NOTES

OFO CO-OCCURRENCE RESTRICTIONS[1]

1. Introduction. This note discusses co-occurrence restrictions operating on aspirated consonants in Ofo. Ofo is an extinct Southeastern (Ohio Valley) Siouan language. The data for this language were first described in Swanton (1909) and fully set forth in Dorsey and Swanton (1912), which includes an Ofo dictionary containing 522 entries.

The segment inventory of Ofo is given in figure 1 (I follow de Reuse 1981 in his interpretation of Swanton's work, but use IPA symbols; the phonemes de Reuse is less certain of appear in parentheses).[2] Notice that the Ofo inventory includes six aspirated consonants (p^h, t^h, $tʃ^h$, k^h, s^h, f^h) in addition to h.

Ofo is the only Siouan language with a labio-dental fricative (Voegelin 1941). Ofo may also be the only language, of any family, for which /f^h/ has been claimed (the appearance of allophonic [f^h] is also extremely rare). A survey of the segment inventories of 317 languages (Maddieson 1984), for example, lists none with this segment.

2. The Ofo restrictions. The existence of distinctive aspiration in Ofo has been disputed. Wolff (1950:65) believed that Swanton was incorrect in marking distinctive aspiration: "Swanton distinguished between normal voiceless consonants (p, t, k, f, s) and aspirated ones (p^h, t^h, k^h, f^h, s^h, etc.); however, in most cases these seemed to be free variants of the same phoneme. In not one case was there a real contrast." (I have altered Wolff's notation to IPA.) Matthews (1958:13) follows Wolff in this matter. However, not all languages with distinctive aspiration yield many minimal pairs for this feature, and the Ofo dictionary is a small one; the lack of such pairs cannot be taken to indicate that distinctive aspiration does not exist.

Swanton (Dorsey and Swanton 1912:4) clearly states that contrastive aspiration exists: "Probably the consonants followed by h, which is here very distinct, correspond to the aspirated consonants of other Siouan dialects." More recently, Haas (1969), Rood (1979), and de Reuse (1981) have all accepted the existence of contrastively aspirated consonants in Ofo.

Ofo aspiration is variously transcribed by Swanton as x, $\underset{\circ}{x}$, and h. No scholar has considered these differences distinctive. Again, evidence comes from Swanton himself: "x, $\underset{\circ}{x}$, and h all usually stand for the aspirate which follows several Siouan consonants and is particularly prominent in the Ofo language" (Dorsey and Swanton

[1] This research was supported in part by a J. K. Javits Fellowship and is included in my 1997 dissertation, a revised version of which was published as MacEachern (1999). I thank Pamela Munro and an anonymous *IJAL* reviewer for their comments on this work.

[2] The standard claim for the related languages Tutelo and Biloxi is that neither of these languages shows an aspiration contrast. However, Munro (1988) reports that Rankin (1981; not seen) claims distinctive aspiration for Tutelo on the basis of some forms recorded by Sapir.

[*IJAL*, vol. 68, no. 3, July 2002, pp. 366–70]

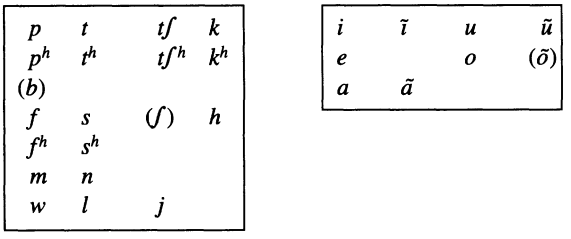

FIG. 1.—Ofo segment inventory.

1912:319). Regarding the distribution of these sounds, all aspirated segments are found accompanied by each aspiration marker, except the affricate, which only appears as *tch* and *tcx* (*tc* represents /tʃ/). I take the lack of *tc̥x̥* to be an accidental gap. Only *h* (not *x* or *x̥*) is found intervocalically and word-initially; thus, *h* is the only symbol used to transcribe the segment /h/.

De Reuse (1981:243) describes a synchronic, intermorphemic deaspiration rule: "A syllable of the shape ChV loses its aspiration when it comes to occur before another syllable of the shape ChV." An example is shown in (1); the transcription has been converted to IPA. The accent marks and nasalization (not relevant to the topic of this article) have been left as in the original.

(1) *o´skʰa* 'the crane' + *afʰã´* 'white' = *oskafʰa* 'the white or American egret'; **oskʰafʰa*.

