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BRIEF RESEARCH REPORT

Preferential use of full glottal stops in vowel-initial glottalization in child speech: Evidence from novel words

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Abstract

Vowel-initial glottalization constitutes a cue to prosodic prominence, realized on a strength continuum from creaky phonation to complete glottal stops. While there is considerable research on children's early utilization of acoustic cues for stress marking, less is understood about the specific implementation of vowel-initial glottalization in American English. Eight sequences of function + novel words were elicited from groups of 5-to-8-year-olds, 8-to-11-year-olds, and adults. Children exhibit a similar rate of prevocalic glottalization to adults but differ in its phonetic implementation, producing a higher rate of glottal stops compared to creaky phonation with respect to adults.

Keywords: vowel-initial glottalization; glottal stops; creaky phonation

Introduction

Vowel-initial glottalization counts as a prominence-lending strategy associated with phrase-initial positions, stress, and pitch accents (Bird & Garellek, 2019; Davidson & Erker, 2014; Dilley et al., 1996; Garellek, 2014, 2022; Malisz et al., 2013; Pompino-Marschall & Żygis, 2010). Crucially, vowel-initial glottalization can be implemented with a full glottal stop or with a period of creaky phonation. Studies on the phonetic realization of vowel-initial glottalization, however, suggest that glottalization is seldom produced with full glottal closure, and creaky phonation appears to be used instead (Davidson & Erker, 2014; Garellek, 2012; Malisz et al., 2013). From an articulatory perspective, both complete glottal stops and creaky phonation involve a constriction in the glottis. Glottal stops are produced with a complete abduction of the vocal folds impeding air from passing through the glottis. In contrast, creaky phonation is realized with vocal folds that are abducted and thickened but still permit the passage of air through the glottis (Esling et al., 2019). These two manners of constriction share an articulatory space, and thus can be represented on a continuum of glottal stricture (Davidson, 2021b; Garellek, 2019; Garellek et al., 2021). On this continuum, creaky voice falls between modal phonation with a larger average vocal fold opening and full glottal stops with the smallest average opening. This continuum helps us model creaky phonation as a weaker form of glottal constriction when compared to complete glottal stops and is evident in how vowel-initial glottalization reflects varying degrees of prosodic prominence strength, by which creaky phonation is the 'weaker' implementation and a complete glottal stop is the 'stronger' realization (Garellek et al., 2021, p.308). The phonetic implementation of prominence-lending glottalization could, thus, depend on the strength of the prosodic boundary or the relative prominence of the word, with greater rates of full glottal stops appearing in higher boundaries and stronger syllables (Davidson, 2021a, p.78). For adult speech, corpus and experimental studies support a strength scale in prevocalic glottalization favoring full glottal stops in stronger contexts. For instance, Davidson and Erker (2014) found that, in vowel-to-vowel sequences, full glottal stops occurred more frequently when the second vowel was stressed than when it was unstressed. Nevertheless, given the frequent use of creaky phonation at word boundaries to indicate prosodic prominence, the question remains whether the target of vowel-initial glottalization is creaky phonation or a complete glottal stop. In this respect, data from acquisition, which are largely missing, could continue to provide evidence on both use and development of creaky phonation and complete glottal stops.

