Bleaching and Coloring

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Current studies in natural phonology have dealt with vowels in terms of three cardinal properties: palatality, labiality, and sonority. Palatality and labiality—the chromatic properties—are optimized by a minimally open, maximally constricted vocal tract; and sonority is optimized by a more open vocal tract. Thus the familiar triangle:

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i  u  a
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represents the maximal opposition of the three properties.2 And in many ways, the vowel space does seem to be triangular: ordinarily, the more sonorant a vowel is, the less color it has; and the more chromatic it is—the less sonorant. Thus, while i, e, and o are all palatal, i is more palatal than e, and e is more palatal than o; and, similarly, the degree of rounding varies for u, o, and ø. The vowels i, ø, and a are colorless or achromatic. They lack both palatality and labiality, and differ only in sonority.3 In this framework, the terms bleaching and coloring are almost self-explanatory: bleaching removes color, and coloring adds color.

Bleaching may remove palatality or labiality, or both simultaneously:

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\begin{array}{c}
\text{V} \\
\text{lower/}
\text{stressed}
\text{+}
\text{-Labial/}
\text{or}
\text{-Palatal}
\text{mixed}
\text{(context)}
\end{array}
```

Full-scale operation of bleaching will produce linear vowel systems like those of the Caucasian languages reported to have i, ø, a. If a lowers, it will produce the system ø, a like that of Kabardian (Kulpers 1965:23 et passim), or that of the child Curth (Oliver forthcoming); or, if all achromatics lower, it will give the single-vowel system a.

The unity of the process is shown by the Middle Welsh change of y to ø (Morris Jones 1913:13-14). If bleaching were two separate processes, and if in Welsh unrounding had operated, then depalatalization, the Welsh y's would have bleached, too; or, if the order of two such separate processes had been depalatalization, then unrounding, u would also have become ø. Since neither of these alternatives occurred, we must conclude that bleaching is a single process (and that, in Welsh, it was limited to operation on mixed vowels).3

The conditions on the applicability of bleaching reflect the fact that the less color a vowel has, the more likely it is to bleach. Thus, bleaching affects lower vowels before higher ones. The Sanskrit merger of e and ø with a (Burrow 1965:103ff.) was probably achieved by a bleaching of o, which lowered of ø to a when long. Here the bleaching affected mid vowels but not high ones. The apparent change of OE æ to ME a (Wright 1928: 19-20) is an example of a bleaching which affects only the low vowel of the series.

The operation of bleaching on unstressed vowels before stressed ones is evident from the bleaching involved in English vowel reduction (Miller 1972b). Bleaching also affects short or lax vowels before their long or tense counterparts. For instance, general American short i becomes a, as in 'not', while long i remains, as in 'nought'.

Bleaching also favors mixed vowels over those with pure colors, as in the Welsh bleaching of y, which left i and u untouched. In Welsh, bleaching removes both palatality and rounding, but the process may remove just one color instead of two.

It is appropriate to show here why changes like y + i are instances of bleaching. Such unroundings (and the corresponding but rarer depalatalizations like y + u) certainly involve the removal of a color, and there is additional evidence that such changes are caused by the same process that makes u become ø (or i + ø).

First, simplifications of mixed vowels share the same hierarchies of applicability as bleaching of pure vowels. The unrounding of OE æ before the unrounding of y (Campbell 1959:76-7 and 132) shows the lower condition to hold; and the fact that both unstressed ø and y unrounded long before their stressed counterparts in OE (Campbell 1959:132-3) upholds the unstressed condition.

Second, it appears that the unrounding of u implies the unrounding of y. The rarity of the u + ø change makes this hard to observe directly, but systematic facts suggest that it is the case. Vowel systems with i, y, ø, but no u, or with y, ø, u, but no i could only be achieved by bleaching pure colors and failing to bleach mixed ones. The non-occurrence of such systems shows that the bleaching of pure-colored vowels implies the bleaching of mixed ones: u + ø > y + i (and i + ø = y + u). This implicational relationship, which shows that the two unroundings result from the same process, is supported by changes observed in diphthongs, which will be dealt with later.

The fact that mixed vowels can bleach while pure vowels maintain their colors reflects the fact that mixed vowels are less chromatic than pure ones. Other processes that depend on degree of color support this view.9

Although bleaching is a context-free process, it can be set off or conditioned by contextual factors, particularly in diphthongs. Bleaching and coloring in diphthongs will be discussed in a separate section of this paper.
