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Introduction

Speech acquisition refers to how children make sense of and use the speech sounds they hear around them (Gildersleeve-Neumann & Wright, 2010). Learning to correctly pronounce language sounds, particularly consonant clusters, is one of the longest-lasting stages of speech acquisition (Kirk, 2008; McLeod et al., 2001a; McLeod et al., 2001b). Children as young as 2;0 (years;months) can pronounce some clusters correctly, but many other children still struggle with consonant clusters at age 8;0 or 9;0 (Bland-Stewart, 2003; McLeod et al., 2001a; McLeod et al., 2001b). Pronunciation plays a major role in the intelligibility of speech sounds made during early language acquisition, and since English contains a large variety of consonant clusters (Anthony & Francis, 2005), not being able to pronounce these sounds correctly makes communication frustrating for many children (McCormack et al., 2010). McLeod et al. (2001b) examined children's acquisition of consonant clusters and found that most children learn single-syllable words first, and since up to one-third of English monosyllables begin or end with consonant clusters, learning to pronounce these differences is an important step for toddlers. Early words generally follow the CV, VC or CVCV pattern, but more complex words often feature a CVCC or CCVC pattern – words that children tend to learn around 1;6 to 2;6 (McLeod et al., 2001b). By about age 2, children undergo a "word spurt" during which their vocabulary expands rapidly; toddlers also experience physical changes that may positively contribute to their ability to pronounce consonant clusters. Their oral space enlarges, there is growth in the lower jaw and other bony structures, and they experience increased muscle tone and "skilled" tongue movement (McLeod & Bleile, 2003). In addition, during the first three years of life the larynx lowers and is able to produce more sophisticated movements (McLeod & Bleile, 2003). Despite these changes, most children at age 2;0 are unable to completely replicate adult consonant cluster

sounds, instead producing forms that are inconsistent with the ambient language (Kuhl et al., 2006; McLeod et al., 2001a; McLeod et al., 2001b).

Research has identified several strategies children use when learning to pronounce consonant clusters. Two of those are easy for even naïve listeners to identify: cluster reduction and cluster simplification (James, et al., 2008; Kirk, 2008; McLeod et al., 2001a; McLeod et al., 2001b). Cluster reduction occurs when one or more of the consonants is removed, leaving only a single consonant sound. Gierut (1999) and Kirk (2008) each found that children tend to produce the least sonorous consonant and omit any other sounds in a word-initial consonant cluster. "The sonority of a consonant depends on the degree of constriction in the vocal tract when that consonant is produced, with the ranking of consonants from the most sonorous to the least sonorous being glides, liquids, nasals, fricatives, and stops" (Kirk, 2008, p 36). For example, many children will say [tɪk] *tick* instead of [stɪk] *stick* since they are unable to produce the /st/ cluster, even though most English-speaking 2-year-olds can successfully produce /s/ and /t/ separately (Li et al., 2009). Anthony and Francis (2005), however, order consonants based on their manner of articulation, stating that the easiest consonants are liquids, followed by nasals, glides, and finally obstruents. They argue that "[c]hildren develop sensitivity to differences in *placement* of articulation, the location along the vocal tract where the tract is occluded or narrowed, before they develop sensitivity to differences in phoneme voicing" (emphasis theirs; Anthony & Francis, 2005, p. 257).

In addition to reducing consonant clusters, children also simplify the sounds in a consonant cluster (James, et al., 2008; Kirk, 2008; McLeod et al., 2001a; McLeod et al., 2001b). Cluster simplification occurs when two elements of the cluster are produced, but one or both of them is pronounced incorrectly. The most commonly observed instance of cluster simplification happens as the result of gliding approximants (McLeod et al., 2001b), for example, pronouncing