Acquisition of prominence

Vowel-initial glottalization has been rarely examined as part of the development of prosodic prominence. However, enough research has been conducted on the use of fundamental frequency (f0), intensity, and duration as cues to prominence in child speech. Stress marking is developed early. Prelinguistic English-acquiring infants are shown to make acoustic distinctions in f0, intensity, and duration between stressed and unstressed syllables in their babbling before acquiring lexical items (Davis et al., 2000). Studies examining the realization of stress mostly show that children acoustically differentiate between stressed and unstressed syllables, but they do not make adult-like use of the stress correlates, with duration being the first correlate to acquire. For example, in a two-syllable novel word repetition task, Pollock et al. (1993) found that, while 2-year-olds used only longer duration in stressed syllables, 3- and 4-year-olds were able to mark stress with duration, f0, and intensity. Kehoe et al. (1995), on the contrary, found that children aged 18-to-30 months were able to control f0, intensity, and duration to mark stress, with the acoustic cue of intensity increasing with age. Schwartz et al. (1996) found that 2-year-olds marked stressed and unstressed syllables distinctively. When compared to adults, however, the distinction between stressed and unstressed syllables was smaller in the children than in the adults for all the acoustic correlates. Further studies on higher prosodic domains show that prosodic control continues to develop during childhood. In a study on listeners' judgements of contrastive stress placement of speech produced by 4-,7-, and 11-year-olds, Patel and Brayton (2009), found that adult American English listeners were more accurate at identifying contrastive stress for 11-year-old (84.3%, *SD* = 9.2%) and 7-year-old productions (84.4%, *SD* = 7.5%) when compared to 4 year-old productions (50.3%, *SD* = 4.8%). Four-year-olds mostly relied on duration to mark contrastive stress, while older children relied on multiple cues. Similarly, Grigos and Patel (2010) provide articulatory evidence using a facial capture system (i.e., jaw, lower lip, upper lip) that, while adults realized focused words with greater movement duration, displacement, and velocity than unfocused words, these differences were not as consistent in the 7- and 11-year-olds and were nonsignificant in the 4 -year-olds. Overall, this suggests that sentence-level prosodic control is developed approximately from the age of 7 and continues to be refined during late childhood and adolescence. Regarding the use of vowel-initial glottalization, these results suggest that children may continue to acquire glottalization as a cue to mark prosodic prominence past early childhood.

Glottalization in child speech

While research on the role of vowel-initial glottalization as a marker of prominence remains limited, I discuss findings on the broader use of glottalization and glottal stops in child speech in this section. During the first year of life, babies produce constricted voice quality parameters, which then decrease according to the language-specific characteristics as infants explore unconstricted voice quality settings (Benner et al., 2007). Overall, Benner et al. (2007) found a significant correlation between age group and laryngeal constriction irrespective of language (i.e., English, Arabic, or Bai). In English, a language that does not use laryngeal constriction contrastively, the rates of constriction decreased from 68% (1-3 months), 61% (4-6 months), to 45% (7-9 months) and slightly increased to 49% (10-12 months) (Benner et al., 2007). At the stage of consonantal acquisition, although not pervasive, glottal stops have been found to be used as replacements for non-acquired consonants in English (Gildersleeve-Neumann et al., 2008; James, 2001).

During the acquisition of multi-word utterances, children may undergo a period of increased use of glottalization as they develop motor control skills and master intergestural relationships between segments across word junctures. For example, Newton (2002) found that an English-acquiring child between the ages of 2;4 and 3;4 years presented glottalization in connected speech processes such as liaison, assimilation, and elision (e.g., [niʔkʊein] for 'need crane', [lɔʔbɜti] for 'lost Bertie', and [hiʔin] for 'he in'), with most connected speech processes showing adult-like patterns around the age of three. During the school-age period, children show similar rates of vowel-initial glottalization compared to adults, with stressed syllables presenting more glottalization than unstressed vowels (Repiso-Puigdelliura, 2023). However, Repiso-Puigdelliura (2023) focused only on highly frequent words (e.g., apple, island, avocado, umbrella), suggesting that children might have relied on stored representations of function word + content word chunks.

Moreover, although English-speaking children exhibit similarities to adults in their use of vowel-initial glottalization, there may still be distinctions in the phonetic implementation of glottalization given a potential exposure to a greater rate of complete glottal stops during language acquisition. Child-directed speech is reported to be hyperarticulated compared to adult directed speech, demonstrating enhanced sound and prosodic categories, such as vowel space expansion, wider pitch ranges, raised pitch, or slower speech rate (Burnham et al., 2002; Cox et al., 2023; Fernald, 2000; Kuhl et al., 1997; Stern et al., 1983; Uther et al., 2007). This is relevant for the analysis of vowel-initial glottalization in child speech because child-directed speech may contain more instances of glottal stops than adult-directed speech (i.e., high-end of the strength continuum). This may result in younger children initially producing a higher rate of glottal stops compared to creaky phonation. As their exposure to child-directed speech decreases, I would expect children to adopt an adult-like use of creaky phonation.