Coloring.
Coloring includes two distinct processes, Palatalization (e.g. \( \dot{a} + i \)) and Labialization or Rounding (e.g. \( \dot{a} + u \)). The two processes have similar conditions of application and thus, presumably, have similar causality: this causality is related to the maximization of distinctiveness in vowels with less-than-optimal sonority. Unlike the two halves of bleaching, palatalization and rounding do not form a single process or produce changes like \( \dot{a} + y \).

Production of a mixed vowel like \( y \) in this way would counteract the basic causality of the coloring processes, since mixed vowels are less distinctive than pure ones.

For the same reason, context-free coloring processes affect only achromatic vowels. Chromatic vowels like \( i \) and \( u \) do not spontaneously add a color. A second color would weaken the original color and would, like adding two colors, contradict the nature of the process. (I will deal with some apparent cases of context-free coloring processes. This too will be dealt with in the section on diphthongs.)

The applicability of coloring varies directly with height—exactly the opposite of bleaching. Children ordinarily operate coloring processes on their high vowels (which represent both high and mid adult vowels because of raising)—thus Joan Veiten, by rounding, had \( u \) and \( a \), and Hildegard Leopold, by palatalization, had \( i \) and \( a \).

Coloring may also affect mid and high vowels, as in languages like Hungarian (Jensen 1972), where palatalisation may affect the underlying back-harmonizing vowels \( i \) and \( a \), making them \( i \) and \( e \). There do not seem to be any cases, however, where palatalisation affects only the mid and low or only the low vowels, leaving \( i \) without \( a \) and \( e \), or leaving \( i \) and \( a \) without \( u \).

As with bleaching, context can catalyze or encourage these essentially context-free coloring processes. This too will be dealt with in the section on diphthongs.

Bleaching and coloring, then, appear to be counter-processes in a variety of ways. First, they have opposite effects: removal of color vs. addition of color. Second, they appear to be favored by opposite conditions. Bleaching affects only chromatic vowels (some vowels lose nothing to bleaching while coloring affects only achromatics. Bleaching favors lower vowels and coloring favors higher ones. Unstressed vowels are more susceptible to bleaching and, in general, stressed vowels are more susceptible to coloring.

Examples of such bleachings are not hard to find. Delabialization of low vowels before a labial glide occurred to produce modern English \( u \) from the earlier \( o \) of speakers like Thomas Batchelor (Chomsky and Halle 1968:284). Mid round syllabics have bleached before labial glides in Cockney (Givertz 1950:34 et passim), and in some New York dialects (Labov 1972:figs 7, 10), so that \( u \) (from mid English \( u \)) has become \( w \). In a number of British and U.S. dialects (e.g. Bethnal Green in London; Norwich, England; and Sheffield, Texas) all the round syllabics before labials have bleached, yielding \( u \), \( o \), and \( a \) for \( u \) (now commonly \( u \)), \( o \), and \( a \) (Labov 1972:figs. 29, 37, 53, 53).

Depalatalization before palatal glides is less common, but it does occur. As when \( i \)--from earlier \( i \)--became \( a \) in Icelandic (Benediktsson 1959:986), and when \( i \) becomes \( aj \) in certain North Carolina and Texas dialects observed by Labov (1972:figs. 38, 50). High vowels may depalatalize too: some of the North Carolina speakers have \( aj \) for \( i \) as well as \( \theta \) for \( o \) (e.g. fig. 41).

Like bleaching, coloring may also be catalyzed by a diphthongal context. Such coloring is characteristically dissimilative: palatalization is favored by the presence of a labial glide, and rounding by the presence of a palatal one. Dissimilative palatalization of high vowels produces \( iy \) from \( u \) in the Outer Banks (North Carolina) dialect where \( iy \) and \( iy \) are the variant pronunciations of more general \( u \) (Labov 1972:figs. 40, 43). Mid achromatics undergo this dissimilative coloring, too, as in French, where the syllabic of \( u \) from older \( o \) became palatal, yielding \( e \) for
original close ø (Pope 1934:104). Among low vowels, the syllabic of ø palatalizes to ø§ in many U.S. dialects; an example is the dialect of East Atlanta (Labov 1972:figs. 46, 47, 48).

Dissimilative rounding also occurs, as in the Lithuanian substitution of ą for Russian ą (S. Anderson 1972:23); in the variation of ø§ with ø§ (from Old English ą) in the British dialects of the South Midlands (Wright 1905:127), and in the change of ø§ to ø§ in the North Carolina dialects mentioned above or the variation of ø§ with ø§ in Worcester and the South Country (Wright 1905:127).