[trejn] *train* as [twejn] *twain* where the /r/ is simplified into /w/. This example of cluster simplification makes sense considering the earliest word-initial consonant clusters to be pronounced correctly are /tw/ and /kw/, while the most difficult clusters to master were /skr/ and /spr/ (McLeod et al., 2001a; McLeod et al., 2001b). Production of /w/ as part of a consonant cluster is also found in children's nonstandard pronunciations. McLeod and Bleile (2003) found that by age 2;0, children were able to correctly pronounce word-initial consonant clusters containing /w/, even if they appeared in clusters not found in the children's native languages, e.g. [bwejn'kət] instead of [blejn'kət] *blanket*. Two-year-olds were also able to pronounce the word-final cluster /-ts/ (McLeod & Bleile, 2003). However, most toddlers continue to mispronounce consonant clusters even though their lexicon often contains a variety of consonant-vowel combinations and includes both monosyllabic and polysyllabic words (McLeod & Bleile, 2003).

In general, children tend to master stop + liquid clusters (e.g., /pl/) before they master fricative + liquid clusters (e.g., /sl/) (McLeod et al., 2001a; McLeod et al., 2001b). Regardless of which clusters a child learns first, learning how to correctly pronounce consonant clusters is an ongoing process that usually takes place in sequential stages (Kirk, 2008; McLeod et al., 2001a; McLeod et al., 2001b). Children typically begin by pronouncing only one of the consonants in a cluster (cluster reduction), then trying to pronounce two consonants in a cluster (cluster simplification), and finally correctly using the "adult" pronunciation of the cluster (McLeod et al., 2001b). However, Anthony and Francis (2005) found that the stages described above overlap, since children can refine the language skills they have already acquired while they are developing new ones. Similarly, Bland-Stewart (2003) noted that "as a the child matures, certain phonological processes are modified and eventually suppressed as more adult-like speech emerges" (p. 109), suggesting that while the acquisition of consonant clusters can be described in

steps or stages, it is important to realize these stages often blend into each other and feature overlapping characteristics.

Anthony and Francis (2005) and Kirk (2008) concluded that pronunciation errors of consonant clusters can be attributed to the difficulty of pronouncing two consonants that do not share the same source of articulation; instead, children are able to acquire correct pronunciations of clusters whose consonants share the same articulation placement. Also, Kirk (2008) found that a child's pronunciation of consonant clusters is not linked to his or her understanding of grammatical morphology. Participants in her study were able to differentiate between singular and plural items, even if they were unable to correctly pronounce a final consonant cluster ending in /s/ or /z/. Song et al. (2009) reported similar results: Phonological constraints, not grammatical knowledge, determine whether or not a toddler is able to produce a final /s/ in third person singular forms.

The study of language acquisition goes back decades, but little research has focused on the acquisition of consonant clusters. McLeod et al. (2001a; 2001b) expanded on the general trends in consonant cluster development they had identified in previous studies. The ten trends they describe were drawn from an examination of more than 70 years of research into children's language acquisition. First, McLeod et al. (2001a; 2001b) found that while two-year-old children are able to produce consonant clusters, the clusters they produce may not be of the same form as the ambient language. Second, children tend to produce word-final clusters earlier than word-initial consonant clusters. Third, clusters containing two elements are generally produced and mastered earlier than clusters containing three elements. Fourth, consonant clusters containing stops are usually acquired before clusters containing fricatives. Fifth, children tend to go through a period of consonant reduction. Sixth, young children's attempts to produce consonant clusters often result in words that are homonyms for other words in their language,

i.e., [bɛd] is used for both *bed* and *bread*. Seventh, children use a variety of other pronunciations while learning consonant clusters, but after cluster reduction, the next most common strategy is cluster simplification. Eighth, children gradually learn consonant clusters, but there is a typical developmental sequence. Ninth, cluster reduction, cluster simplification, and correct production of consonant clusters are interrelated; a child may proceed from cluster reduction to correct pronunciation, from cluster reduction to cluster simplification to correct pronunciation, and/or from no cluster pronunciation to cluster reduction to cluster simplification to correct pronunciation, depending on the child and the particular consonant cluster he or she is learning. Finally, despite evidence of a typical developmental sequence in acquiring consonant clusters, children go through the stages differently and sometimes reverse progress or revise their pronunciation as they get closer to achieving adult-like pronunciation of consonant clusters (McLeod et al., 2001a; McLeod et al., 2001b).

