International Journal of English Linguistics; Vol. 3, No. 1; 2013
ISSN 1923-869X E-ISSN 1923-8703
Published by Canadian Center of Science and Education

Constraints Ranking among Bilingual Nigerian Adult Aphasics

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Received: November 24, 2012 Accepted: December 19, 2012 Online Published: January 25, 2013

doi:10.5539/ijel.v3n1p46 URL: http://dx.doi.org/10.5539/ijel.v3n1p46

Abstract

The speech of aphasics is a kind of language in which constraints are ranked differently from what obtains in the speech of non-aphasics. Bilingual aphasics rank constraints in ways that reflect that they have more than one language in their language faculty. Therefore, this paper examined the manner in which constraints are ranked among Nigerian adult aphasics, using 40 purposively sampled Yoruba-English aphasics from the University College Hospital, Ibadan, Nigeria. A normative text was given these subjects to read, and their speeches were tape-recorded. The data were analyzed perceptually. The frequency and percentage of each form of deviation noticed in their speeches were calculated. Optimality Theory was then used to explicate the way constraints were ranked by these subjects before those forms of deviation emerged as the optimal candidates. Three forms of deviation were discovered at the segmental level of their phonology, namely deletion, substitution and epenthesis. Generally, the subjects ranked constraints in ways opposite those of non-aphasics. Markedness dominates faithfulness in all their rankings.

Keywords: bilinguals, constraints, markedness, faithfulness, Nigerian aphasics

1. Introduction

The major consequence of aphasia is disorganization and reorganisation of the language area of the cerebral cortex. This leads to the emergence of a different grammar in the aphasics. Thus, the ranking of constraints in the aphasics will necessarily be different from those of non-aphasics. Such ranking has some consequences on Universal Grammar (UG). Aphasiology has concentrated mainly on first language speakers, particularly English and some other European languages (Bouhman and Grumbaum 1925; Goldstein, 1948; Luria 1966; Lecours and Lhermitte 1969; Goodglass *et al.*, 1972; Blumstein 1973; Peuser and Fittschen, 1977; Goodglass and Kaplan, 1983; and Niemi, *et al.*, 1985). It is recently that bilingual aphasics are receiving attention of linguists. Notable studies on Nigerian aphasics include Salami (2005), which is on one dysphasic Nigerian; Salami (2008), which is on a Nigerian woman with dysarthria; Sunday (2008), a doctoral thesis that describes the phonology of bilingual Nigerian adult aphasics; and Sunday (2010), which is on the suprasegmental phonology of bilingual Nigerian adult aphasics, using 20 aphasics.

In the production of speech, certain constraints are involved. These constraints are universal but they are ranked differently in languages (Archangeli, 1997, p. 11). The speech of aphasics is better conceived as a different kind of grammar, involving a ranking of constraints quite different from those of non-aphasic people. Studying the ranking of aphasics will definitely reveal the nature of the functioning of the brain in relation to language. It appears that the language faculty contains neatly programmed linguistic components. It is like Scrabble. The Scrabble bag has many letters; so also language has different components. A scrabble player has access to all the desired words; so also the user of language has access to different constraints but s/he selects the one s/he wants based on her/his exposure and knowledge. When there is damage to the cortex, there is reorganization of the components of the language faculty. This reorganization produces other languages which are different from the first language (L1) and any other language people in the environment are familiar with. Even though the neologisms of aphasics may not tally precisely with any known language, a careful analysis of such neologisms could reveal that they have structures.

In this paper, the ranking of constraints among bilingual Nigerian adult aphasics is examined from the angle of Optimality Theory, with a view to bringing out the regular patterns in the rankings; and suggesting how the care and rehabilitation of these aphasics can benefit from constraints ranking.

2. Types of Aphasia

Seven main types of aphasia could be identified: Broca's Aphasia, Wernicke's Aphasia, Global Aphasia, Conduction Aphasia, Transcortical Sensory Aphasia, Transcortical Motor Aphasia, and Mixed Transcortical Aphasia. But all of these could be broadly categorized into either Broca's aphasia or Wernicke's aphasia, since the site of the lesion would either be in the Broca's or Wernicke's areas of the brain or both. For instance, Global Aphasia shares the features of both. Conduction Aphasia is close to Wernicke's. Transcortical Sensory Aphasia is like Wernicke's Aphasia. However, in the former, what is said is better retained and repetition is relatively intact. Transcortical Motor Aphasia is similar to Broca's Aphasia, but there are better repetition abilities in it than in Broca's Aphasia. Mixed Transcortical Aphasia is close to Broca's Apahsia (Parker, 1986, p. 191; Whitaker, 1975, pp. 38-39; Wertz, 1996, p. 48; Cartell, 2006).

Broca's aphasia is also referred to as motor or expressive aphasia. In this aphasia, the lesion is situated in the lower frontal lobe, just anterior to the Rolandic fissure. This is the fissure that divides the frontal and parietal lobes. The features of Broca's aphasia include: effortful and non-fluent speech articulation; simplification of consonant clusters; substitution; and missing of affixes and function words. Broca's aphasics know what to say but they could not accurately present it (Wingfield, 1992; Caplan, 2003, p. 585).

Wernicke's aphasia is otherwise called sensory or receptive aphasia. The lesion is located in the upper surface of the temporal lobe; it affects the auditory cortex, and, at times, the parietal lobe. Its features include fluent spontaneous speech; verbal paraphasias; phonemic paraphasias; neologisms; use of general proforms and hackneyed phrases; difficulty with comprehending other people's speech; word-retrieval problems; paragrammatisms; and circumlocutions (Crystal 1987, p. 271; Edwards, 2002).