The examples given above show that bleaching and coloring have the same hierarchies of applicability in diphthongs as they display for simple vowels. This may not always be immediately apparent, since the non-syllabic elements of the diphthongs affect the application of the processes by producing hierarchies of application which may cross-cut the intrinsic hierarchies of the processes. A fair example of this is the bleaching of Cockney ø§ to ø§, while ø remains chromatic. According to bleaching’s lower condition, if ø becomes ø, ø should become ø. But as I noted earlier, in diphthongs the glide preserves the color of the nucleus and thus may condition, or catalyze, the bleaching process. Bleaching, then, may be limited to occurrence in diphthongs; if the glide—the catalyst—is missing, the process does not operate.

Other apparent violations of the process hierarchies may be explained by ordering. The Outer Banks dialect of Nora Herbert (Labov 1972:fig. 41) provides an interesting example. Nora has ø§ and ø§ from ø§ and ø§, but

ø§ ø§ for ø§ ø§

—an apparent violation of the higher coloring hierarchy. This situation can be explained, however, by suggesting that dissimilative coloring applied in its most general form, affecting the low chromatics, before a general bleaching affected the mid and high diphthongs. (Note that ø§ and ø§ did not bleach because their syllabic and glide elements were not like-colored.)

<table>
<thead>
<tr>
<th>Coloring:</th>
<th>ø§</th>
<th>ø§</th>
</tr>
</thead>
<tbody>
<tr>
<td>ø§ + ø</td>
<td>ø§</td>
<td></td>
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<tr>
<td>ø§ + ø§</td>
<td>ø§ + ø</td>
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<tr>
<td>Bleaching:</td>
<td>ø§</td>
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<td></td>
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<td>ø§</td>
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</tbody>
</table>

Neighboring dialects which have undergone the coloring of ø§ and ø§ but not the general bleaching suggest that this order may be correct.

An important relationship between bleaching and coloring becomes especially apparent in diphthongs; that is, bleaching ordinarily feeds coloring, and crisis-cross changes between palatal and labial often result in the syllables. Nora Herbert’s ø§ and ø§ reflexes of OE ð and ø show such a crossing, as do the British variations—and in the South Midlands of ø§ with ø§ from OE ð and ø§ with ø§ from OE ð (Wright 1905:127, 146).

Diphthongization sets up a situation in which bleaching is quite common; and bleaching, in turn, by producing achromatic vowels (especially by producing achromatics in the environment of chromatic glides), provides material for the coloring process. This natural sequence of processes provides a possible solution to the problem presented by context-free color-adding changes like the change of ø to y in languages like French, Yiddish, Paroese, Greek, and others, and the similar changes of ø to ø in some of these and in Northern English.

So-called ‘frontings’ like ø + y or ø + ø are problematic because, by producing less-optimal vowels from more-optimal ones, they run counter to the basic phonetic causalities of bleaching and coloring, which exist to produce an optimal system.

In explaining such changes as ø + y, the fact that the surrounding of y to i is bleaching is an important clue. It is notable that in a number of languages the change of ø to y was preceded by the surrounding of y. Traditionally, this would be described as a chain shift, but the chain model is not thoroughly satisfactory. First, the changes in question here are not due to a change in a single feature, and the chain is thus not easily interpreted as a single process. And second, simplification of the y segment may be viewed as the initiating movement of the chain, but the motivation for the change of ø to y is still obscure. The drag-chain theory leaves unexplained the fact that in such chains the language is sometimes temporarily left without an ø, so that in terms of pure pattern, the state of the language after ø + y is worse than the state before the change.

I suggest that the change of ø to y took place by a series of processes beginning with the diphthongization of ø to ø§, and that the same process of bleaching which surrounds y to i also surrounds the ø of ø§ to ø§, producing the nucleus ø§ for ø. The ø to y change, then, would be a matter of

Diphthongisation: ø + ø§
Bleaching: ø§ + ø
Coloring: ø + ø
and Monophthongisation: ø + y.

Some developments of ø to y are paralleled by similar developments in the mid vowels, where ø becomes ø:

ø + ø§ + ø§ + ø + y
ø + ø§ + ø§ + ø + ø
ø + ø§ + ø + y
ø + ø§ + ø + ø
Such parallel changes took place in the histories of Faroese, French, and Yiddish. (In Yiddish, the ś unrounded to s.)

