eleven of the thirteen participants showed this pattern, while one child showed the contrasting pattern, and one child omitted the initial syllable equally frequently in monosyllabic and disyllabic verb contexts. The interaction between name type and verb syllable number was not significant ($F(1, 12) = 0{\cdot}24$, $p = 0{\cdot}63$).

Acoustic analysis

Acoustic analyses using SoundEdit 16 (version 2) were performed on the categories Disyllabic Target Produced and Initial Syllable Omitted, in an identical manner to Experiment 1. Reliability coding yielded 85% agreement by a second coder within 25 msec. Any measurement differences greater than 25 msec. were resolved through replay and a third coder.

Two analyses were performed on the verb-to-name durations between reduced and non-reduced utterances. The first analysis was an attempt at replicating the main finding of Experiment 1 (main effect of name prosody). Twelve of the thirteen participants showed a longer verb-to-name duration for sentences containing the reduced '_cinda' and '_sandra' forms than for those containing the non-reduced 'Cindy' and 'Sandy' forms. Ten of the thirteen children omitted initial syllables in both monosyllabic and disyllabic verb contexts, and the data from these 10 children were subjected to a (2) name prosody × (2) verb syllable number ANOVA with name prosody and verb syllable number as within-subjects factors. The ANOVA showed children's verb-to-name durations to be significantly longer for reduced '_cinda' and '_sandra' forms (mean duration = 524·66 msec.) than for non-reduced 'Cindy' and 'Sandy' forms (mean duration = 433·29 msec.; $F(1, 9) = 14{\cdot}62$, $p < 0{\cdot}01$). Results are shown in Table 4. This finding replicates the main finding of Experiment 1 and provides further evidence for the Trace Hypothesis. No main effect of verb syllable number ($F(1, 9) = 0{\cdot}23$, $p = 0{\cdot}64$) and no interaction ($F(1, 9) = 1{\cdot}10$, $p = 0{\cdot}32$) were found,

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TABLE 4. *Mean verb-to-name durations (in msec.) and standard error for reduced and non-reduced names in monosyllabic and disyllabic verb contexts, for 10 participants who omitted initial syllables in monosyllabic and disyllabic verb contexts*

	Reduced names (_sandra & _cinda)		Non-reduced names (Sandy & Cindy)	
	Mean duration	SE	Mean duration	SE
Monosyllabic verbs	521·51	71·27	412·92	42·15
Disyllabic verbs	527·81	33·03	453·66	28·94

indicating that there was no difference in verb-to-name durations between sentences containing a monosyllabic verb or a disyllabic verb.

As in Experiment 1, in order to ascertain whether the acoustic trace we found is correlated with the duration of the syllable for which the trace exists, we examined the difference in trace duration between the two name types. The data from just the eight children who omitted syllables from both names and in both verb contexts were subjected to a (2) name prosody × (2) verb syllable number × (2) name type ANOVA with name prosody, verb syllable number, and name type as within-subjects factors. Figure 2 shows the results from this analysis. Consistent with the analysis of the acoustic data, the ANOVA revealed a significant effect of name prosody on verb-to-name durations ($F(1, 7) = 9{\cdot}16$, $p < 0{\cdot}05$), such that verb-to-name durations were longer for reduced than for nonreduced names. Also consistent with the first analysis, there was no main effect of verb syllable number, suggesting that the acoustic trace is not exaggerated when following a monosyllabic verb. No main effect of name type ('_cinda' vs. '_sandra') was found, indicating that, as in Experiment 1, there was no significant verb-to-name difference between '_cinda' utterances (in which the omitted syllable contains a tense vowel and sonorant onset) and '_sandra' utterances (in which the omitted syllable contains a schwa and obstruent onset). None of the interactions were significant (all F's < 1).