In addition to the deaspiration rule in (1), and implicit in de Reuse's statement of this rule, is an intramorphemic co-occurrence restriction on aspirated consonants. There are no monomorphemic entries with more than one aspirated consonant: **kʰetʰi*, **fʰepʰi*, etc.[3]

At this point, we might ask what the limits of the Ofo deaspiration rule are. There are several other languages (e.g., Souletin Basque, Sanskrit, and Cuzco Quechua) that prohibit the co-occurrence of two aspirated consonants. These three languages also prohibit the co-occurrence of /h/ with aspirated consonants, and of two /h/'s. (See Lafon 1958, Grassmann 1863, Orr and Longacre 1968, and Carenko 1975 for early descriptions of these co-occurrence restrictions.)

On the other hand, there are also languages (e.g., the Rajasthani language Gojri and Aymara) that prohibit nonidentical aspirated consonants from co-occurring, but do not prohibit the presence of identical aspirated consonants, /h/ and an aspirated consonant, or two /h/'s.[4] (See Hardman, Vasquez, and Yapita Moya 1974, Adelaar 1986, and Landerman 1994 for early descriptions of the co-occurrence restrictions of Aymara; the Gojri restrictions are described in MacEachern 1999.)

[3] Interestingly, de Reuse's deaspiration rule can be taken as phonological evidence supporting the existence of the unique segment /fʰ/. The form given in (1), for example, shows deaspiration of /kʰ/ provoked by the occurrence of /fʰ/ in the following syllable. Had Swanton's *fʰ* actually been /f/, deaspiration should not have occurred.

[4] Actually, the possibility of a form containing two /h/'s does not arise in Gojri, because the language limits /h/ to word-initial position.

MacEachern (1999) provides a cross-linguistic survey of co-occurrence restrictions operating over what could be called "laryngeally active" segments (voiceless aspirated segments, breathy-voiced segments, ejectives, implosives, *h*, and *ʔ*) and establishes that these restrictions are characterized by many regularities: the typological statement is quite restrictive. For example, there are no languages that allow the co-occurrence of identical aspirated consonants that do not also allow the co-occurrence of two /h/'s (assuming /h/ exists in the language in question).

Cross-linguistic comparison, then, suggests that it is important to determine exactly which sets of segments are prevented from co-occurring by the Ofo restrictions.

The data in Dorsey and Swanton (1912) establish that aspirated consonants do occur with /h/: *inf^{h}ihi* 'afraid, scared', *ink^{h}ehi* 'it is enough', *tuft^{h}ahe* 'to hoe', *itʃ^{h}o ˊhi* 'green, unripe'. /h/ may also co-occur with /h/: *ahiˊhi* 'blood', *hóhĕ* 'to bellow (like a bull), to howl (like a wolf)', *ehõˊhé* 'to grunt (like a pig)'.

Given this information, the Ofo restrictions appear to resemble those of the second set of languages mentioned above (Gojri and Aymara). In both of these languages, however, IDENTICAL aspirated consonants ARE allowed to co-occur (e.g., Gojri *c^{h}ɪc^{h}ləp* 'cobra' and *k^{h}ək^{h}ɾi* 'a kind of cucumber'; Aymara *p^{h}usp^{h}u* 'boiled beans' and *tʃ^{h}atʃ^{h}u* 'tattered'; the Gojri data are from Sharma 1979, the Aymara data from Ayala Loayza 1988).

Did Ofo allow the co-occurrence of identical aspirated consonants? It is true that Dorsey and Swanton (1912) contains no Ofo words with identical aspirated consonants (**t^{h}it^{h}a*). The existence of such a restriction is also supported by a few Ofo words analyzed by de Reuse (1981). De Reuse presents three words (*ta'sis^{h}ihi* 'to whine', *tʃin'tʃ^{h}inti* 'to crawl', *'tufaf^{h}a/dufaf^{h}a/tufaf^{h}ahi* 'to tear') and proposes that these words involve reduplicated verb stems which have been subjected to the deaspiration rule. For example, de Reuse analyses *ta'sis^{h}ihi* 'to whine' as /ta/ + reduplicated /s^{h}i/ + /hi/. If the deaspiration rule applies to identical aspirated consonants, this suggests that the intramorphemic co-occurrence restrictions also prohibited the co-occurrence of these segments.

