

Articulation Of Consonants In The Speech Of Cerebral Palsy Learners Of English As A Second Language

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Abstract: This study sought to investigate the articulatory characteristics of school-aged children with Cerebral Palsy (CP) learning English as a second language in Kenyan schools. 27 pupils that is 18 boys and 9 girls with CP and speech impairment participated in this study. Through a picture naming task, single and double syllable words were obtained through recording. A sample of 60 words covering initial, middle and final positions of words was used in this study covering all the English phonemes according to the IPA chart.

Phonetic transcription of oral consonants was performed independently by the researcher. More than half of the children had a variety of problems with the articulation of consonants. The sample for the study was divided into three categories namely mild, severe and acute. Twenty-three consonant phonemes were transcribed in order to represent variations in phoneme articulation. Error frequencies were examined with respect to two variables: place of articulation, manner of articulation of the target phoneme. Results showed that target phonemes with high articulatory complexity were most often misarticulated. Majority of the respondents produced articulations close to the place of the target word.

Keywords: Cerebral Palsy, Articulation, Consonants, Second language

I. INTRODUCTION

Cerebral Palsy is a medical condition that results from a brain injury that was either sustained before, during or very shortly after a child's birth. Although this condition is not progressive, that is, it does not worsen with time, the characteristics and effects may change over a given period of time. Brain injury as a result of Cerebral Palsy causes the impairment especially in muscles responsible for speech production.

Speech problems associated with cerebral palsy may include articulation errors, oral motor difficulties and dysarthria. Dysarthria is defined as "speech disorders resulting from disturbances in musculature control over the speech

mechanism due to damage of the central or peripheral nervous system. It designates problems in oral communication due to paralysis, weakness, or in coordination of the speech musculature" (Duffy, 2005). Dysarthria can greatly reduce the intelligibility of one's speech, and make it difficult for those with dysarthria to communicate with others.

Cerebral Palsy speech research and analysis in adults is well established regarding the assessment and management of articulatory abilities, whereas a research for children articulatory abilities and in this case for children learning English as a second language has been less studied (Hartley et al., 2003). Therefore, this study was focused on children articulation of the consonants.

Most studies of speakers with Cerebral Palsy have been conducted in English speaking countries (Leonard, 1998). There are some studies of the speech characteristics of this population in languages other than English such as Mandarin and Cantonese (Jeng, 2000; Whitehill and Ciocca, 2000). Their studies offer both clinical and theoretical benefits. Clinically, data is urgently needed to inform the assessment and treatment of speakers with Cerebral Palsy. Theoretically, investigation of different languages/varieties allows testing of hypotheses based on English-speakers (Leonard, 1998) and also examine hypothesis on universals of language.

More importantly, studies on second language in Kenya have focused mainly on acquisition and syntax errors made by learners (Bartoo, 2004). Literature on the speech of second language learners affected by Cerebral Palsy in Kenya seems to be scanty. The study was focused on characterization of speech errors in Cerebral Palsy children learning English as a second language in order to provide critically needed data to inform assessment and intervention for these speakers.

II. METHODOLOGY

A. RECORDING TOOLS

The researcher encountered problems while collecting data from cerebral palsy children which included poor concentration in some children, getting exhausted after speaking at long period and involuntary body movements such as jerking, spasm and drooling. To cope with these problems and have a natural speech conversation from those subjects, a simple language task was developed. The task involved showing picture plates of pictures representing a group of target words covered all consonants of English including initial, medial and final consonants and cluster consonants.

The output speech sample for children was acquired through recording of the speech sample elicited from the picture naming task. In the language tasks a score sheet was used to transcribe each of the words from the speech samples of the respondents. Each word was transcribed while highlighting the target phoneme in the word whether it was in initial, medial or final position. The consonant clusters were also considered in their respective positions.

B. SUBJECTS

The sample comprised of 27 second language learners of English diagnosed with Cerebral Palsy. The subjects ranged in age from 7 to 14 with a mean of 11.0 years. There were nine males and nine females. All speakers were students from St Martins Deporres School for cerebral Palsy (a school for children diagnosed with Cerebral Palsy).