3. The Data

Forty subjects were used for this study; none of them was less than 35 years old. They were Nigerian adult aphasics got from the University College Hospital (UCH) Ibadan. All of them were Yoruba-English bilinguals. They were sampled at the wards and at the Medical Out-Patient (MOP) Clinic of the hospital. The clinic sessions were conducted on Fridays. The data collection lasted about ten months.

The purposive sampling technique was used to select the subjects used, as not all stroke patients are suitable for the research. Only those patients with language impairment were sampled. Before interacting with the patients at all, it was ascertained that they had speech deficits. Those who had almost fully recovered their lost speech ability at the time of data collection were excluded from the research. The tape-recording method was used to document their speech and other interactions the researcher had with them. The unstructured interview method was used to elicit information from the subjects. In most cases, the patients were asked to narrate the onset of the stroke. They eagerly did so. Other issues bordering on how they felt about their loss of speech were raised in the course of interacting with them.

The consultant neurologists on duty did the clinical diagnosis of the subjects. The researcher was granted access to their case files from which some demographic and relevant clinical data were collected. However, the subjects were identified as P1, P2, and P3 and so on, so as to conceal their identities.

Apart from the level of recovery, the level of education was another exclusion criterion. Those patients who did not have Western education were not used for the research. So as to have the same parameter to measure the general patterns of the phonology of the subjects, a normative text was administered to them. This text was a short passage containing some words representing some of the concepts examined in the study.

The data were subjected to perceptual analysis. This involved listening to the recorded data in order to discover the features being investigated. The analysis was mainly endonormative. The phonology of the subjects was assessed based on Nigerian English (NE) instead of Received Pronunciation (RP). The rationale for this was that the phonology they had acquired should be the standard for analysing the deviation or impairment noticed. Some patterns which RP (based on Daniel Jones' [2006] *Cambridge English Pronouncing Dictionary*) will see as deviation are the norms in NE. Seeing such as errors will be inappropriate. The speech patterns which deviate from RP but are regular in NE are not regarded as part of the peculiarities of the phonology of Nigerian aphasics. The statistical approach was also employed. The patients were broadly classified as Broca's aphasics and Wernicke's aphasics, using both clinical and linguistic criteria. The instances of deviation noticed in their speech were identified; the frequency of occurrence of each instance of deviation was recorded. Thereafter, how some of these instances of deviation, instead of the output candidates of NE and RP, emerged as optimal outputs was explicated with Optimality Theory (OT).

4. Constraints in Optimality Theory

Optimality Theory (OT) claims that CON, which refers to a universal set of constraints, forms part of human innate knowledge of language. This means that all languages use the same set of constraints; that is, all languages have access to exactly the same set of constraints. The violability of a constraint is not due to the property of that constraint; instead, it is due to its position in that language. The constraints thus have some consequences on markedness: the higher ranked constraints, which are so rarely violated, show the way in which the language is unmarked; whereas the lower ranked constraints, which are so frequently violated, show the way in which the language is marked. The incorporation of markedness into CON is an important feature of OT, as earlier models cater for theories of markedness separately (Archangeli, 1997, p. 15). In OT architecture, the input feeds into GEN(erator), which creates candidates but the candidates are considered by EVAL(uator), which selects the optimal candidates from the set Archangeli (1997, p. 13), as schematically presented below:

Input → *GEN* → *candidate* → *EVAL* → *Output* [Adapted from McCarthy (2002, p. 10)]

Dominance relation exists among the constraints. This dominance could be either by direct ranking or by a legitimate inference made from direct ranking arguments. The two ways are captured in what is known as Transitivity of Ranking (McCarthy, 2002, p. 6):

Transitivity of Ranking*: If* $C_1 >> C_2$ *and* C_3 *then* $C_1 >> C_3$ (Kager, 1999, p. 21)

This translates as: if C_1 dominates C_2 and C_2 dominates C_3 then C_1 dominates C_3. However, for the analysis to be correct, when both direct and inferred arguments for ranking are present, they must not contradict each other (McCarthy, 2002, p. 6).

In OT analyses, only the optimal candidate is given linguistic interpretation, although EVAL imposes harmonic ordering on all the candidates. This means that 'valid ranking arguments…must always involve an actual output form as one of the candidates being compared' (McCarthy 2002). Therefore, EVAL should be seen as a function from sets of candidates to sets of candidates. Each constraint works on a set of candidates and returns the subset that consists of those candidates that perform best on that constraint. In other words, EVAL can be understood in terms of function composition, as a lower-ranking constraint has as input the set of best performers on the higher-ranking constraint. This way, EVAL will produce at least one winner since a constraint can never return less than one best performer. In a nutshell, EVAL starts with the highest ranking (innermost) constraints and takes the other constraints in the order of their hierarchy until there is no constraint remaining (Samek-Lodovici and Prince, 1999, p. 18).

OT identifies two main types of constraints, namely **faithfulness** and **markedness**. Faithfulness constraints require identity between the input and the output, using the nature of the difference between the input and the output supplied by GEN. Initially, Prince and Smolensky (1993) proposed **containment,** which requires that the input be contained in each of the output candidates. This has been replaced by the **Correspondence Theory** proposed by McCarthy and Prince (1995). The **Containment Theory** sees epenthesis as an instance of overpassing phonetic interpretations of empty positions; and sees deletion as an instance of underparsing. Conversely, the Correspondence Theory predicts that the segments involved in epenthesis may participate in phonological processes. It claims that the two processes reflect the dominance of syllabic well-formedness over faithfulness, just as the Containment Theory claims (Kager, 1999, p. 100). Put differently, the two phonological processes show that faithfulness is violated at the instance of well-formedness.