However, de Reuse's analysis of the forms given above is speculative. This fact, combined with the small size of the dictionary, raises the question of whether the absence of forms containing identical aspirated consonants—and perhaps even the absence of forms containing nonidentical aspirated consonants—could be due to chance. In the remainder of this note, I provide statistical evidence that although the absence of forms containing nonidentical aspirated consonants is not due to chance, the absence of forms containing identical aspirated consonants could be due to chance. The Ofo dictionary is small enough that we cannot conclude from it that identical aspirated consonants were prohibited from co-occurring within Ofo words or morphemes.

3. A statistical look at the Ofo restrictions. The dictionary has 522 entries, constituting 1,417 syllables (there are 11 words with vowel sequences; I treated these vowels as heterosyllabic). These entries include a total of 201 aspirated consonants. Like other Siouan languages, Ofo restricts aspirated consonants to syllable-initial position, so there are no cases of syllables containing more than one aspirated consonant. Dividing the total number of aspirated consonants by the total number of syllables (201 ÷ 1,417) indicates that the rate of occurrence of aspirated consonants per syllable is .14.

Assume that aspirated consonants are limited to one per syllable but occur in a freely independent fashion. There are 195 disyllables; if we let A be a syllable containing an aspirated consonant and C be its complement (i.e., a syllable without an aspirated consonant), then the possibilities in a disyllable are AA, AC, CA, and CC. The probability of AA is (.14)(.14) = .02. The probability of AC is (.14)(.86) = .12. The probability of CA is the same. The probability of CC is (.86)(.86) = .74. There are 195 disyllabic entries in the dictionary, so (.14)(.14)(195) = 3.9 indicates that we could expect about four disyllables with two aspirated consonants, if the aspirated consonants were occurring independently of one another (i.e., if they were not subject to a lexical co-occurrence restriction).

Similar calculations for words with three, four, five, and six syllables predict that an additional 19 forms with two or more aspirated consonants should be found. Apart from de Reuse's compounds, I did not attempt to decompose longer words into constituent morphemes. However, four-fifths of the dictionary entries are disyllabic or trisyllabic. Even if some of the longer words are bimorphemic, this would have little effect on the results. Thus, given the rate of occurrence of aspirated consonants in the dictionary, and the number of forms of different syllable counts, we would expect 23 forms with two or more aspirated consonants. Instead, we find none; a chi-square goodness-of-fit test yields $\chi^2 = 24.06$. This indicates that the probability of this occurring by chance is less than .001. I conclude that the lack of forms with more than one aspirated consonant is not due to chance.

As indicated above, however, consideration of languages other than Ofo suggests that the co-occurrence of identical and nonidentical aspirated consonants should be separately addressed. There are no examples of forms containing identical aspirated consonants. A consideration of the independent occurrence of the relevant consonants suggests that this gap could be due to chance. The dictionary entries include 32 occurrences of p^h, 50 t^h, 19 $tʃ^h$, 33 k^h, 25 f^h, and 42 s^h; these consonants occur at rates of occurrence of .023, .035, .013, .023, .018, and .030 per syllable, respectively. Calculations similar to those described above suggest that, if these consonants occurred independently, we would expect to find just one form including two identical aspirated consonants (the actual probability summed across aspirated consonants at all places of articulation is .96). The absence of one expected form would not be unusual; I conclude that we cannot assert the existence of a lexical co-occurrence restriction operating on identical aspirated consonants.

As noted earlier, the expected number of forms containing two or more aspirated consonants is 23. Subtracting one from this number (representing the hypothetical form containing identical aspirated consonants) will not significantly alter the results of the earlier calculations: we would expect 22 forms to contain nonidentical aspirated consonants, and the likelihood of finding none—in the absence of a co-occurrence restriction—is still improbably high. The chi-square goodness-of-fit yields $\chi^2 = 22.97$, indicating that the chance of this having occurred by accident is less than .001.

4. Conclusion. I conclude that although the Ofo data available to us do establish the existence of a co-occurrence restriction operating over nonidentical aspirated consonants, the existence of a co-occurrence restriction operating over identical aspirated consonants is not definitively established. This gap in the data could be accidental; the Ofo data set is too small to make a claim on this issue. However, the

three forms highlighted by de Reuse, which he suggests contain reduplicated verb stems, do indicate the existence of a co-occurrence restriction operating over identical aspirated consonants. The existence of such a restriction is also supported by the analysis given in MacEachern (1999). In that work, I provide an Optimality Theory account of laryngeal co-occurrence restrictions in eleven languages, and demonstrate that the only constraint ranking that will generate the observed forms of Ofo, while prohibiting forms containing nonidentical aspirated consonants, will also prohibit forms containing identical aspirated consonants.

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