There are, of course, other reasons for suggesting that u to y and similar changes occur through diphthongization. In French, for example, the diphthongal stage of ś is indicated in the spelling 'où'.

Also, in some languages with these color-mixing developments, diphthongal intermediate stages may remain in some environments. Faroese old long û and ë (which I will call tense to avoid confusion) diphthongized, and the old tense-lax distinction was evidently reinterpreted to diphthong-vs.-monophthong, because the language then developed a new, predictable length distinction. The short variants of the diphthongs from old tense û and ë eventually monophthongized, but the long variants remained diphthongal:

\[ \text{û} \rightarrow \text{u} + \text{y} \rightarrow \text{uy:} \]

\[ \text{ë} \rightarrow \text{e} + \text{y} \rightarrow \text{ey:} \]

Intermediate stages of a fronting via diphthongs may also be preserved in neighboring dialects within a language. Middle English ś (02 ś) became û in the Great Vowel Shift, but it has since become û + ū in Cambridge, iy - ë in North East Norfolk, and ë in East Devon and East Suffolk (Wright 1905:131-132).

\[ \text{u} \rightarrow \text{u} + \text{y} \rightarrow \text{uy:} \]

\[ \text{e} + \text{y} \rightarrow \text{ey:} \]

Diphthongal intermediate stages may also be revealed by changes in the glide elements of the diphthongs. Glide absorption or sharpening may 'strand' the syllabic elements at some point in the middle of a series of changes and thus offer further justification for diphthongal fronting. In Faroese, certain glides were sharpened to homorganic affricates (Rischel 1968:103) or absorbed by tautosyllabic homorganic consonants (examples from Lockwood 1955:10-12):

\[ \text{ajov} \rightarrow \text{ajov} \rightarrow \text{sea}' \]

\[ \text{fjov} \rightarrow \text{fjov} \rightarrow \text{ten}' \]

\[ \text{friv} \rightarrow \text{friov} \rightarrow \text{health}' \]

\[ \text{évov} \rightarrow \text{évov} \rightarrow \text{new}' \]

\[ \text{fík} \rightarrow \text{fíov} \rightarrow \text{cow}' \]

\[ \text{tól} \rightarrow \text{tól} \rightarrow \text{to think}' \]

The quality of the vowels before these new consonants shows the quality of the syllables of the earlier long or short diphthongs.

These stranded syllables thus provide further evidence for the intermediate diphthongal stages.

The above data indicate that in languages like the ones mentioned, the apparent 'fronting' u → y may take place by diphthongization, bleaching, and monophthongization. These 'frontings' are sometimes paralleled by simultaneous 'backings'. In Faroese, while ś became y/uy: or uy: and ë became ë/ey: or ey:

\[ \text{f} \rightarrow \text{uy:} \]

\[ \text{ë} \rightarrow \text{ey:} \]

Diphthongization

Bleaching

Dissimilative Coloring

Dissimilative Coloring

Bleaching

Diphthongization

Dissimilative Coloring

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With this analysis, these 'backings' and 'frontings' have a common origin in diphthongization and bleaching, and the criss-cross changes, which at first glance seem so puzzling, can be accounted for by the opposite but similarly-motivated processes of dissimilative coloring.

Presumably changes like these, which often produce mixed vowels, would not occur if it were not for the fact that the processes—or the speakers who use them—are quite 'short-sighted', so that a series of processes may eventually produce effects which contradict the basic casuality of any one or more of the individual processes.

The processes themselves are simple and consistent; it is their response to a variety of applicability conditions that makes their operation in language appear complex. I have tried to show here, however, that these various conditions on applicability are themselves consistent—though they have phonetic explanations related to the degree of features like palatality or rounding which a segment can be expected to possess, and that the applicability of a process is a response to its function—in particular, that the opposite applicibilities of bleaching and coloring are related to their opposite functions.

The complexity of some of the changes I have outlined and the multiplicity of their intermediate stages make the theory particularly vulnerable. However, the promising aspect of the theory is this fact: while these intermediate stages offer a great many targets, no clear counterexamples have yet been found. The work presented here is, of course, only a beginning, but I hope that further evidence like that which I have found will eventually show
that phonologically-operated but phonetically-motivated processes, similar to the ones I have described, are real and universal.