In essence, the Correspondence Theory of faithfulness posits that there is a correspondence K from the input to each of its output candidates (McCarthy, 2002, p. 12). For instance, any epenthetic vowel does not correspond to the input, while other segments do. In such a case, the constraint DEP is violated. This constraint says that K must be surjective, so that every element of the output stands in correspondence with the output; that is, the output depends upon the input. Similarly, a deleted segment violates the constraint MAX, which requires that the inverse relation K^{-1} be surjective, so that every element of the input is in correspondence with the output; that is, the input is maximally expressed in the output (McCarthy and Prince, 1995). A candidate is unfaithful any time its associated correspondence relation describes anything different from an order-and structure-preserving mapping which is one-to-one and onto (McCarthy, 2002, p. 14).

Markedness constraints, on the other hand, evaluate the output candidate form which favours a particular structure over others without making reference to the input (Moreton, 1996/1999). For instance, it could favour syllables with coda over syllables without coda. 'Markedness constraints' refers to any constraint which assigns violation marks to a candidate based mostly on the structure of its output, without considering its similarity to the input. If a

candidate is marked by or with respect to that constraint, such a candidate gets at least one violation-mark from it (McCarthy, 2002, p. 14).

5. The Analysis

5.1 Background Information on the Subjects

Before proceeding on the analysis proper, it is necessary to present some necessary background information about the subjects. Most of the subjects were more than 50 years old (29 out of 40 (72.5%)). This suggests that aphasia is more rampant among people within this age bracket; or that aphasics within this age bracket patronized the hospital more than those below 50 years. 11 of them (27.5%) were females, while 29 (72.5%) were males. Thirty-six (36) of the subjects were right-handed, whereas the remaining four (4) were left-handed. The stroke affected the right side in 29 of them (72.5%); it affected the left side in 9 of them (22.5%); while it affected both sides in 2 of them (5%). 20 of the subjects (50%) suffered right hemispheric CVD, while 20 of them (50%) suffered left hemispheric CVD. Twenty-seven (27) of the subjects had Broca's aphasics, while 13 of them had Wernicke's aphasics.

5.2 Phonological Processes in the Speech of the Aphasics

Table 1 summarizes the phonological processes noticed in the speech of the Broca's aphasics.

Table 1. Summary of the phonological processes in the Broca's aphasics

Deviation																						
	Deletion							**Substitution**							**Epenthesis**							
	Vowel			Consonant				Vowel			Consonant				Vowel			Consonant			
	In	Med	Fin	In	Med	Fin	Total	In	Med	Fin	In	Med	Fin	Total	In	Med	Fin	In	Med	Fin	Total
F	1	8	4	56	35	82	186	8	61	21	87	37	55	269	4	6	22	17	23	20	92
%	0.5	4.3	2.6	30.1	18.8	44.1	100	3.0	22.7	7.8	32.3	13.8	20.4	100	4.3	6.5	24.0	18.5	25.0	21.8	100

As shown in Table 1, there were 186 instances of deletion. Only 1 involved vowels in word-initial position; 8 involved vowels in word-medial position; while 4 involved vowels in word-final position. As for consonants, 56 of the instances of deletion were in word-initial position; 35 were in word-medial position; while 82 were in word-final position. As for substitution, 8 affected vowels in word-initial position; 61 affected vowels in word-medial position; and 21 affected vowels in word-final position. 87 of the consonants substituted were found in word-initial position; while 55 were found in word-final position. Altogether, there were 269 instances of substitution. Epenthesis occurred 4 times in word-initial position; 6 times in word-medial position, and 22 times in word-final position. Instances of epenthesis involving consonants occurred 27 times in word-initial position; 23 times in word-medial position; and 20 times in word-final position. Thus, there were 92 instances of epenthesis.

The above analysis shows that in the Broca's aphasics, substitution accounts for about half of the total forms of deviation (49.2%); deletion follows with 34.0%; while epenthesis takes the remaining 16.8%. Table 2 below reveals this:

Table 2. Comparison of the deviation forms in the Broca's aphasics

Deviation	f	%
Deletion	186	34.0
Substitution	269	49.0
Epenthesis	92	16.8
Total	547	100

Table 3 below captures the deviation in the Wernicke's aphasics.

Table 3. Summary of the phonological processes in the Wernicke's aphasics

Deviation																						
	Deletion							**Substitution**							**Epenthesis**							
	Vowel			Consonant				Vowel			Consonant				Vowel			Consonant			
	In	Med	Fin	In	Med	Fin	Total	In	Med	Fin	In	Med	Fin	Total	In	Med	Fin	In	Med	Fin	Total
F	2	3	2	15	15	31	68	10	6	-	17	8	6	47	2	6	7	4	6	14	39
%	2.9	4.4	2.9	22.1	22.1	45.6	100	21.3	12.8	-	36.2	17.0	12.8	100	4.3	15.4	18.0	10.3	15.4	35.9	100

As revealed in this table, the frequencies of the forms of deviation in the Wernicke's aphasics sharply contrast with those of the Broca's aphasics, though both display the same forms of deviation. Deletion has the highest frequency of occurrence (68). 2 instances of deletion involved vowels in word-initial position; 3 involved vowels in word-medial position; while 2 involved vowels in word-final position. 15 of the instances of consonant deletion were in word-initial position; 15 were also in word-medial position; while 31 were in word-final position. Vowel substitution occurred only in word-initial and word-medial positions. 10 out of the 16 instances of this involved vowels in word-initial position; the remaining 6 instances took place in word-medial position; but there was none in word-final position. 17 out of the 31 instances of consonant deletion occurred in word-initial position; 8 occurred in word-medial position; while 6 occurred in word-final position. Altogether, 47 instances of substitution of segment were recorded. 2 of the instances of vowel epenthesis occurred in word-initial position; 6 at word-medial position; and 7 in word-final position. 4 of the cases of consonant epenthesis occurred in word-initial position; 6 in word-medial position; and 14 in word-final position. In all, there were 39 instances of epenthesis of segments.