This paper will examine a two-year-old's consonant cluster acquisition at age 2;6 and compare the results with the trends identified by McLeod et al. (2001a, 2001b). Their work a decade ago noted that there are few studies that focus solely on the acquisition of consonant clusters, and since there still are relatively few studies of this type, I chose to examine the speech of my nephew in an attempt to provide additional data about how toddlers acquire consonant clusters. Does my nephew's speech follow the ten trends listed above? How does his production of consonant clusters compare with research on other toddlers' acquisition of consonant clusters?

Methods

The participant in this case study is my nephew, a typically developing child with no identified learning disabilities or medical conditions. At the time of this writing, he is 2;7. Both of his parents are college educated. His mother has a master's degree and is a high school

science teacher; his father has a bachelor's degree and is an store assistant manager. My nephew attends day care regularly and also interacts with children in the nursery at church and in his church's Awana program. The speech used as data for this project was all spontaneously generated, although some of the instances are my nephew's attempt to repeat what an adult had said. Most of the speech samples were collected at his home during play time with his mother and me when he was age 2;6, but I have included a few short video recordings his parents made to have speech samples from when my nephew was closer to 2;0.

The video recordings I made were done using the built-in video camera on my iPhone 4, and the audio-only recordings were made using the iTalk app on the same iPhone 4. The video recordings provided by my nephews' parents were made using an RCA Small Wonder EZ 200 digital camcorder. The total time for all recordings is just over one hour. In addition to the recordings, I am including information from my own informal interactions with my nephew as well as speech data reported by his parents. I used information from the online database of lexical norms compiled by Dale and Fenson (1996), which is part of the MacArthur-Bates Communicative Development Inventories, to provide additional samples of my nephew attempting to pronounce words with consonant clusters. I decided to include words from this database since the amount of recorded data collected was limited. I accessed the database and printed the list of words that children at 2;6 should know, highlighting words containing consonant clusters. I asked my nephew to either identify objects or repeat words to record his pronunciations.

I then reviewed the video and audio recordings and listed the words and phrases my nephew used. I used my own shorthand to represent the nonstandard sounds he used in words rather than IPA symbols because I found this to be a quicker way to transcribe my nephew's speech. Next, I examined the data for words that include consonant clusters and then created a

list of these words, which I analyzed to determine the type of production errors he makes (either cluster reduction or cluster simplification). The focus of this case study is consonant clusters, so as long as the cluster was said correctly, I categorized the word as being pronounced correctly, even if the rest of the word was said using nonstandard pronunciation. Finally, I made comparisons between my nephew's results and the ten trends described by McLeod et al. (2001a, 2001b).

Results and Discussion

This section will describe the speech sounds my nephew used while attempting to pronounce consonant clusters, followed by a comparison between the data and the ten trends described by McLeod et al. (2001a, 2001b). Table 1 provides an overview of the results.

Table 1

Consonant clusters produced during the study

cluster attempts	90
correct pronunciations	33
cluster reduction	23
cluster simplification	34

My nephew produced 90 words that included one or more consonant cluster (Appendix A). Of these, he was able to pronounce the consonant clusters in about one-third of them correctly (Appendix B). I included words like *elephant*, which he mispronounced as [ɛ'əfant], with words he correctly pronounced, such as *shoe* [ʃu], since he was able to correctly pronounce the consonant cluster. Overall, my nephew was most successful pronouncing /tʃ/, both word-initially (*chair, cheese, chicken, chip, choo-choo*) and word-medially (*kitchen*). My nephew was also able to consistently use /θ/ (*that, the, there, these, this, another*), as well as /ʃ/ (*shirt, shoe,*

shopping, wash). He was also able to pronounce the /ks/ in word-final position (*box, fix*), /f/ in word-initial position (*phone*) and word-medial position (*elephant*), and /pl/ in word-initial position (*plate, play*).