C. MATERIALS

The study consisted of 60 words covering all the possible 77 phonemes in the English language, however, only 20 phonemes were selected for constructing language tasks of the

target words using the criteria that every word was a single syllable word and was able to be represented by a picture.

D. PROCEDURE

Recoding was carried out in a quiet classroom with the door without additional soundproofing materials. Subjects were instructed to speak each word in isolation. During the recording, the speech stimuli (the target picture) was presented to the subjects. In the case of unknown the target picture, the target words will be told and those pictures will be repeated after some pre-setup order.

Each child's speech was digitally recorded with a SONY recorder held within 16 inches of the child's mouth. All children were recorded in two sessions on consecutive days. Recording each child in two separate sessions enabled us to collect multiple productions of a large number of target clusters. Each session lasted 20– 40 minutes and took place in school.

E. TRANSCRIPTION

The recorded speech samples were transcribed on a score sheet by the researcher. After tape recording and later transcribing the speech sample of the respondents. The researcher also tape recorded the focus group discussions. The process of analysis of the speech samples from the respondents started with the preparation stage which was the selection of units of analysis (Guthrie, et al, 2004.) A unit of analysis can be a word or theme (Polit and Beck, 2004). In this study the units of analysis were words, sentences, narrative retellings and focus group discussions session.

The next stage was the analysis stage which involved the researcher analysing the manifest content. At this point the researcher organised the qualitative data. This process involved open coding, creating categories and abstraction. In open coding the researcher created headings as observed from the data. Then, the list of categories were grouped under high order headings (Mc cain, 1988, Burnard, 1991).

In order to reduce the number of categories the researcher collapsed those that are similar and those that are dissimilar. By creating the categories, this provided a means of describing the phenomenon to increase understanding and to generate knowledge (Cavanagh, 1997). The last stage was the abstraction stage. Each category was named using content characteristic words. Subcategories with similar events and incidents were grouped together as categories and categories grouped together as main categories.

III. RESULTS

A. CONSONANT ACCURACY

The consonant was described in terms of place and manner of articulation. Data from this study shows inaccuracies/misarticulations in terms of the place and manner of articulation. Error patterns affecting articulation of consonants were categorized as substitution, distortion, and addition. Substitutions were divided into manner only, place

only, or a combination of these subcategories. Distortion was used for realizations, which remained within the target phoneme. For example, in the production /n/ → [nl], the realization was lateralized but still within the target /n/. Addition was used to describe the pattern that a phoneme was added to the target initial.

There were a total of 60 target words that were to be elicited through a picture naming task covering the initial, medial and final position. While the number of respondents was 27. Therefore the total number of words elicited during the study was 1620. The researcher did the recording twice and therefore the number doubled to 3240.

In order to account for the percentages and the inaccuracies, the researcher took the total number of consonants that underwent substitution, omission or insertion for the each of the words divided by the expected consonants to be pronounced correctly which was 54 divided by 100%. Therefore for any accuracy/ articulation the percentage of the correct consonant PCC score would be:

$$\text{PCC score} = \frac{\text{Number of misarticulated consonant}}{\text{Total number of consonants produced}} \times 100$$

$N/54 \times 100$ whereby N is the number of mispronounced/misarticulated consonants while 54 is the total number of correctly articulated consonants that are expected.

INITIAL CONSONANTS

Consonant accuracy for initial consonants was examined in terms of manner and place of articulation. Manner of articulation involved:

✓ Stops/plosives

Phoneme	Words
[p]	Pencil
[b]	Boy, banana, blue, brush
[t]	Tree
[d]	Duck, drum
[k]	Cup, car
[g]	Girl
[?]	