The foregoing analysis reveals that deletion accounts for 44.2% of the deviation in the speech of the Wernicke's aphasics. Substitution accounts for 30.5% of the deviation in their speech. Epenthesis accounts for the remaining 25.3%. Table 4 below captures this.

Table 4. Summary of the forms of deviation in the Wernicke's aphasics

Deviation	F	%
Deletion	68	44.2
Substitution	47	30.5
Epenthesis	39	25.3
Total	154	100

5.3 Constraints Ranking in Bilingual Nigerian Adult Broca's Aphasics

The instances of deviation discussed above present interesting issues about constraints ranking. To capture these issues vividly, we need to examine some examples of each form of deviation, so as to see the relationship between the input and the output candidates. Let us first consider examples of each form of deviation before considering how some of the candidates emerged as optimal outputs.

Table 5. Substitution

		NE	RP
1. **tont** [tɒnt]	for *tongue*	/tʌng/	/tʌŋ/
2. **polit** [polit]	for *police*	/polis/	/pəlis/
3. **breaquast** [brɛkwɑst]	for *breakfast*	/brɛkfɑ:st/	/breɪkfɑ:st/
4. **toctor** [tɒktɒ]	for *doctor*	/dɒktɒ/	/dɒktə/
5. **ding** [din]	for *thing*	/tin/	/θɪŋ/
6. **mashnic** [mæʃnik]	for *mechanic*	/mekænik/	/mɪkænɪk/
7. **resended** [rɪsended]	for *defended*	/dɪfended/	/dɪfendɪd/
8. **mik** [mit]	for *meat*	/mi:t/	/mi:t/
9. **pway** [pwɛ]	for *pray*	/prɛ/	/preɪ/
10. **dannot** [dænɒt]	for *cannot*	/kænɒt/	/kænɒt/

Table 6. Deletion

		NE	RP
1.**etatit** [etat]	for *exercise*	/eksæsɑɪs/	/eksəsɑɪs/
2. **yesiday** [jesidɛ/	for *yesterday*	/jestædeɪ/	/jestədeɪ/
3. **tout** [tɑʊt]	for *proud*	/prɑʊd/	/prɑʊd/
4. **ice** [aɪs]	for *rice*	/raɪs/	/raɪs/
5. **allenge** [ælendʒ]	for *challenge*	/tʃælendʒ/	/tʃælɪndʒ/
6. **adam** [ædæm]	for madam	/mædæm/	/mædəm/
7. **sponded** [spɒnded]	for *responded*	/respɒnded/	/rɪspɒndɪd/
8. **dug** [dɒg]	for *drug*	/drɒg/	/drʌg/
9. **ank** [ænk]	for *thank*	/tænk/	/θæŋk/
10. **appotment** [æpɒtment]	for *appointment*	/æpɔɪntment/	/əpɔɪntmənt/

Table 7. Epenthesis

		NE	RP
1. **normanlly** [nɒmænlɛ]	for *normally*	/nɒmælɛ/	/nɒməlɪ/
2. **tipik** [tipik]	for *speak*	/spik/	/spi:k/
3. **waki** [wɒki]	for *walk*	/wɒk/	/wɔ:k/
4. **mandam** [mændæm]	for *madam*	/mædæm/	/mædəm/
5. **dut** [dʊt]	for *use*	/jʊs/	/ju:z/
6. **lour** [læwæ]	for *our*	/æwæ/	/ɑuə/
7. **hunsband** [hɒnsbænd]	for *husband*	/hɒsbænd/	/hʌsbənd/
8. **funlly** [fʊnlɛ]	for *fully*	/fʊlɛ/	/fʊlɪ/
9. **fak** [fæk]	for *car*	/kɑ:/	/kɑ:/
10. **asathack** [æsætæk]	for *attack*	/ætæk/	/ətæk/

How constraints are ranked in cases involving substitution is now considered. **Mashnic** and **meat** are used to illustrate**.** Tableaux 1and 2 show the constraints ranking for each of these words, respectively.

Tableau 1. The emergence of /mæʃnik/

Input /mɪkænɪk/ → Output /mæʃnik/

/mɪkænɪk/	*MAX	*IDENT (place)	*IDENT (manner)	*IDENT (low)	FAITH (σ)
mɪkænɪk	*	*	*!	*	
mekænɪk	*	*	*!		
☞mæʃnik					*

Tableau 2. The emergence of /mik/

Input /mi:t/ (meat) → Output /mik/

/mi:t/	*IDENT(place)	FAITH C
mi:t	*!	
☞mik		*

Tableau 1 shows how **mashnic /**mæʃnik/ emerges as the optimal candidate for the input /mɪkænɪk/.There are three output candidates: /mɪkænɪk/ (the RP candidate); /mekænɪk/ (the NE candidate) and /mæʃnɪk/ (the aphasic's candidate). For the patient to have chosen /mæʃnɪk/ instead of the other two output candidates, some re-ranking of markedness constraints must have taken place. Before considering the constraints, let us examine the substitution more carefully. Two phonemes are substituted: /æ/ for /ɛ/ and /ʃ/ for /k/. /ɛ/ is chosen as the norm rather than /ɪ/, which is found in the RP output candidate, because this assessment is based on NE, not RP. Thus, any speech therapy effort should aim at /ɛ/ not /ɪ/. /æ/ is low front unrounded open vowel, while /ɛ/ is low front unrounded half-open vowel. The only feature that distinguishes the vowels is the shape of the mouth. /ʃ/ is voiceless palato-alveolar fricative, while /k/ is voiceless velar plosive. Both consonants are voiceless but they differ in place and manner of articulation. Another phonological process in this data is syncope (elision of a vowel). The vowel in the second syllable of the NE output candidate is elided in the output of the aphasic.