However, there were 23 words that my nephew pronounced using cluster reduction (Appendix C) and 34 words he pronounced by simplifying the clusters (Appendix D). Although he is able to use /ʃ/ in most words, his pronunciation of *sheep* more resembled /sip/ than /ʃip/. Similarly, he is able to use /θ/ in most instances but pronounces *something* like [sʊm'kin] and *birthday* like [bərfˈdej]. His most common use of cluster reduction is in his pronunciation of /st/, which he consistently reduces to just /t/ in words like *stairs, stay, stick, stop, store,* and *stuck*. He also reduces the /str/ cluster at the start of *strawberry* to either [taw'bɛri] or [saw'bɛri]. My nephew also has difficulty with /sp/, reducing it to /p/ in *spell* [pɛl] and *spoon* [pun].

Thirty-four of the words feature some sort of cluster simplification, with /θ/ being the most commonly simplified cluster. My nephew used cluster simplification in 11 words containing /θ/: *bath, bathtub, birthday, both, forth, something* (two types of cluster simplification), *think, three, through, toothbrush,* and *with*. He simplified /θ/ to /f/ word-initially in *through*, *think*, and *three*; word-medially in *bathtub*, *birthday*, *toothbrush*, and *something*; and word-finally in *bath*, *both*, *forth* and *with*. He also changed the initial /θ/ to /d/ in *through* when singing "The Wheels on the Bus." Five words beginning in /br/ were simplified to begin with /bw/: *Brett, bridge, bring, broke,* and *broom.* Two other consonant clusters were each simplified in four of the data samples: /fr/ became /fw/ (*fries, from, fruit, refrigerator*) and /tr/ became either /tw/ or /sw/ (*train, trash, tree, truck*). Other common changes were /pl/ to /pw/ in three words (*airplanes, please, Playstation*) and /kr/ to /kw/ in two words (*cry, ice cream*).

Using the data in conjunction with the ten trends from McLeod et al. (2001a, 2001b), the following conclusions can be made about my nephew's pronunciation of consonant clusters.

Trend 1 –"Two-year-old children can produce consonant clusters, but these clusters may not be of the same form as the ambient language" (McLeod et al., 2001a; McLeod et al., 2001b). This trend held true for my nephew's pronunciation of several consonant clusters. He produced some clusters that are found in English (e.g., /tʃ/ and /ʃ/) but often created his own clusters that are against the phonotactics rules of English. He frequently used C+/w/ combinations that are not used in English such as /bw/, /fw/, /pw/, /sw/ and /tw/ in his simplified versions of certain clusters. He also pronounced the initial /tʃ/ in *church* as /sj/ several times.

Trend 2 – "Word-final consonant clusters generally appear in inventories earlier than word-initial clusters" (McLeod et al., 2001a; McLeod et al., 2001b). I was unable to determine this based on the data since the recordings were primarily done when my nephew was age 2;6, and he produced words with both word-initial and word-final clusters.

Trend 3 –"Two-element clusters are generally produced and mastered earlier than three-element clusters" (McLeod et al., 2001a; McLeod et al., 2001b). This trend also appears true for my nephew; he does not produce any three-element clusters. The initial /skw/ in *squirrel* was reduced to /k/, and the initial /str/ in *strawberry* was reduced to /s/ or /t/. Likewise, the initial /str/ in *strong* was simplified to /sw/. However, these are the only four samples of three-element consonant clusters found in the data, so this result could change if I had more results.