SUMMARY

In sum, there were two goals of Experiment 2. The first goal was to replicate the main phonetic finding of Experiment 1: that utterances containing reduced disyllabic proper names yield longer verb-to-name durations than utterances containing their trochaic counterparts. This important result was replicated in Experiment 2, and we interpret this finding to mean that the children left an acoustic trace of the syllables that were coded as omitted in

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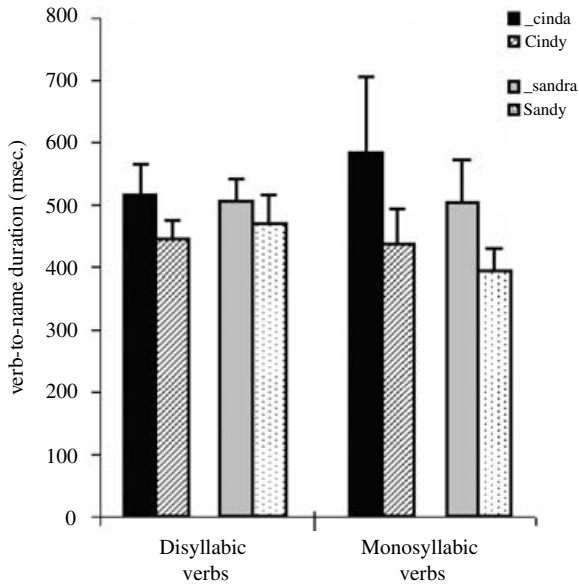


Fig. 2. Mean verb-to-name durations (in msec.) between reduced and non-reduced forms separated by name type and verb syllable number, for 8 subjects who omitted syllables from both name and verb contexts. Error bars shown represent standard error.

the transcription data. Additionally, the lack of a main effect of name type ('Lu-' vs. 'Ca-') on verb-to-name durations was also replicated. Combined, the results from the two experiments support the Trace Hypothesis, in which children do not delete a weak initial syllable in its entirety, but instead leave a measurable trace of a generic length that is not affected by the segmental material of the syllable.

The second purpose of Experiment 2 was to investigate the effect of verb syllable number and to determine if the effect of name prosody really is attenuated in utterances with disyllabic verbs. There was a significant effect of name prosody with both monosyllabic and disyllabic verbs, and no difference was found in verb-to-name durations with regard to verb syllable number. Taken together, these findings indicate that the effect is not attenuated when the syllable preceding the name is unstressed. Interestingly, an effect of verb syllable number did exist on omission rates of the initial weak syllable. Consistent with previous studies, children omitted initial syllables in disyllabic verb contexts significantly more often than they omitted initial syllables in monosyllabic verb contexts. This finding was absent in Experiment 1. This disjunction may be due to the morphological nature of the verbs. In Experiment 1, verbs were polymorphemic, and 40% of the disyllabic verbs were reduced by the children to a monosyllable.

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However, in Experiment 2, we employed monomorphemic verbs, and only 16% of disyllabic verbs were reduced to a single syllable.

GENERAL DISCUSSION

Let us review why phonetic data were collected initially in Experiments 1 and 2. A number of theoretical accounts of the phenomenon of weak syllable omissions exist in the current literature. Although these accounts differ from each other in several ways, they all assume that weak syllables that do not appear in transcriptions have truly been deleted. The question we asked in the current research was: is an utterance from which a weak syllable has been omitted phonetically identical to an utterance in which a weak syllable in the same phonetic environment never existed in the target? The two experiments we have presented revealed data that may help answer this question. We will discuss five specific aspects of our findings and their implications. Three aspects are related to the acoustic analyses and two to the omission rate analyses.

The main acoustic effect and focus of the study was the effect of name prosody, which was strongly present in both experiments and suggests that a measurable acoustic trace of the syllable that is omitted does in fact exist in the utterance. This finding indicates in turn that children do not completely delete syllables, and that they do have at least a partial representation of the adult word form. Of course, our data do not eliminate the possibility that some of children's omissions reflect an impoverished representation. Importantly, data from the children who alternate between non-reduced and reduced trisyllabic proper names would seem to be consistent with this view.