Therefore, five constraints are involved in this ranking. Four of them are ranked in the opposite form, with (*) which indicates unacceptability. This means that in the phonology of the aphasics, such constraints are unacceptable, although they are acceptable in the phonology of non-aphasic adults. It is only in this way that we can account for the emergence of their optimal output candidates. In other words, the aphasics too use the same constraints the non-aphasic adults use but these constraints are in the opposite form of how non-aphasic adults use them. This suggests that there is a section of the brain meant for ranking constraints, and that damage to the cortex makes it work in a direction opposite to what is found in non-aphasic adults. Thus, the constraints in the phonology of non-aphasic adults are unacceptable to them. Since the focus of OT is on the output, the analysis has to consider the nature and ranking of the aphasics' constraints, which have resulted in the peculiar optimal outputs. The argument here is that, if the analysis sees them as violating the constraints of the non-aphasic adults, it will be impossible to arrive at their optimal output, since such an output will necessarily incur *many* lowest violations; while, 'the optimal candidate should be one with the fewest lowest violations' (Archangeli, 1997, p. 12). Below are the five constraints involved in the emergence of '**mashnic'** as the optimal output:

a. *MAX: allows deletion, since MAX states that every segment/feature of the input has an identical correspondent in the output (see Pulleyblank, 1997, p. 63 for Max).

b. *IDENT (place): allows difference in the place of articulation between the input and the output, contrary to IDENT(place) [see Kager (1999, p. 45)for IDENT (place)].

c. *IDENT (manner): allows difference in the manner of articulation between the input and the output, contrary to IDENT (manner).

d. *IDENT (low): allows difference in the height of the tongue between the input and the output, contrary to IDENT (low) [see Kager (1999, p. 128) for IDENT (low)].

e. FAITH (σˇ): means pronounce stressed vowels (Hammond, 1997, p. 50).

The constraints are ranked thus:

*MAX, *IDENT (place), *IDENT (manner), *IDENT (low)>> FAITH (σˇ)

This means that the four markedness constraints dominate FAITH (σˇ); that is, FAITH (σˇ) is ranked low. The other two output candidates fatally violate *IDENT (manner); consequently neither of them could be the optimal output. The optimal output violates only FAITH (σˇ); but, since this faithfulness constraint is ranked low in the phonology of the aphasic, /mæʃnɪk/ still emerges as the optimal candidate.

In Tableau 2, two constraints are involved:

*IDENT (place): allows difference in the place of articulation between the input and the output

FAITH C: requires faithfulness of consonants between the input and the output (Archangeli, 1997, p. 11).

The patient ranked the constraints thus: *IDENT (place)>> FAITH C.

This means that FAITH C is lowly ranked; as such, its violation does not disallow /mik/ from emerging as the optimal output. /mi:t/ (NE and RP output candidate) fails to emerge as the optimal output because it fatally violates *IDENT (place), which is dominated by FAITH C. The foregoing analysis shows that the substitution process involves M>>F; that is, markedness dominating faithfulness. In addition, the markedness constraints are in forms opposite to what is seen in the phonology of non-aphasic adults, owing to brain damage.

Constraints ranking in cases involving deletion are now considered. **Ice** and **tout** are used to illustrate.

Tableau 3. The emergence of /ɑɪs/

Input /rɑɪs/ rice → /ɑɪs/

/rɑɪs/	*MAX	*ONSET	FAITH C
rɑɪs	*!	*	
☞ɑɪs			*

Tableau 4. The emergence of /tɑYt/

Input /prɑʊd/ (proud) → Output /tɑʊt/

/prɑʊd/	*IDENT (place)	*IDENT (voice)	*MAX	FAITH C
prɑʊd	*	*	*!	
☞tɑʊt				*

The deviation in '**(r)ice'** involves the deletion of voiced palate-alveolar approximant in onset position. There are two output candidates, as shown in Tableau 4: /rɑɪs/ and /ɑɪs/. The aphasic ranks *MAX and *ONSET higher than FAITH (C): *MAX, *ONSET >> FAITH C. Due to this, /ɑɪs/ emerges as the optimal candidate, whereas /r ɑɪs/ which obeys FAITH C fails to emerge as the optimal candidate, because it violates*ONSET and fatally violates *MAX.

The realization of 'proud' /prɑYd/ as '**tout'** /tɑYt/ also involves substitution. /p/ and /d/ are both realized as /t/. /p/ is voiceless bilabial plosive; /d/ is voiced alveolar plosive; while /t/ is voiceless alveolar plosive. Two output candidates are involved in this ranking, since the NE and the RP output candidates are similar. The other output candidate violates *IDENT (place), which disallows sameness of place of articulation between the input and the output, as it contains /p/ instead of /t/ at the onset position. It violates *IDENT (voice), which disallows sameness of voicing between the input and the output; it contains /d/ instead of /t/ in the coda position. This output candidate fatally violates *MAX, which allows deletion, since it retains /r/. It, however, obeys FAITH C, which requires sameness in the input and the output. Conversely, the optimal candidate obeys the three constraints violated by the other output candidate. It violates only FAITH C. But, since the aphasic ranks the constraints as: *IDENT (place), *IDENT (voice), *MAX >> FAITH C, allowing other constraints to dominate FAITH C, /tɑʊt/ emerges as the optimal candidate. This optimal candidate simplifies the onset, making it only one consonant instead of two consonants.