✓ Fricatives

Phoneme	Words
[f]	Phone, feather
[v]	Vehicle
[θ]	This
[d]	Feather
[s]	Spoon
[z]	Zip
[ʃ]	Ship
[z]	

✓ Affricates

Phoneme	Words
[tʃ]	Chair
[dʒ]	Jumping

✓ Nasals

Phoneme	Words
[m]	Mobile
[n]	Knife

✓ Liquids

Phoneme	Words
[l]	Lamp, flowers
[r]	Rabbit

✓ Glides

phoneme	Words
[w]	Window
[y]	Yellow

Error patterns were categorized as substitution, distortion, and addition. Substitutions were divided into manner only, place only, or a combination of these subcategories. Distortion was used for realizations, which remained within the target phoneme. For example, in the production /n/ → [nl], the realization was lateralized but still within the target /n/. Addition was used to describe the pattern that a phoneme was added to the target initial. Table 2 below shows the percentage distribution of the consonants in initial position.

INITIAL CONSONANT ACCURACY

Consonant	substitution	distortion	insertion
[p]	56	15	4
[b]	45		
[t]	-		
[d]			
[k]	-		
[g]	-	02	4
[ʔ]			
[f]	-		
[v]	-		
[θ]			
[d]			
[s]	-		
[z]	-		
[s^]			
[z^]			
[c^]	-		
[j^]	-		
[m]	-		
[n]			
[n^]			
[l]		22	
[r]	-	06	
[w]	-		
[j]	-		

Data from this study shows that initial consonants were observed to undergo substitutions, distortions and insertions. The percentage accuracy of each initial consonant is shown in Table 1. The most robust initial consonant was /P/ at (56%) for substitution, 15% for Distortion and 4% for insertions. The strongest consonants were /r/ /f/ /t/ /ts/ /dz/ /s/ /z/ /m/ /w/ /k/ /j/ /k/ /g/ at (0%) for substitution. However the consonants /l/ /r/ and /g/ had distortions of 22%, 06% and 2% respectively. In addition the consonant /g/ had insertions of 4% that mainly involved an insertion of a consonant /n/ before the consonant /g/. The dentals [θ] and [d] and affricates [s^],[z^],[c^],[j^] as well as palatals did not have percentages because there was no response from the respondents. The

accuracy of initial consonants was analysed by manner and place of articulation as shown in Table 40 below.

Substitution was the most common pattern (30 instances or 56% of all errors). The next most common pattern was distortion (24 instances or 45% of errors), followed by addition (4 instances or 8%). When substitution errors were broken down by feature, the most frequent error pattern involving a change of only one feature was combination (64), follow by manner (39) and place (24) instances. The most common distortion errors were alveolization (29 instances or 53.8% of distortion errors) and labialization (3 instances or 23.1%). Insertions were relatively rare.

Feature	Phonemes	Accuracy (%)
Manner		
Plosives	b, d	72.2
Affricate	c, ch	66.7
Nasal	m, n, N	50.4
Fricatives	f, s, h	57.4
Liquid	l, r	0
Glides	w, j	72.2
Place		
Labial	p, b, m, w	64.8
Alveolar	t, th, d, n, s, r, l	43.7
Alveolar Palatal	c, ch, j	38.2
Velar	k, N	52.2
Glottal	P, h	0%
Labiodental	f, v	60
Dental	0 d	50

Table 2: Accuracy of initial consonants by manner and place of articulation

Plosives were the most robust manner class (72.2%); the lowest accuracy was for liquids (0%), fricative (57.4%), and nasals (50.4%), respectively. The most robust place of articulation was labial (88.9%); alveolar was the most vulnerable place of articulation was alveolar and alveolar palatal at 43.7% and 38.2 accuracy respectively.

Error patterns of initial consonants.		
Error pattern	#Occurrences	Error (%)
Substitution	82	75.9
Manner only	24	
Place only	11	
Combination	47	
Distortion	18	16.6
Addition	8	7.4
Total	108	100.0

Table 3: Error patterns of initial consonants

The above tables show the following conclusions for initial consonants for children with Cerebral Palsy who participated in this study:

- ✓ The most stable manner of production for initial consonants was fricatives, followed by plosives then by affricates

- ✓ The weakest manner of production was glides followed by liquids then by nasals
- ✓ The weakest / most vulnerable place of articulation was the glottal followed by the velar while alveolar and alveolar palatals showed almost similar vulnerability
- ✓ The most robust manner of production was the bilabials, followed by labiodentals and then dentals.
- ✓ Substitution was the most common error pattern followed by distortion and insertion.
- ✓ When substitution errors were broken down by feature, the most frequent error pattern involving a change of only one feature was combination, followed by manner and place.