Trend 4 – "Consonant clusters containing stops (e.g., /pl/, /kw/) are acquired generally before consonant clusters containing fricatives (e.g., /st/, /θr/)" (McLeod et al., 2001a; McLeod et al., 2001b). Based on the list of correctly pronounced words, my nephew has acquired eight clusters containing stops in comparison to 21 clusters containing fricatives; four of the words contained neither a stop nor a fricative as part of the consonant cluster. Taken alone, this result would indicate that Trend 4 is inaccurate; however, the full word list shows that 20 of the words containing consonant clusters my nephew cannot say contain consonant clusters with a stop,

while 38 of them contain consonant clusters with a fricative. Since there is evidence of greater difficulty in producing fricative consonant clusters, I can tentatively conclude that Trend 4 is correct in my nephew's case, even though he has mastered the pronunciation of 21 words containing fricative clusters.

Trend 5 – "Young children typically delete one element of a consonant cluster (cluster reduction)" (McLeod et al., 2001a; McLeod et al., 2001b). My nephew exhibited 23 examples of cluster reduction, so for him, Trend 5 is accurate. For example, he reduced the initial /gr/ in *green* to /g/ and the initial /fl/ in *flower* to /f/.

Trend 6 – "Homonymy occurs in young children's attempts to produce consonant clusters. Homonymy frequently occurs as a result of cluster reduction; however, homonyms can also occur as a result of cluster creation" (McLeod et al., 2001a; McLeod et al., 2001b). The data showed several examples of homonymy in my nephew's speech. His pronunciation of *crawl* was more like [kal] *call*, and his pronunciations of *sleep* and *sweep* were both more like *seep*. He also said *tick* instead of *stick*, *top* instead of *stop*, *tore* instead of *store*, *drew* instead of *through*, and *tank* instead of *thank*.

Trend 7 – "There are a number of other nonadult realizations of consonant clusters; the most common is cluster simplification, with others including epenthesis and coalescence. Metathesis is rare" (McLeod et al., 2001a; McLeod et al., 2001b). My nephew's speech does fit this trend since 34 of his mispronunciations were as a result of cluster simplification. In fact, he used simplification more times than he used cluster reduction, which he only used 23 times.

Trend 8 – "The acquisition of consonant clusters is gradual, and there is a typical developmental sequence. It is not an all-or-nothing process. For word-initial clusters, children may initially delete a member of a consonant cluster (one-element realization); then preserve the members, but one may be produced in a nonadult manner (two-element realization); and finally

they will produced the consonant cluster correctly (correct realization). Other developmental sequences are possible, particularly for word-final consonant clusters" (McLeod et al., 2001a; McLeod et al., 2001b). Since the data was collected within a short time frame when my nephew was 2;6, it is difficult to track his progression using the samples gathered for this case study. Therefore, I cannot provide concrete results for this trend.

Trend 9 – "There is an interrelationship among cluster reduction, cluster simplification, and correct productions of consonant clusters. Initially, most children reduce consonant clusters. Over time, the occurrence of cluster reduction diminishes, whereas the occurrence of cluster simplification increases. Simultaneously, the occurrence of correct productions increases, until eventual mastery of production" (McLeod et al., 2001a; McLeod et al., 2001b). My nephew appears to be in the cluster simplification phase since he has more examples of cluster simplification than cluster reduction, and cluster reduction is usually the first stage of acquiring adult-like pronunciations of consonant clusters. However, since I do not have longitudinal data for his production of consonant clusters, it is difficult to determine how my nephew relates to this trend, but his ability to correctly pronounce one of two consonant clusters in words like *toothbrush* and *Playstation* can be seen as indications that he is progressing normally toward acquiring consonant clusters.

Trend 10 – "Despite there being a typical developmental sequence, the acquisition of consonant clusters is marked by reversals and revisions, with considerable individual variation" (McLeod et al., 2001a; McLeod et al., 2001b). This trend was shown in my nephew's changing pronunciations of *something, strawberry,* and *sweep/sweeping*. He was not consistent in his pronunciation of these words, which implies he was trying new ways to say the clusters. The recordings are also marked by my nephew repeating words with clusters several times in different styles while he tries to master the correct cluster pronunciation.