In sum, therefore, deletion in the phonology of bilingual Nigerian adult Broca's aphasics reveals that they rank FAITH C low and rank *MAX and *ONSET high. This is contrary to what is noticed in the phonology of the non-aphasic adults.

The third form of deviation, epenthesis, is now considered. '**Fak**' and '**tipik**' are used to illustrate. Tableaux 5 and 6 show the ranking of constraints in each of them.

Tableau 5. The emergence of /fæk/

Input /kɑ: / (car) → Output /fæk/

/kɑ:/	*DEP	*IDENT(place)	*IDENT(length)	FAITH (σ)
kɑ:	*!	*	*	
☞fæk				*
kæ	*!	*		

Tableau 6. The emergence of /tipi:k/

Input/spi:k/ (speak) → output /tipi:k/

/spi:k/	*DEP	*IDENT (manner)	FAITH (σ)
☞tipi:k			*
spi:k	*!	*	

In Tableau 5, /fæk/ emerges as the optimal candidate. This candidate has epenthesis of /k/ at the onset of the input; it replaces the onset with /f/. /k/ is voiceless velar plosive, while /f/ is voiceless labio-dental fricative. Four constraints are in operation in this tableau: *DEP, *IDENT (place), *IDENT (place), *IDENT (length) – which disallows sameness of length of the vowels in the input and the output – and FAITH C. /kɑ:/ violates only *DEP and *IDENT (place), but it fatally violates *DEP too. /fæk/ violates only FAITH C. It emerges as the optimal candidate because the patient ranks the constraints as *DEP, *IDENT (place), *IDENT (length)>> FAITH C.

In Tableau 6, the NE and the RP output candidates are similar. Three constraints are involved in this ranking. The output candidate that fails to emerge as the optimal candidate fatally violates *DEP, which permits segment insertion; this candidate disallows the insertion of /i/ between the consonant cluster found in the onset. It also violates *IDENT (manner), a markedness constraint which allows difference in the manner of articulation of the input and the output. The optimal candidate violates only FAITH (σ), which requires sameness in the number of syllables in the input and the output. This optimal candidate substitutes /t/ (voiceless alveolar plosive) for /s/ (voiceless alveolar fricative), in obedience to *IDENT (manner). Its violation of FAITH (σ) makes it to have two syllables instead of one syllable which the input has. The emergence of this candidate as the optimal candidate is possible because the constraints are ranked as *DEP, *IDENT (manner) >> FAITH (σ). This ranking makes violating FAITH (σ) incapable of preventing /tipi:k/ from emerging as the optimal candidate.

One of the issues that arise in the instances of epenthesis just analyzed is that, as in other instances of deviation analyzed above, markedness often dominates faithfulness (M>>F) in the phonology of aphasics.

5.4 Constraints Ranking in Bilingual Nigerian Adult Wernicke's Aphasics

Before examining the way constraints are ranked by the Wernicke's aphasics, some examples of forms of deviation in the speech of the Wernicke's aphasics are presented.

Table 8. Deletion

		NE	RP
1**. Hypertenion** [hæpætenæn]	for *hypertension*	/hɑɪpætenʃɒn/	/hɑɪpətenʃn/
2. **Prou** [prɑo]	for *proud*	/prɑod/	/prɑʊd/
3. **Caendar** [kændæ]	for *calendar*	/kælendæ/	/kælɪndə/
4. **Milely** [mɪlɛlɛ]	for *immediately*	/ɪmɪdɪɛtlɛ/	/ɪmɪdɪətlɪ/
5. **Ank** [ænk]	for *thank*	/tænk/	/θænk/
6. **Bea** [beɑ]	for *better*	/betɑ/	/betə/
7. **Respoded** [respɒded]	for *responded*	/respɒnded/	/rɪspɒndɪd/
8. **Iro** [ɑɪro]	for *biro*	/bɑɪro/	/bɑɪrəʊ/
9. **Poli** [poli]	for *police*	/polis/	/pəlɪs/
10. **Ye** [je]	for *yes*	/jes/	/jes/

Table 9. Substitution

		NE	RP
1. **Corina** [korɪnæ]	for *carina*	/kærɪnæ/	/kərɪnæ/
2. **Quckly** [kʊklɛ]	for *quickly*	/kʊɪklɛ/	/kwɪklɪ/
3. **Polit** [poliːt]	for *police*	/poliːs/	/pəliːs/
4. **Typhod** [tɑɪfɒd]	for *typhoid*	/tɑɪfɔɪd/	/tɑɪfɔɪd/
5. **Teach** [tiːtʃ]	for *which*	/wiːtʃ/	/wiːtʃ/
6. **Toing** [toin]	for *going*	/goin/	/gəʊɪŋ/
7. **Festerday** [festɑdɛ]	for *yesterday*	/jestɑdɛ/	/jestədɪ/
8. **Pully** [pʊlɛ]	for *fully*	/fʊlɛ/	/fʊlɪ/
9. **Fap** [fæp]	for *pap*	/pæp/	/pæp/
10. **Kawor** [kæwɒ/	for *carrot*	/kærɒt/	/kærət/

Table 10. Epenthesis

		NE	RP
1. **Fifuty** [fifuti]	for *fifty*	/fifti/	/fɪfɪtɪ/
2. **Responted** [resɪpɒnted/	for *responded*	/respɒnded/	/rɪspɒndɪd/
3. **Entertmated** [entætmɛted]	for *terminated*	/tæmɪnɛted/	/tɜːmɪneɪtɪd/
4. **Feen** [fiːn]	for *fee*	/fiː/	/fiː/
5. **Tenl** [tenl]	for *tell*	/tel/	/tel/
6. **Stonle** [stonl]	for *stole*	/stol/	/stəʊl/
7. **Iresponded** [ɪrespɒnded/	for *responded*	/respɒnded/	/rɪspɒndɪd/
8. **Aspeted** [æspeted]	for *arrested*	/ærested/	/ərestɪd/
9. **Thsick** [tsiːk]	for *thick*	/tik/	/θɪk/
10. **Sash** [sɑʃ]	for *sir*	/sɑː/	/sɜː/

The way constraints are ranked in cases involving deletion are considered first. ‘Milely’, and ‘recollect’ are used to illustrate.