MEDIAL CONSONANTS

Consonants in medial position of words were similarly examined on the basis of manner and place of articulation. In this study consonants in medial position of words were observed to undergo omissions and substitution. It was noted that the most omitted consonant in medial position was the /dz/ with 54% while the most substituted consonant was /z/ with 63%. Consonants such as /r/, /m/, /l/, /n/, /s/ did not undergo any omissions. However consonant /r/ and /n/ had 35% and 20% as substitutions respectively. A comparison between the two shows that consonants in medial position had more substitutions as compared to omissions. Table below summaries these findings.

Consonant	Omissions %	Substitutions %
[l]	-	35
[r]	-	20
[s^]	54	
[j]	45	
[m]	-	
[n]	-	
[z]	19	63
[j^]	-	-

Table 4: Medial Consonants

A look at place and manner of articulation for consonants in medial position shows that the most robust place of production was the bilabials followed by alveopalatals and lastly by alveolar. The most robust manner of articulation was the nasals followed by plosives and finally by liquids. While the most vulnerable manner of articulation for the respondent with Cerebral Palsy in this study was fricatives.

Feature	Phonemes	Accuracy (%)
Manner		
Plosives	j^	31
Affricate		
Nasal	m, n	20
Fricatives	z, s^	45
Liquids	l, r	38
Glides		
Place		
Labial	m	18
Alveolar	l, r, n, z	33

Alveolar Palatal	s [^] j [^]	24
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Table 5: Accuracy of medial consonants by manner and place

Error patterns for medial consonants shows that substitution was the most common error pattern at 88.8% that is 45 instances. When broken down substitution by manner had 19 instances, place 16 instances while combination had 45 instances. Omissions had 7 instances which is 13% of the total expected production of consonants in medial position. This is summarised in table 44 below

Error patterns of medial consonants.		
Error pattern	#Occurrences	Error (%)
Substitution	45	88.8
Manner only	19	
Place only	16	
Combination	45	
Omission	7	12.01
Total	132	100.0

Table 6: Error Patterns of Medial Consonants

FINAL CONSONANTS

For the consonants in final position of words, the error patterns were categorized as substitutions and omissions. Substitution errors were subdivided into manner only, place only, and a combination of these subcategories. Omission referred to the case when the target phoneme was missing.

The percentage accuracy of each consonant in final position is shown in Table. The most substituted consonant in final position as /θ and /d/ at 44% and 45% respectively followed by the consonant /f/, /p/ and /n/ at 37%, 35% and 30% respectively. It was noted that consonants /g/, /l/ /dz/ and /w/ were not substituted therefore being the most stable consonant. In regard to omissions the most omitted consonant /d/ followed by /p/ and /n/ at 70%, 60% and 52% respectively. The consonants /dz/ and /s/ were observed to be the least omitted at 15% and 12% while the nasal/n/ was at 28% omission. From this table the robust consonants in final position of words were /k/, /g/, /f/, /l/, /θ/, /d/ and /w/ at 0% omission thereby meaning that they did not undergo any omission.

consonant	Substitutions	Omissions
	%	%
k	4	-
d	7	70
g	-	-
f	37	-
l	-	-
dz	-	15
s	16	12
n	15	28
	43	
	44	
n	30	52
p	35	60
w	-	-

Table 7: consonants in final position

Analysis by manner of articulation revealed similar accuracy for nasals (mean percentage accuracy 66.7% and 72.2%, respectively) as shown in Table 4. Analysis by place of articulation showed that alveolar was the lowest accurate (mean percentage accuracy 63.9%), followed by velar (72.2%) and palatal was the most accurate (100.0%).