Conclusion

By examining my nephew's production of consonant clusters at age 2;6, I am able to set a benchmark for future studies of his speech. This is significant for me as an aunt because my sister, the subject's mother, needed speech therapy as a child to correct serious pronunciation errors. By collecting data on my nephew's developing speech skills, I will be able to provide crucial information to speech pathologists should the need arise. In addition, there is scant data on how two-year-olds acquire consonant clusters, so this research should provide additional insight into how one such toddler produces consonant clusters. Finally, by comparing my results to the ten trends described by McLeod et al. (2001a, 2001b), I am adding information to the field of early childhood language acquisition, although the results are limited by the small scale of this project and the single participant. Another limitation to this study is my close familiarity with the subject. While I was able to obtain spontaneously generated speech, it was difficult to separate my role as "Aunty Tata" from my role as data collector. My nephew's parents often needed me to intervene in behavior issues, such as trying to get him to take a nap or put away his toys, which often interrupted data collection.

Future studies into consonant cluster acquisition should include larger sample sizes and a mix of male and female subjects. Future studies should consider age, socio-economic, and cultural differences when generalizing about consonant cluster acquisition; for instance, how do the ten trends used in this case study apply to female children or to children from a higher or lower socio-economic status? Are these same trends applicable to research on languages other than English? By expanding our knowledge of consonant cluster acquisition, insight can be made into language acquisition in general, as well as how non-native speakers of a language learn to reproduce consonant clusters in their new language.

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Appendix A: Word inventory sorted alphabetically

Word	Age	Production notes	Phonetic changes
airplanes	2;6	cluster simplification	/pl/ → /pw/
another	2;6	correct pronunciation	
bath, bathtub	2;6	cluster simplification	/θ/ → /f/
beans	2;6	correct pronunciation	
birthday	2;6	cluster simplification	/θ/ → /f/
blanket	2;6	cluster simplification	/bl/ → /bw/
blue	2;6	correct pronunciation	
both	2;6	cluster simplification	/θ/ → /f/
box	2;6	correct pronunciation	
bread	2;6	correct pronunciation	
Brett	2;6	cluster simplification	/br/ → /bw/
bridge	2;6	cluster simplification	/br/ → /bw/
bring	2;6	cluster simplification	/br/ → /bw/
broke	2;6	cluster simplification	/br/ → /bw/
broom	2;6	cluster simplification	/br/ → /bw/
bump	2;6	correct pronunciation	
chair	2;6	correct pronunciation	
cheese	1;10	correct pronunciation	
chicken	2;0	correct pronunciation	
chip	2;6	correct pronunciation	
choo-choo	2;0	correct pronunciation	
church	2;6	cluster simplification of word-initial /tʃ/; correct pronunciation of word-final /tʃ/	/tʃ/ → /sj/

close	2;6	cluster reduction	/kl/ → /k/
crawl	2;1	cluster reduction	/kr/ → /k/
cry	2;6	cluster simplification	/kr/ → /kw/
delicious	2;6	cluster reduction	/ʃ/ → /s/
drink	2;6	correct pronunciation	
elephant	2;6	correct pronunciation	
empty	2;6	correct pronunciation	
fix	2;6	correct pronunciation	
flower	2;6	cluster reduction	/fl/ → /f/
forth	2;6	cluster simplification	/θ/ → /s/
fries	2;6	cluster simplification	/fr/ → /fw/
from	2;6	cluster simplification	/fr/ → /fw/
fruit	2;6	cluster simplification	/fr/ → /fw/
green	2;6	cluster reduction	/gr/ → /g/
ice cream	2;6	cluster simplification	/kr/ → /kw/
kitchen	2;6	correct pronunciation	
Marsha	2;6	cluster reduction	/ʃ/ → /s/
milk	2;6	correct pronunciation	
phone	2;6	correct pronunciation	
plate	2;6	correct pronunciation	
play	2;6	correct pronunciation	
Playstation	2;6	cluster simplification of /pl/; correct pronunciation of /st/ and /ʃ/	/pl/ → /pw/
please	2;6	cluster simplification	/pl/ → /pw/
pretty	2;6	correct pronunciation	