Tableau 7. The emergence of /mɪlɛlɛ/

Input /ɪmɪdɪətəlɪ/ (immediately)→ Output /mɪlɛlɛ/

/ɪmɪdɪətəlɪ/	*MAX	*IDENT (OBS)	*IDENT (central)	FAITH C
(i)ɪmɪdɪətəlɪ	**!	*	*	
(ii)ɪmɪdɪɛtəlɪ	**!	*	*	
☞ (iii) mɪlɛlɛ				*

Tableau 8. The emergence of /rikɒlet/

Input /rekɒlekt/ (recollect) → Output /rikɒlet/

/rekɒlekt/	*MAX	*IDENT(raised)	IDENT(back)	FAITH C
(i)rekɒlekt	*!	*	*	
(ii)rikɒlekt	*!			
☞(iii) rikɒlet				*

Tableau 7 shows the three output candidates for immediately: (i) RP output fatally violates *MAX twice, by allowing the initial vowel /ɪ/ and the consonant /d/, which the optimal output /mɪlɛlɛ/ deletes. (i) also violates *IDENT (OBS), which disallows the obstruent /t/ from appearing in the output; it also violates *IDENT (central), which disallows the occurrence of the diphthong /ɪə/, a centring diphthong. Output candidate (ii) also fatally violates *MAX twice, just the way the RP candidate does. It violates IDENT (OBS), like candidate (i) does; its diphthong /ɪɛ/ also violates *IDENT (back). The optimal candidate does not violate any of these constraints, because they are ranked as: *MAX, *IDENT (OBS) >> *IDENT (central).

There are three output candidates in Tableau 8. The NE output candidate (ii) differs from the RP output candidate with respect to two segments. While the peak of the first syllable of the RP output candidate (i) has /e/, the peak of the first syllable of the NE output candidate has /i/. /e/ is slightly more raised than /i/, although both are front vowels. The peak of the second syllable in the RP output candidate (i) has schwa, whereas the peak of the NE output candidate has /ɒ/. /ə/ is a central vowel while /ɒ/ is a back vowel. The aphasic's output candidate only differs from the NE candidate with respect to the deletion of /k/ in the coda of the last syllable. The journey from the input to the output involves four constraints. The RP and the NE output candidates fatally violate *MAX, by not deleting /k/. The RP candidate also violates *IDENT (raised), which does not permit raised vowel in the first syllable, and IDENT (back), which demands that there should be a back vowel in the output. These violations prevent the emergence of the RP and the NE candidates as the optimal output. The aphasic's output candidate violates only FAITH C, which requires that the kind of consonant in the input should also be in the output. This violation is not capable of preventing it from emerging as the optimal output because, in the language area of the aphasic, FAITH C is lowly ranked, as seen in the ranking of the constraints: *MAX, *IDENT (raised), IDENT (back)>> FAITH C.

From the analysis, it is deducible that the subjects rank *MAX above any other constraint. This means that in their phonology, markedness dominates faithfulness (M>>F), as it is with the Broca's aphasics analysed above.

Constraints ranking in cases involving substitution in the Wernicke's aphasics is considered next. Three words are used to achieve this end: '**police**' and '**cawor**'. Their output candidates are presented in Tableaux 9 and 10, respectively.

Tableau 9. The emergence of /poli:t /

Input /pəli:s/ (Police) → Output /poli:t /

/ pəli:s /	*IDENT (manner)	*IDENT (place)	FAITH (coda)	FAITH V
(i) pəli:s	*!	*		
(ii) poli:s	*!	*		*
☞(iii) poli:t			*	*

Tableau 10. The emergence of /kæwɒ/

Input /kærət/ (carrot) →Output /kæwɒ/

/kærət/	*MAX	*IDENT(place)	IDENT(back)	FAITH C
(i)kærət	*	*!	*	
(ii)kærɒt	*	*!		
☞(iii)kæwɒ				*

The substitution in 'police', as shown in Tableau 9, involves four constraints ranked as: *IDENT (manner), *IDENT (place) >> FAITH (coda), FAITH V. Output candidate (i), which is the RP output candidate, obeys FAITH (coda) and FAITH V. However, it does not emerge as the optimal candidate. The reason is that it fatally violates *IDENT (manner) and violates *IDENT (place). The former disallows sameness in the manner of articulation between the input and the output, while the latter disallows sameness in the place of articulation between the input and the output. These two constraints dominate FAITH (coda), which requires that the coda in the output must be faithful to the coda in the input, and FAITH V, which requires that the vowel in the output must be similar to that in the input. Output candidate (ii), NE output candidate, like the RP candidate, fatally violates *IDENT (manner); the manner of articulation of its final consonant is similar to that of the final consonant in the input, which *IDENT (manner) disallows. It also violates *IDENT (place) and FAITH V. Output (iii), that of the aphasic, emerges as the optimal candidate because it violates only FAITH (coda) and FAITH V, which are lowly ranked. The way the constraints are ranked in the brain of the aphasic allows /t/, voiceless alveolar plosive, to replace the voiceless alveolar fricative /s/.