Aims of the study

In order to examine the implementation of vowel-initial glottalization during childhood, I ask the following questions:

- Given previous findings showing that children exhibit a period of enhanced use of glottalization during multiword speech (Newton, 2002), I ask whether school-aged American English-speaking children produce greater rates of vowel-initial glottalization in newly presented words when compared to adult American English speakers.
- Previous research has found that the acquisition of acoustic cues to mark prominence continues past early childhood. I, thus, ask whether lexical stress differentially affects the production of vowel-initial glottalization in children and adults (i.e., interaction between age group and stress), such that adults will show a significant difference between stressed and unstressed positions and children will demonstrate a similar use of vowel-initial glottalization in both stressed and unstressed positions.
- To shed light into the production of vowel-initial glottalization along the creaky phonation – glottal stop continuum, I ask whether younger children (5-8 years old) produce a greater rate of glottal stops in contrast to creaky phonation when compared to older children (8-11 years old) and adults.

Methods

Participants

Data for this study were collected in the framework of a larger study examining the development of connected speech in monolingual and heritage bilingual grammars (Repiso-Puigdelliura, 2022). The subset of the English speakers raised in monolingual environments was analyzed in this paper. In total, 19 adult American English speakers (14 F, 5 M, *M* = 20;7 years [*SD* = 11.92 months], age range = 18;3 – 22;5 years) and 42 child American English speakers (24 F, 18 M, *M* = 8;7 years [*SD* = 17.82 months], age range = 5;7 – 11;5 years) residing in California at the time of testing participated in this study. Children were divided into a group of younger children (9 F, 11 M, *M* = 7;1 years [*SD* = 7.56 months], age range = 5;7 – 8 years) and a group of older children (15 F, 7 M, *M* = 9;8 years [*SD* = 10.81 months], age range = 8;2 – 11;5 years). None of the participants used languages other than English on a regular basis at home, nor were speakers of a heritage language. The adult participants were undergraduate students at the University of California, Los Angeles and data were collected through the recruitment pool SONA. Twenty-four child participants were recruited at the UCLA primary school Lab School. The rest of the child participants were recruited through social media.

Production task

To account for potential variations in lexical frequency that might impact glottalization patterns differently in adults and children, novel words were elicited. Eight phonotactically legal novel words were created, consisting of four trochaic words (e.g., *adgy* [ˈæd͡ʒi]) and four iambic words (e.g., *abeed* [əˈbid]), which were preceded by the function word ‘all’. Syllable weight was used to attract stress. The trochaic words were created with an initial closed syllable and a /VC.CV/ syllabic structure, and the iambic words with a closed ultimate and a /V.CVC/ syllabic structure.

The sequences of ‘function + content words’ were elicited using a word-naming task. Each novel word was assigned a picture from the Novel Object and Unusual Name (NOUN) Database (Horst & Hout, 2016). Participants were presented visually with a known object and an unknown object associated with two characters (see Figure 1). The

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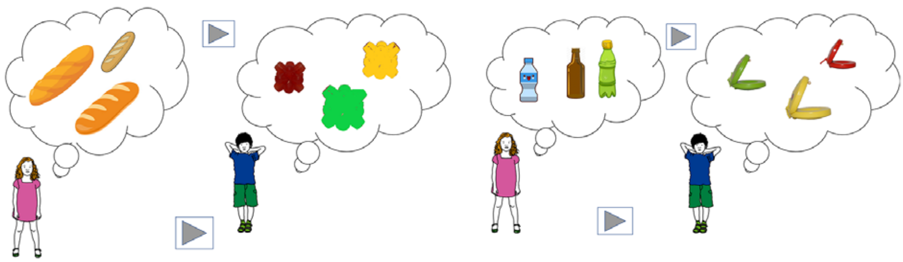