Feature	Phonemes	Accuracy (%)
Manner		
Nasal	m, n, N	72.2
Approximant	w, j	100.0
Place		
Labial	p, m, w	90.7
Alveolar	t, n	63.9
Palatal	j	100.0
Velar	k, N	72.2

Table 8: Accuracy of medial consonants by manner and place

In contrast to what is seen in initial consonants and medial consonants, whereas substitution was the most common pattern, omission is seen as the most common pattern for consonants in final position. When substitution errors were broken down by feature, the most frequent error pattern involving a change of only one feature was place only. The other two features (manner only and combination) provided the same number of instance errors of 7. The total number of phoneme omission errors was 73

Error patterns of final consonants.		
Error pattern	#Occurrences	Error (%)
Substitution	18	32.5
Manner only	7	
Place only	11	
Combination	18	
omission	37	67.5
Total	91	100.0

Table 8: error patterns of final consonants

CONSONANT CLUSTERS

A consonant cluster is a group or sequence of consonants that appear together in a syllable without a vowel between them. Jones, (1976). So as to give a complete picture of initial (onset) and final (coda) clusters in English, the following sources have been looked at: Heinz J. Giegerich (1992) who analyses consonant clusters in terms of generative phonology, Peter Roach (2002) whose analysis of possible phoneme combinations is based on more traditional structural approach, San Duanmu (2009) who supplements Giegerich's and Roach's descriptions of the phonotactic possibilities of English with the aspects of Optimality Theory and gives the reliable statistical data, and one internet source (<http://www.btinternet.com/~ted.power/clustersindex.html>) which offers the practical list of some consonant clusters in English.

The word, i.e. the syllable in English can begin with a vowel, with one, two or three consonants. No word in English begins with more than three consonants (Roach 2002: 71), thus the maximum number of segments in the word-initial consonant cluster is three. At the beginning of English words

(syllables), there are 55 two-consonant clusters. In many cases the first element is /s/ and the second consonant is approximant /l, r, w, j/ (Roach 2002; Duanmu 2009). Initial Consonant clusters in English are shown in table below

category	Consonant cluster
Oral plosives	pr, pl, pj, pw, pf, ps, pʃ, br, bl, bj, tr, tw, tj, dr, dj, dw, kr, kl, kw, kj, km, kn, kv, gr, gl, gw
Nasal plosive	nj, mj, mw
fricatives	fl, fr, fj, vj, vw, θr, θw, θj, st, sp, sk, sl, sw, sn, sm, sf, sj, sr, sv, zl, jr, jm, fn, fp, fw, hj

Table 9: Table of consonant clusters

The sample of 60 words involved in this study consisted of 12 consonant clusters as follows: pl, bl, tr, sp, sw, gr, fl, br, dr, kr, and tl all the consonants are found in initial position of the words except for tl which is found in final position for the word little.

The error patterns observed in this study were categorized as reductions and substitutions. Reductions were defined as the target consonant cluster being realized as a consonant (for example, /pr/ → [p] or /kl/→[k]). Substitutions were defined as the target consonant cluster being realized as another totally different consonant or another consonant cluster altogether. (for example, /thr/→[c]). Table below gives a summary of the percentages of reductions and substitutions for the consonant clusters found in the speech of the respondents in this study.

Consonant cluster	Reduction %	Substitution %
1	Pl	35
2	Bl	52
3	Tr	69
4	Sp	28
5	Sw	26
6	Gr	-
7	Fl	31
8	Br	-
9	dr	4
10	Kr	-
11	tl	7
12	fr	4

Table 10: Consonant cluster accuracy

As seen in the above table reduction was the most common error pattern in consonant clusters. The consonant cluster [tr] in the word tree underwent the most reduction at 69% followed by [br] in the word blue at 52%. The most stable consonant cluster is [fr] in the word friend with 4% reduction and 0% substitution. The most substituted consonant cluster was [br] in the word brush at 24% the substitution involved coming up with a totally different consonant cluster altogether.

An observation from this shows a difficulty in the articulation of consonant clusters that involved two different articulators such as the tongue and the palate for the consonant cluster [tr] and [bl]. It was however easy for the articulation of the consonant cluster [sw] probably because it did not involve a direct contact of two articulators that is the lips. Furthermore it was noted that between consonant clusters that are plosives such as [pl],[bl],[tr] and consonant clusters that are fricatives such as [fr],[fl],[sw], the ones that are plosives showed more

reduction and substitution compared to the ones that have fricatives.