There are two main phonological process involved in the case of '**cawor**', viz, substitution and deletion. The last consonant in the input (/t/) is deleted in the aphasic's output candidate. This consonant is voiceless alveolar plosive. /r/ which is in word-medial position in the input is substituted as /w/ in the aphasic's output candidate. /r/ is voiced palato-alveolar approximant, while /w/ is voiced bilabial approximant. Both the RP and the NE output candidates [(i) and (ii), respectively] violate *MAX by not deleting /t/. They both also fatally violate *IDENT (place), by permitting a consonant that shares the same place of articulation with the input, which this constraint disallows. The RP output candidate also violates IDENT (back), by not having the back vowel /ɒ/, which both the NE and the aphasic's output candidates have. The aphasic output candidate violates only FAITH C, a lowly ranked constraint. Because the aphasic's output candidate has only one violation, it emerges as the optimal candidate. In the language area of this aphasic, the constraints are ranked as *MAX, *IDENT (place) >> IDENT (back) FAITH C.

As it is with deletion, substitution in the speech of the Wernicke's aphasics involves ranking markedness above faithfulness (M>>F). This ranking is responsible for the choices made by the patients in this study.

'**Entertmated**' and '**tenl**' are used to illustrate how constraints are ranked in cases of epenthesis. Tableaux 11 and 12 capture this.

Tableau 11. The emergence of /entætmɛted/

Input /tɜ:mɪneɪtɪd/(terminated) →Output /entætmɛted/

/tɜ:mɪneɪtɪd/	*DEP	*IDENT(low)	*IDENT(voice)
(i)tæmɪnɛted	***!	**	*
(ii)tɜ:mɪneɪtɪd	***!	**	
☞(iii)entætmɛted			*

Tableau 12. The emergence of /tenl/

Input /tel/ (tell) →Output /tenl/

/tel/	*DEP	FAITH C
(i)tel	*!	
☞(ii) tenl		*

Tableau 11 illustrates instances of multiple violation of a single constraint. The NE output (i) fatally violates *DEP thrice, as it disallows the epenthesis of the vowel /e/ in word-initial position; disallows the epenthesis of /n/ after the epenthetical vowel /e/; and disallows the epenthesis of /t/ before /m/. This output also violates *MAX twice, because it disallows the deletion of /ɪ/ and /n/ from the input. It also violates *IDENT (low); it substitutes /e/ for /ɪ/ found in the last syllable of the input. The RP output candidate (ii) also incurs the same violation marks exactly the way output (i) does, except that it is faithful to the input by obeying IDENT (low). The optimal candidate violates only IDENT (low). Because the patient ranks *DEP very high, this candidate is able to insert the front unrounded half closed vowel /e/, the voiced alveolar nasal /n/, and the voiceless alveolar plosive /t/. The ranking of *MAX high too makes it possible for the optimal output to delete /n/ in word-medial position and /ɪ/ which is the peak of the ante-penultimate syllable of the input. These constraints are ranked thus: *DEP, *MAX >> IDENT (low).

There are two output candidates in Tableau 12, because the RP and the NE output candidates are similar. The second candidate /tenl/ is the aphasic output candidate. Two constraints are involved in this derivation. The first output candidate fatally violates *DEP, because it has no epenthetic consonant. It, however, obeys FAITH C, because its consonants are faithful to the consonants in the input. The optimal candidate violates FAITH C. This violation is incapable of preventing it from emerging as the optimal candidate, because, in the language area of the aphasic, the constraints are ranked as *DEP>> FAITH C.

6. Recommendations

The findings of this study have some implications for the rehabilitation of bilingual aphasics. Any meaningful speech therapy or rehabilitation has to consider the phonologies that the aphasic has. Particular focus must be given to the dominant phonology before the brain damage. For aphasics that are bilingual in English and any other language, the variety of English in the language faculty of the aphasic should form the target of the therapy. If a variety that the aphasic had not acquired, particularly RP, is targeted, the efforts may be unproductive, because it will be like learning an entirely new phonology. Conversely, if the already-acquired phonology is targeted, recovery might not be difficult, as speech therapy is essentially a resuscitating endeavour, not a planting process.

Moreover, the constraints that are ranked highest by the aphasics will help the speech therapists to know the kind of sound to focus on. This is where it is necessary to complement the efforts of neurologists and other professionals involved in the care of aphasics with the work of phonologists, who will concentrate on the constraints and how they are ranked to generate useful data and suggest how other specialists and caregivers should interact with aphasics. From the way the constraints are ranked, speech therapists can generate simple rhymes that can be used as exercises, which the caregivers can also adopt to assist aphasics at home.

7. Conclusion

The analysis of how constraints were ranked by the aphasics shows that the ranking is contrary to what obtains in non-aphasic adults. It also shows that the language area of these subjects ranks Markedness above Faithfulness (M>>F). In their phonology, certain constraints are marked and seen as being more important than faithfulness. This manifests in all the three forms of deviation identified at the segmental level of their phonology: deletion, substitution, and epenthesis.

For the aphasics to be able to rank the constraints the way non-aphasics do, the speech therapist has to gradually and systematically bring in simple exercises that will revive the ability of the brain to rank those often violated constraints high. The brain can be conceived of as a battery. Brain damage makes it to run down quickly. Speech therapy can reactivate it. The brain is also like firewood. If there is no damage it burns brilliantly. Any damage to it is like pouring water on the firewood. This makes the firewood dead. Continuous fanning can rekindle the firewood. Carefully selected exercises can make the aphasics to obey the violated constraints.

Considering the ranking of constraints from the perspective of the aphasics rather than the perspective of the non-aphasics is helpful in their rehabilitation. It makes it clear that their speech is deviation from a particular norm, specifically that of non-aphasics; it is not an error.

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