Figure 1. Examples of elicitation materials for the sequences 'all + novel word' ('These are some funny *baguettes* and these are some fancy *egoons.* The girl likes all *baguettes* and the boy loves…/ These are some funny bottles and these are some fancy *adgies.* The girl likes all bottles and the boy loves…').

supporting object had the same stress pattern as the novel word in order to prime initial or non-initial stress patterns. Simultaneously, a sound stimulus prompted participants to produce a sentence containing 'all + target word'. The novel words were recorded by a male voice and cross-spliced into the carrier phrases recorded by a female voice. The decision of cross-splicing between different voices was made to prevent participants to perceive an artificially inserted acoustic pause as a glottal stop. With different voices, it is less likely that participants expect a phonological process to occur between the two words. Eight consonant-initial words (e.g., *nadgy* [ˈnæd͡ʒi]), and eight vowel-initial words (e.g., *adgy* [ˈæd͡ʒi]), and eight /l/-initial words (e.g., *lamby* [ˈlæmbi]) were added as distractors. The tasks were presented using a PowerPoint presentation with four different random orders.

Coding

Tokens were classified by the author as containing either modal phonation, creaky phonation, or glottal stops (see Figure 2). Complete glottal stops were identified when the spectrogram presented a period of silence not exceeding 150 ms, with possible evidence of creaky phonation in the flanking segments (Scarpace, 2017). Creaky phonation was identified in instances in which either the consonant or the vowel showed aperiodicity (i.e., discontinuous duration of consecutive pulses), widening of pulses, diplophonia (i.e., alternation in amplitude of the glottal pulses and/or an alternation in their frequency – Huang, 2023), or lowered f0 (Dilley et al., 1996; Keating et al., 2015; Davidson & Erker, 2014). Modal phonation was coded when the segment across the consonant and the vowel demonstrated regular pulses and amplitude (See Figure 2). Cohen's kappa scores were calculated as a measure of scoring reliability using 184 tokens annotated by a trained research assistant. The agreement rate for the presence of glottalization was 0.87 (95% CI: 0.72–1.00), and the agreement rate for the presence of complete glottal stops was 0.86 (95% CI: 0.72–1.00), both indicating strong agreement.

Results

Mixed effects logistic regression models were fitted in R (R Core Team, 2021), using the packages lme4 (Bates et al., 2007) and lmerTest (Kuznetsova et al., 2017), and reported using the package report (Lüdecke et al., 2022). Average marginal effects were calculated using the package margins (Leeper, 2021).