The strong effect of name prosody in both experiments supports the Trace Hypothesis, thereby casting doubt on an important assumption common to most accounts of children's weak syllable omissions, namely that syllables transcribed as omitted are truly missing. If these syllables in fact leave an acoustic trace, purely phonological accounts of omissions cannot be completely accurate. What then is the omission mechanism? We included two additional manipulations to explore it. Unfortunately, both yielded null results, making it difficult to draw any firm conclusions. Let us, however, consider each manipulation and what the null results might say about future research.

The first exploratory manipulation was name type ('Lucinda' vs. 'Cassandra'). We predicted that, if children's acoustic traces were correlated with the duration of the omitted syllable, the trace for 'Lucinda' would be longer than the one for 'Cassandra'. The lack of a significant effect of name type might be taken to indicate that, consistent with Autosegmental Theory, some higher level in the phonological representation

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higher than the segment (e.g. the syllable) is what is reflected by children's acoustic traces. However, another interpretation of the null result is that the syllables we chose are not in fact sufficiently distinct in length when actually produced to yield a reliable difference in trace length. To examine this possibility, we performed two subsidiary analyses. First, we examined the lengths of a random subset of the two syllables [lu] and [kə] produced by the experimenter in each carrier phrase of Experiment 2. A two-tailed t-test revealed a significant difference ($t(6) = 2{\cdot}74$, $p < 0{\cdot}05$). This result suggests that the model for children's productions of the two names manifest the intended properties.

We then examined the small number of utterance pairs in which a child produced the full trisyllabic version of both names in the same carrier phrase (e.g. 'Follow Lucinda,' 'Follow Cassandra'). Of the eight such pairs that existed, children produced [lu] with a longer duration than [kə] in five and showed the opposite pattern of durations in three. These results suggest that children may not produce the same length difference for the initial syllables of 'Lucinda' and 'Cassandra' that the adult experimenter did. The lack of a length difference in the actual child-produced syllables makes it impossible to interpret the lack of a duration difference in their acoustic traces. Future studies must attempt to identify pairs of syllables that children do produce with distinct durations and then measure the traces of these syllables when they are omitted.

The second exploratory manipulation was of verb syllable number. It was undertaken to investigate whether the effect of name prosody really is attenuated in utterances with disyllabic verbs. The lack of an effect of verb syllable number would seem to indicate that the acoustic trace exists regardless of the metrical assignment of the syllable preceding the omitted syllable (stressed or unstressed). That is, we did not observe a longer trace for a stressed syllable preceding the omission site than for an unstressed syllable, as evidenced by the findings in light of procedural changes made to Experiment 2. The somewhat confusing results from the first study may be attributed to a high rate of inflection deletion, or confounds from morphology. If the prosodic domain of compensatory lengthening is not the stressed syllable, then the question remains as to what is the domain. One possibility is that it is the preceding phonological word, a second is that it is the preceding foot, and a third is that children simply mark the omitted syllable with a pause between verb and name. Additional acoustic analyses did not yield any conclusive data as to the domain of lengthening. In fact, there was considerable variability among individuals. For example, certain children produced a longer pause before omitted syllables than before their trochaic counterparts, while others produced no pause at all. Future studies will be necessary to answer this question more satisfactorily.

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Two other aspects of our findings relate to the omission rate analyses from the transcription data. These analyses were also conducted in order to bring to light information that might bear on the omission mechanism at work behind syllable omissions. Results from the omission rate analyses indicate that both the name type and verb syllable number factors affected the rate at which weak syllables are omitted. With respect to name type, we found in both experiments that the initial syllable of 'Cassandra' was omitted significantly more frequently than the first syllable of 'Lucinda'. The difference in omission rate of these syllables might appear paradoxical, given the lack of an effect of name type on trace duration. Based on other research, we can currently suggest one solution to this apparent paradox. Kehoe & Stoel-Gammon (1996) and Carter & Gerken (2003) report instances of children who appear to shift stress to an initial weak syllable in order to retain it in their production. Similarly, Goffman & Malin (1999) report that the kinematic traces of four-year-olds' productions of unstressed initial syllables have the same or higher movement amplitude as their productions of initial stressed syllables. Taken together, these data suggest that one developmental path for children attempting to master the production of weak initial syllables is to give them some acoustic properties of stressed syllables. Furthermore, initial syllables with tense vowels appear to be more likely to be targeted for stress shift than syllables with lax vowels (Carter & Gerken, 2003). Perhaps children of the ages studied in the current experiments were more likely to employ the production strategy of attempting to stress the initial syllable of 'Lucinda' than the initial syllable of 'Cassandra'. Such a difference in strategy could have led to the greater number of trisyllabic productions of 'Lucinda' than 'Cassandra'. Note that this production strategy could affect the number of syllables successfully produced, but not affect the trace durations of syllables when they were not produced.