Footnotes

1. The ancient Indian grammarians seem to have identified neutral or schwa-like vowel quality with voice (Allen 1961:59-60). Just as palatality and labiality are degrees of properties, then, sonority could be described as degree of voicing. The vowel-devoicing hierarchy (!high) supports this view.

2. The two-dimensionality of the triangle as diagrammed should not be taken to imply that the vowel space (phonetic or phonological) is two-dimensional. Palatality, roundness, and sonority are distinct properties and should ideally be represented as separate dimensions. Also, there are probably other less important colors, e.g. velarization, or Crj-coloring of vowels. The remarks on r-coloring and 1-coloring in Holly Seminoff-Celasko's article in this volume reveal the parallelism of these colors to palatality and labiality with respect to assimilation and desyllabification.

3. Although the physical vowel space is clearly triangular, the evidence from processes described here and in Stampe (1972a) indicates that the phonological vowel space is, in Stampe's term, 'orthogonal', so that phonological changes take place by rock-like moves rather than bishop-like ones. Thus, for example, a change of o to a must have an intermediate stage o or A; 0 + A

4. Curt has $ for i, u, e, o, ï, í, and a for e, ò, A.

5. This is thus an example of a process capable of changing two features at once. People (e.g. Chomsky and Halle 1968:Ch. 9) have conjectured that all changes involve a single feature, and this is probably true of most processes. It is true of coloring, according to arguments I give below. But the function of bleaching is to increase sonority, and both colors must be removed to accomplish this.

6. Unstressed is also shown in Icelandic, which has an i, û, a system of unstressed vowels (Benediktsson 1959:286) because the mixed vowels simplify when unstressed.

7. The assumption here is that separate processes are not implicationally related, so that strict implication entails identity. There may be statistical preponderances of one process over another, but there is no evidence that strict interprocess implications (of the sort Nasal + -Nasal = Spirant + -Spirant) exist. If there were such implications, one could expect the order of acquisition to be far more uniform and linearized than it actually turns out to be.

8. Also, it does not seem to be the case that all subprocesses of a process are necessarily hierarchically related; the frequency of unrounding exceeds that of depalatalization, but depalatalization does not seem to imply unrounding. And finally, it looks as if the hierarchies within a process are on single feature-parameters so that e.g., for bleaching, -[context] > [+context], or high > mid > low, but the hierarchies do not hold between features, so that [+context] does not entail [-low] (e.g. Cockney ãu > ãu / o + A). One would expect statistical hierarchies across features (e.g. maybe high lax vowels bleach less often than low tense ones), but not strict cross-feature hierarchies.

9. Lowering, for example, rarely affects pure colors—it is favored for a chromatics—but it may affect mixed vowels, as shown is the French lowering of ù to ù in open syllables (Morin 1971:104-105), and the Kentish unrounding of OE y to e, possibly through an intermediate stage $, since ù had earlier become e (Wright 1923:22).

10. Joan had a for ù, ò, ò, ò, and U for mid and high vowels (Velten 1962:23 et passim); Hildegard had a and ÷ with basically the same substitutions (Leopold 1953-4:353 et passim).

11. Since not all diphthongs consist of a syllabic plus a glide, it might be more accurate to regard the nuclei resulting from diphthongisation as consisting of a lax element plus a tense element and to say that the tense element is usually a glide, since a syllable contains only one syllabic. This will allow for diphthongisations which result in two syllabics. But if tenseness is regarded as intensity of color, the tense element will still be the color-preserving element, and diphthongisation as polarization of tenseness and laxness within a nucleus will still be equivalent to Stampe's diphthongisation as polarization of color and sonority.

12. Similarly, Old Icelandic long ù: (from older ù and ù) has become the modern diphthong ãu, presumably by the sequence:

   ù ~ ù + ãu + ãu + ãu + ãu.

13. The posited diphthongal stage of y is not shown in spellings, perhaps because iy monophthongized earlier than uy did. (Monophthongization favors high vowels—see Stampe 1972a). Stampe
also suggests that early English borrowings of French y as ı (pur 'pure') may indicate that the ı stage did exist in French.)

14. Assimilation and monophthongization then produce the current reflexes. The old e did not take part in all the changes described here, having undergone—after diphthongization—a stress shift associated with 'breaking'.

15. French i did not take part in these changes. It may have been diphthongized, but it apparently did not bleach, and it must have re-monophthongized.

Bibliography