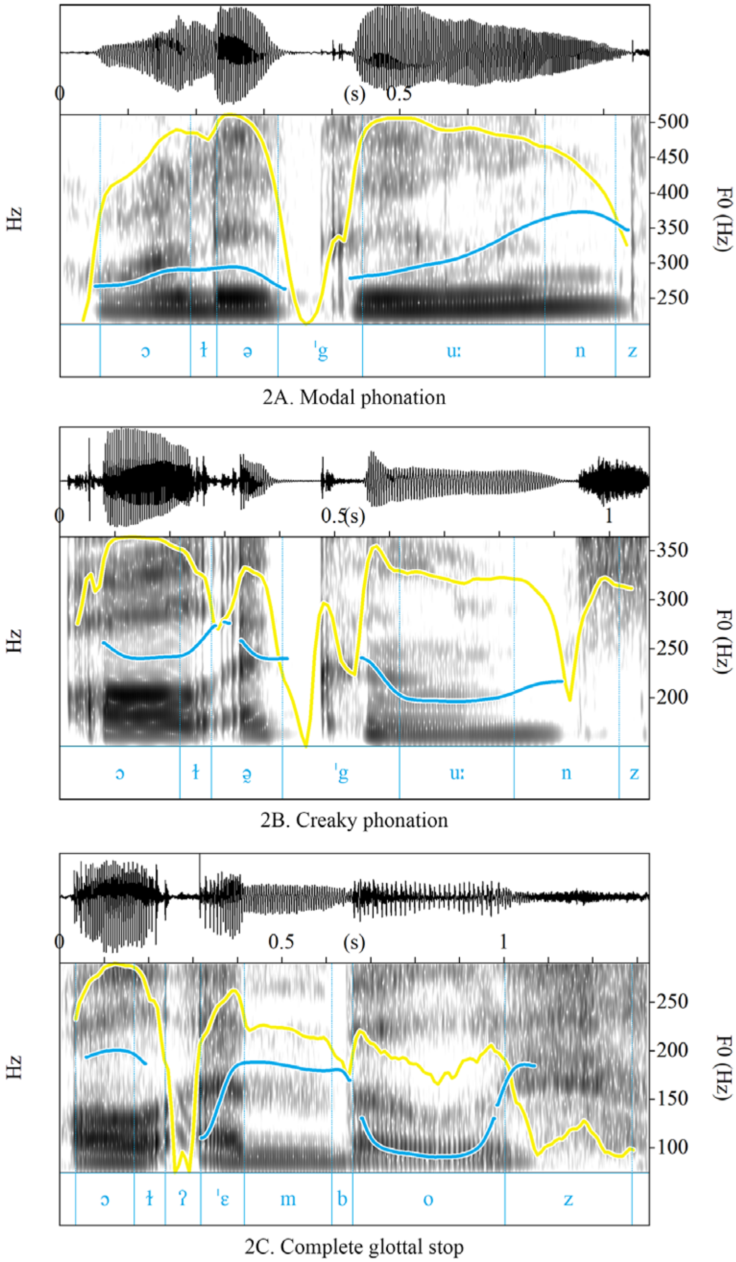

Figure 2. Examples of tokens classified as containing modal phonation (A: *all egoons*), creaky phonation (B: *all egoons*), and complete glottal stop (C: *all embos*).

Rate of vowel-initial glottalization over modal phonation

I fitted a logistic mixed model to predict rate of glottalization (i.e., modal phonation coded as 0 and vowel-initial glottalization coded as 1) with AGE GROUP (i.e., younger children,

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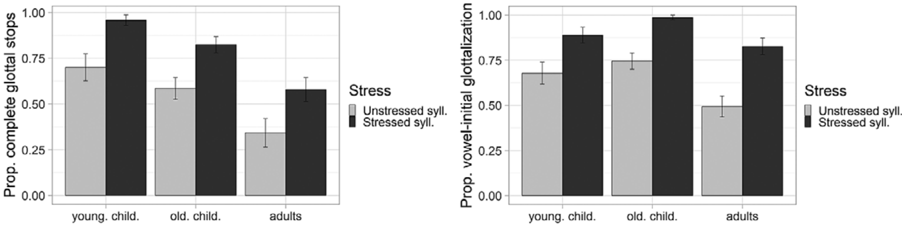

Figure 3. Proportion of vowel-initial glottalization by groups (i.e., younger children, older children, adults) and stress (i.e., unstressed initial syllable, stressed initial syllable) when vowel-initial glottalization is coded as 1 and modal phonation is coded as 0 (left) and proportion of complete glottal stops by group and stress in the subset of tokens containing vowel-initial glottalization with glottal stops coded as 1 and creaky phonation coded as 0 (right). The error bars in both graphs refer to the standard errors for the aggregated proportion of vowel-initial glottalization across groups.

older children, adults) and STRESS (i.e., unstressed initial syllable, stressed initial syllable) as fixed factors, which were coded using simple coding. The model included participant and word as random intercepts. The model's explanatory power related to the fixed effects alone (marginal R^2) is 0.42.