pretzel	2;6	cluster simplification	/pr/ → /s/
pumpkin	2;6	cluster simplification	/mp/ → /n/
Q	1;10	cluster reduction	/kju/ → /ku/
refrigerator	2;6	cluster simplification	/fr/ → /fw/
school	2;6	correct pronunciation	
sheep	2;6	cluster reduction	/ʃ/ → /s/
shirt	2;6	correct pronunciation	
shoe	2;6	correct pronunciation	
shopping	2;6	correct pronunciation	
skates	2;6	cluster reduction	/sk/ → /k/
sleep	2;6	cluster reduction	/sl/ → /s/
snow	2;6	correct pronunciation	
something	2;5	cluster simplification	/θ/ → /k/
something	2;6	cluster simplification	/θ/ → /f/
spell	2;6	cluster reduction	/sp/ → /p/
spoon	2;6	cluster reduction	/sp/ → /p/
squirrel	2;6	cluster reduction	/skw/ → /k/
stairs	2;6	cluster reduction	/st/ → /t/
stay	2;6	cluster reduction	/st/ → /t/
stick	2;6	cluster reduction	/st/ → /t/
stop	2;6	cluster reduction	/st/ → /t/
store	2;6	cluster reduction	/st/ → /t/
strawberry	2;6	cluster reduction	/str/ → /s/
strawberry	2;6	cluster reduction	/str/ → /t/
strong	2;6	cluster simplification	/str/ → /sw/

stuck	2;6	cluster reduction	/st/ → /t/
sweep, sweeping	2;6	cluster reduction	/sw/ → /w/
sweep, sweeping	2;6	cluster reduction	/sw/ → /s/
swing	2;6	correct pronunciation	
thank	2;6	cluster reduction	/θ/ → /t/
that	2;6	correct pronunciation	
the	2;6	usually correct production but occasionally cluster simplification	/θ/ → /d/
there	2;6	correct pronunciation	
these	2;6	correct pronunciation	
think	2;6	cluster simplification	/θ/ → /f/
this	2;6	correct pronunciation	
three	2;6	cluster simplification	/θ/ → /f/
through	2;6	cluster simplification	/θ/ → /d/
toothbrush	2;6	cluster simplification of word-medial /θ/ but correct pronunciation of word-final /ʃ/	/θ/ → /f/
train	2;0	cluster simplification	/tr/ → /tw/
trash	2;6	cluster simplification	/tr/ → /tw/
tree	2;6	cluster simplification	/tr/ → /tw/
truck	2;6	cluster simplification	/tr/ → /sw/
wash	2;6	correct pronunciation	
with	2;6	cluster simplification	/θ/ → /f/

Appendix B: Words usually pronounced correctly sorted alphabetically

Word	Age
another	2;6
beans	2;6
blue	2;6
box	2;6
bread	2;6
bump	2;6
chair	2;6
cheese	1;10
chicken	2;0
chip	2;6
choo-choo	2;0
drink	2;6
elephant	2;6
empty	2;6
fix	2;6
kitchen	2;6
milk	2;6

Word	Age
phone	2;6
plate	2;6
play	2;6
pretty	2;6
school	2;6
shirt	2;6
shoe	2;6
shopping	2;6
snow	2;6
swing	2;6
that	2;6
the	2;6
there	2;6
these	2;6
this	2;6
wash	2;6