The verb syllable number manipulation also affected omission rate, at least in Experiment 2. In that experiment, omission rates were higher for the weak initial syllable of the name when it was preceded by a disyllabic verb than when it was preceded by a monosyllabic verb. This finding was not present in Experiment 1, however the lack of an effect of verb syllable number probably reflects the high proportion of omitted inflections, which resulted in monosyllabic verb forms. In addition to the possibility that a greater number of syllables in the utterance affected initial syllable omissions, it is possible that the finding was due to the more local effect of two adjacent weak syllables. As was shown by Gerken (1994*a*, *b*), if there are two adjacent weak syllables in a word or utterance, children often omit one of them. In Experiments 1–2, the trochaic disyllabic verbs created this type of adjacent weak syllable combination with the initial weak syllable of the proper name. In either case, the combination of the disyllabic trochaic

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verb and proper name yielded a difference in percent of omissions from the monosyllabic verb and proper name. Taken together, the transcription data point to various local and global factors that appear to play a role in the mechanism behind weak initial syllable omissions.

Although the current research does not offer a clear mechanism to explain children's weak syllable omissions, it suggests that phonological accounts of omissions, in which syllables that are not transcribed are entirely missing from the output, must be modified to accommodate these new phonetic data. The finding that some trace exists of the syllable that has been omitted indicates importantly that phonological accounts may miss an aspect of the production component in children's utterances that are not identical to the adult target output. A syllable that is perceived to be omitted seems instead to be represented (to some extent) in the child's internal representation, and manifest in the timing of the child's utterance. In addition, various factors seem to dictate the extent to which a certain initial weak syllable is omitted, including segmental, metrical, or positional factors.

A final issue to consider is whether the fact that our data come from sentence imitation, and not spontaneous speech, influence their generalizability. Obviously, instrumental measures of the type employed in the current research would be quite difficult, if not impossible, to perform on spontaneous speech, in which the possible omission site is located internal to the utterances and surrounded by material identifiable on a waveform. There is evidence that children perform differently in imitation tasks than in spontaneous speech (Kresheck & Socolofsky, 1972; Slobin & Welsh, 1973; Leonard, Schwartz, Folger & Wilcox, 1978; Leonard, Fey & Newhoff, 1981). Other data suggest that important properties of children's utterances are the same under both spontaneous and imitative conditions (e.g. Brown, 1973; Valian, 1991; Gerken, 1994*a*). Furthermore, many of the claims about omissions are based on imitation data (Gerken, 1991, 1994*a*, 1996; Kehoe, 1995; Kehoe & Stoel-Gammon, 1997*a*, *b*; Paradis, 2001). Taken together, these observations about the relation of spontaneous and imitative speech suggest that the conclusions drawn in the present research are noteworthy.

In sum, the present research leads us to conclude that children do leave a measurable phonetic trace of the syllables that they omit. This trace that is left does not appear to be correlated with the duration of the specific syllable it represents, but instead is possibly of some standard length independent of the segmental information. The trace also appears to exist regardless of whether or not a stressed or stressless syllable precedes the site of omission. To explore and come to understand the mechanism behind syllable omissions more completely, and behind the trace that is left when syllables are omitted, further research is necessary. For the moment, however, these experiments highlight the additional information that phonetic analyses can

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give to phonological analyses of children's production errors. In addition, this research opens the door onto future studies of the mechanism involved when children seemingly delete syllables in their utterances.

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