Figure 3A shows the proportions of glottalization across the three age groups and syllable stress. With the younger children set as the reference, the effects of older children and adults are statistically non-significant. This indicates that younger children (M = 77.88%, SE = 3.92%), older children (M = 85.21%, SE = 2.74%), and adults (M = 65.07%, SE = 3.96%) produced similar rates of vowel-initial glottalization. As for STRESS, with the reference level set to unstressed initial syllable, the model shows a statistically significant and positive effect (β = 2.35, SE = 0.44, z = 5.33, p < 0.001), indicating that stressed initial syllables are more likely to be glottalized (M = 90.4%, SE = 2.1%) than unstressed initial syllables (M = 64.35%, SE = 3.17%).

Rate of complete glottal stops over creaky phonation

To investigate the implementation of vowel-initial glottalization, I first subset the tokens exhibiting glottalization (327 tokens). These tokens were coded with 0 for creaky phonation and 1 for glottal stops, considering creaky phonation as the lenited variant of the complete glottal stop. Subsequently, I conducted a mixed-effects logistic regression (as shown in Table 1) with fixed effects for AGE GROUP (i.e., younger children, older children, adults), STRESS (i.e., unstressed initial syllable, stressed initial syllable), and their interaction. The model included participant as a random effect. Adding word as a random effect in this model resulted in a singular fit model. The model's total explanatory power is substantial (conditional R2 = 0.57) and the part related to the fixed effects alone (marginal R^2) is of 0.29. The model's intercept, corresponding to AGE GROUP = adults, and STRESS = stressed, is at 1.16 (95% CI [0.60, 1.72], p <.001). I report the mean and standard error proportions for complete glottal stops (i.e., 0 for creaky phonation, 1 for complete glottal stop).

Figure 3B shows the proportion of complete glottal stops by reference to the proportion of creaky phonation. Within the model, the effects of younger and older children are statistically significant (younger children: β = 3.08, SE = 0.78, z = 3.93, p < 0.001, older children: β = 1.65, SE = 0.61, z = 2.69, p = 0.007). That is, younger children (M = 84.09%, SE = 3.92%) and older children (M = 70.83%, SE = 3.8%) produce significantly more vowel-initial words with complete glottal stops than adults (M = 48.42%, SE = 5.15%). After

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Table 1. Target sequences with words with initial stress (left) and words with unstressed initial syllables (right). Neighborhood densities (i.e., ND) and neighborhood frequencies (i.e., NFreq) reported for the novel words searched with CLEARPOND (Marian et al., 2012) using orthographic neighbors and the singular forms of the words

Initial stress	ND	Nfreq	Non-initial stress	ND	Nfreq
all adgies [ɔɫˈæd͡ʒiz]	1	2.27	all abeeds [ɔɫˈəbidz]	0	0
all imbos [ɔɫˈɪmboz]	2	2.23	all egoons [ɔɫˈəgunz]	1	2.27
all embos [ɔɫˈɛmboz]	0	0	all iboons [ɔɫˈɪbunz]	1	2.12
all ombies [ɔɫˈɔmbiz]	0	0	all ozeeds [ɔɫˈəzidz]	0	0

Note: The option for orthographic neighbors needed to be selected given that phonological neighbors detected phonemes and monosyllabic words.