Consonants	initial		mid		final		consonant clusters		
	Substitutions %	distortions %	omissions %	substitutions %	omissions %	substitutions %	reductions %	substitutions %	
p	56	15	7	r	-	64	k	-	4
b	52	11	6	dz	-	-	d	70	7
t	-	-	-	z	19	-	f	-	-
d	4	-	4	m	-	63	g	-	37
f	-	-	-	n	-	37	ts	-	-
v	-	-	-	l	-	-	l	-	-
ts	-	-	-	s	-	33	dz	-	15
dz	-	-	-	-	-	-	s	16	13
s	-	-	-	-	-	-	n	25	15
z	-	-	-	-	-	-	d	-	15
h	-	-	-	-	-	-	θ	-	44
m	-	-	-	-	-	-	n	52	30
n	-	-	-	-	-	-	p	60	35
l	-	-	-	-	-	-	w	-	-
r	22	11	-	-	-	-	-	-	-
w	-	-	-	-	-	-	-	-	-
j	-	-	-	-	-	-	-	-	-
k	-	-	-	-	-	-	-	-	-
g	-	-	4	-	-	-	-	-	-
Average	7%	2%	1%	3%	28%	16%	15%	14%	7%

Table 9: Summary table on articulation impairments in the speech of SLL children with CP

IV. DISCUSSION

The general goal of this study was to examine the speech of school going children between the ages of 4 to 14 years of age suffering from Cerebral Palsy with an aim of describing the and analysing articulation of consonants in terms of accuracy. Herein below we present the discussions of findings on two levels: consonant accuracy and error patterns. In this study its noted that the speech of Cerebral Palsy children is characterised by imprecise articulation, whereby it was noted that consonants were mainly affected.

The consonants in this study were observed to undergo error patterns of impairment that included substitutions, omissions, additions and distortions. The error patterns in this study were the phonological impairments. Substitution was observed to be the most common error pattern for initial consonants. This finding is similar to studies done in English speaking countries (Leonard, 1998). The second most common pattern error pattern was omissions followed by additions and distortions. Whereas substitution was the most common pattern observed for initial consonants, omission was the most common pattern for final consonants. This finding is dissimilar for studies done on the English language (Platt, 1980) and Thai (Manochiopinig, 2008) The finding was similar to a study done on the Cantonese (Whitehill and Ciocca, 2000).

As earlier observed, initial consonants were observed to have imprecise articulations especially for fricatives and plosives. For example, the consonant [s], was substituted with [th] while [p] was substituted for [b], and vice versa. This finding was in agreement with studies done on English language whereby similarly there is imprecise articulation of word initial consonants for the consonants [n], [s],[z],[d] and [t] (Sawner and Wheeler,1999).

In regard to manner errors, it is noted that place and voice errors were the most predominant on initial consonants. Manner errors occurred more on plosives as compared to fricatives. Affricates underwent devoicing especially for consonants in initial position such as [dz] in jumping. In initial position manner errors also involved a change of liquid to glide. Example the word rabbit to wabbit. Phoneme omission occurred three times more frequently on final consonants. A finding that is dissimilar to findings done on English language. (Platt, 1980). Consonants in medial position underwent

substitutions and omissions. The most omitted consonant in medial position was the /dz/ with 54% while the most substituted consonant was /z/ with 63%. Substitutions therefore were the most predominant compared to omissions.

In this study the pattern of feature retention in substitution is that place of articulation was less retained in the substituted sound than manner of production or voicing. The order/pattern of retention was as follows, voicing was most maintained, manner of production as the next most retained and place of articulation as the feature that is less retained when substitution occurred for initial consonants.

The accuracy of the consonant clusters were observed to be the lowest. Notably, by comparison to consonants in initial, medial and final positions, it was difficult for the respondents to articulate consonant clusters. The error patterns for consonant clusters showed that reduction which involved the target consonant cluster being realised as a consonant was the most common pattern. Substitution which was defined as the target consonant cluster being realised as another consonant was rare.

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