Appendix C: Examples of cluster reduction sorted by phonetic changes

Word	Age	Production notes	Phonetic changes
flower	2;6	cluster reduction	/fl/ → /f/
green	2;6	cluster reduction	/gr/ → /g/
Q	1;10	cluster reduction	/kju/ → /ku/
close	2;6	cluster reduction	/kl/ → /k/
crawl	2;1	cluster reduction	/kr/ → /k/
delicious	2;6	cluster reduction	/ʃ/ → /s/
sheep	2;6	cluster reduction	/ʃ/ → /s/
Marsha	2;6	cluster reduction	/ʃ/ → /s/
skates	2;6	cluster reduction	/sk/ → /k/
squirrel	2;6	cluster reduction	/skw/ → /k/
sleep	2;6	cluster reduction	/sl/ → /s/
spell	2;6	cluster reduction	/sp/ → /p/
spoon	2;6	cluster reduction	/sp/ → /p/
stairs	2;6	cluster reduction	/st/ → /t/
stay	2;6	cluster reduction	/st/ → /t/
stick	2;6	cluster reduction	/st/ → /t/
stop	2;6	cluster reduction	/st/ → /t/
store	2;6	cluster reduction	/st/ → /t/
stuck	2;6	cluster reduction	/st/ → /t/
strawberry	2;6	cluster reduction	/str/ → /s/
strawberry	2;6	cluster reduction	/str/ → /t/
sweep, sweeping	2;6	cluster reduction	/sw/ → /s/
sweep, sweeping	2;6	cluster reduction	/sw/ → /w/
thank	2;6	cluster reduction	/θ/ → /t/

Appendix D: Examples of cluster simplification sorted by phonetic changes

Word	Age	Production notes	Phonetic changes
blanket	2;6	cluster simplification	/bl/ → /bw/
Brett	2;6	cluster simplification	/br/ → /bw/
bridge	2;6	cluster simplification	/br/ → /bw/
bring	2;6	cluster simplification	/br/ → /bw/
broke	2;6	cluster simplification	/br/ → /bw/
broom	2;6	cluster simplification	/br/ → /bw/
fries	2;6	cluster simplification	/fr/ → /fw/
from	2;6	cluster simplification	/fr/ → /fw/
fruit	2;6	cluster simplification	/fr/ → /fw/
refrigerator	2;6	cluster simplification	/fr/ → /fw/
cry	2;6	cluster simplification	/kr/ → /kw/
ice cream	2;6	cluster simplification	/kr/ → /kw/
pumpkin	2;6	cluster simplification	/mp/ → /n/
airplanes	2;6	cluster simplification	/pl/ → /pw/
please	2;6	cluster simplification	/pl/ → /pw/
Playstation	2;6	cluster simplification of /pl/; correct pronunciation of /st/ and /ʃ/	/pl/ → /pw/
pretzel	2;6	cluster simplification	/pr/ → /s/
strong	2;6	cluster simplification	/str/ → /sw/
truck	2;6	cluster simplification	/tr/ → /sw/
train	2;0	cluster simplification	/tr/ → /tw/
trash	2;6	cluster simplification	/tr/ → /tw/
tree	2;6	cluster simplification	/tr/ → /tw/

church	2;6	cluster simplification of word-initial /tʃ/; correct pronunciation of word-final /tʃ/	/tʃ/ → /sj/
through	2;6	cluster simplification	/θ/ → /d/
bath, bathtub	2;6	cluster simplification	/θ/ → /f/
birthday	2;6	cluster simplification	/θ/ → /f/
both	2;6	cluster simplification	/θ/ → /f/
think	2;6	cluster simplification	/θ/ → /f/
three	2;6	cluster simplification	/θ/ → /f/
with	2;6	cluster simplification	/θ/ → /f/
toothbrush	2;6	cluster simplification of word-medial /θ/ but correct pronunciation of word-final /ʃ/	/θ/ → /f/
something	2;6	cluster simplification	/θ/ → /f/
something	2;5	cluster simplification	/θ/ → /k/
forth	2;6	cluster simplification	/θ/ → /s/