re-leveling the model (i.e., older children as reference level), I observe that younger children are more likely to produce complete glottal stops than older children (β = 1.43, *SE* = 0.72, z = 1.99, p = 0.04). My results further demonstrate a significant effect of STRESS (β = 1.92, *SE* = 0.4, z = 4.84, $p < 0.001$), indicating that stressed initial syllables are more likely to be produced with complete glottal stops (*M* = 78.21%, *SE* = 3.92%) than unstressed initial syllables (*M* = 55.41%, *SE* = 4.1%). In addition, I calculated average marginal effects (i.e., AME) to understand the impact of predictor changes on the probability of producing creaky phonation. The most notable effect is observed in the younger children (AME: 0.43, 95% CI: 0.24, 0.62), indicating that younger children have a 42.79% higher probability of producing complete glottal stops compared to adults. The second most significant effect pertains to the older children (AME: 0.29, 95% CI: 0.09, 0.62), suggesting that older children have a 28.78% higher probability of producing glottal stops than adults. The third effect is that of STRESS (AME: 0.26, 95% CI: 0.16, 0.35), showing a 25.58% greater likelihood of complete glottal stops in stressed syllables than in unstressed syllables. Lastly, upon re-leveling the model, I identified a relatively smaller effect between the younger children and the older children (AME: 0.14, 95% CI: -0.49, 0.29), indicating that younger children have a 14.01% higher chance of producing complete glottal stops than older children. No interaction is found between STRESS and AGE GROUP.

Discussion

Returning to my first research question, where I asked whether English-speaking children produced greater rates of vowel-initial glottalization than adults, my results show a non-statistically significant decreasing trend among the children (younger children: *M* = 77.88%, *SE* = 3.92%, older children: *M* = 85.21%, *SE* = 2.74%), and the adults (*M* = 65.07%, *SE* = 3.96%). While a lack of significant effects may not necessarily indicate an absence of differences at the population level, my findings seem to indicate that, from ~ 5 years of age, children produce similar rates of vowel-initial glottalization when compared to adults. These results suggest that vowel-initial glottalization is an acoustic cue that English speakers incorporate early in the production of consonant-to-vowel sequences in newly presented words and continue to produce during adulthood. Further studies are needed including children younger than 5 years old to determine the strength of glottalization in earlier multiword speech (Newton, 2002; Newton & Wells, 1999; Repiso-Puigdelliura, 2023).

My second question asked whether stress affects children and adults differently in the production of vowel-initial glottalization. With regard to the main effect of stress, my

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results show that stressed syllables (*M* = 90.4%, *SE* = 2.1%) are more likely to be glottalized than unstressed syllables (*M* = 64.35%, *SE* = 3.17%). These findings provide further evidence for accounts proposing vowel-initial glottalization as a cue to prominence (Crowhurst, 2018; Garellek, 2014; Redi & Shattuck-Hufnagel, 2001; Steffman, 2021). Contrary to my prediction, my findings do not demonstrate an interaction between age group and stress. Although larger samples are needed to rule out the possibility that my results are not due to lack of statistical power, these findings suggest that children from 5 years of age, similarly to adults, incorporate vowel-initial glottalization as a cue to mark stress. Future research should include data from earlier childhood periods to determine the age at which children begin to use vowel-initial glottalization as a cue to mark prominence.

Despite the meaningful difference between stressed and unstressed syllables, my findings also show that, in unstressed syllables, vowel-initial glottalization is the preferred strategy for producing word-external consonant-to-vowel sequences. Recall that my task contained only novel words. If we compare these rates to those found in highly frequent words, Repiso-Puigdelliura (2023) found similar rates of glottalization in stressed positions (*M* = 92.98%, *SE* = 1.69%), but lower rates in unstressed syllables (*M* = 40.17%, *SE* = 3.18%). This could suggest that vowel-initial glottalization also serves to prosodically enhance low-predictability words. From a listener-oriented account of phonetic production (Turnbull, 2017, 2019), wherein speakers guide phonetic effort by considering the listener's needs, speakers will use the least effort possible in elements easily retrievable by the listener, and greater phonetic effort will be employed in elements considered as less likely to be retrieved from the context. In this study, sequences containing novel words may be deemed less likely to be retrieved by the listener, and thus, speakers may dedicate more phonetic effort to the novel words to ensure that the listener retrieves the word from the speech signal.

My second question asked whether the target of vowel-initial glottalization changed during childhood. I predicted that children would show a reduction in the use of complete glottal stops with age. My results indicate that complete glottal stops are more common in children aged 5;7 to 8 years old (*M* = 84.09%, *SE* = 3.92%) compared to those aged 8;2 to 11;5 years old (*M* = 70.83%, *SE* = 3.8%). Moreover, both of these age groups exhibit a higher occurrence of complete glottal stops compared to adults (*M* = 48.42%, *SE* = 5.15%). This suggests that younger children tend to favor complete glottal stops over creaky phonation, with this preference diminishing as they reach the age of 8 and continuing into adulthood. If I consider that creaky phonation and complete glottal stops are on a continuum of prosodic prominence, then my results suggest a developmental trend. Initially, children produce complete glottal stops, enhancing vowel-initial glottalization as an acoustic cue for prominence, and, with age, they shift to a weaker variant on the continuum.

These results could be attributed to the type of input to which younger children are exposed. According to this explanation, the speech of the children in my study would reproduce the probabilities of complete glottal stops and creaky phonation possibly found in child-directed speech. Interestingly, in a recent study, Shi et al. (2022) found that unknown words in child-directed speech are produced with larger pitch ranges, slower speaking rates, and wider intensity than known words. Therefore, in the context of my study, children should be more likely to produce hyperarticulated speech in novel words compared to frequent words. Nevertheless, unpublished observations using descriptive statistics from a real word study eliciting similar sequences of function and content words (e.g., *all onions*) with the same group of participants (i.e., rates of vowel-initial glottalization were published in Repiso-Puigdelliura, 2023), reveal a similar pattern in the use of creaky phonation -full glottal stops to that of novel words. More specifically, the

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prevalence of complete glottal stops decreases from younger children (stressed syllables *M* = 90.77%, *SE* = 3.62%, unstressed syllables *M* = 80.95%, *SE* = 6.13%) to older children (stressed syllables *M* = 78.75%, *SE* = 4.60%, unstressed syllables *M* = 53.12%, *SE* = 8.96%) and adults (stressed syllables *M* = 61.64%, *SE* = 5.73%, unstressed syllables *M* = 35.71%, *SE* = 9.22%). That is, the increased use of glottal stops over creaky phonation in children does not appear to be unique to newly presented words.

A competing explanation is that children are still developing the implementation of the continuum creaky phonation – glottal stops along different degrees of prosodic prominence. Recall that studies on the acquisition of stress show early development of stress patterns (Kehoe et al., 1995; Pollock et al., 1993; Schwartz et al., 1996) but later prosodic control of focus within an utterance (Grigos & Patel, 2007, 2010; Patel & Brayton, 2009). In the case of the current study, it is possible that, between the ages of 5 to 8 years to a greater extent, and 8 to 11 years to a lesser extent, children are still acquiring prosodic control at the utterance level, and with that, learning to map the creaky phonation – glottal stops continuum into a hierarchical scale of prosodic prominence. As a result, children less frequently lenite glottal stops to mark low levels of prosodic prominence. Although the present proposal cannot tease apart the two hypotheses, my results are a first step toward understanding the implementation of the glottalization continuum across age groups. To further investigate these accounts, future research should elicit child-directed speech from the caregivers along with speech at different levels of the prosodic structure (e.g., intermediate phrase boundaries, intonational phrase boundaries).

Conclusion

In this study, I investigated the rate of vowel-initial glottalization production and its phonetic implementation in the production of novel words by American English-speaking children. Participants were divided into a group of younger children (5;7 - 8 years) and a group of older children (8;2 - 11;5 years) and their results were compared to those of adults. Results from a production task eliciting 'all + novel word' (e.g., *all adgies*) showed that, while English-speaking children and adults glottalize at similar rates (non-significant statistical results), 5-to-8-year-olds produce a higher rate of complete glottal stops over creaky phonation when compared to 8-to-11-year-olds. In addition, 8-to-11-year-olds also show greater rates of complete glottal stops when compared to adults.

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