Sverre Stausland Johnsen
University of Oslo
stausland.johnsen@iln.uio.no

Department of Linguistics
University of Ottawa
February 9, 2015

Vowel reduction in Old English and its origin in phonetic error

Overview:

- In Old English, an original unstressed *ō is in some morphological categories reflected as variation between *u* and *a*.

- The traditional explanation is that *ō generally developed to *a*, but developed to *u* when the following syllable also had a *u*.

- My hypothesis is that *ō reduced to *u* in medial syllables due to the short duration of such syllables.

- A statistical study of an Old English corpus strongly supports my new hypothesis, and finds no support for the traditional explanation.

- I suggest that *ō has reduced and raised to *u* as the result of phonetic errors by speakers and listeners.

1 van Helten's rule

An original unstressed *ō generally develops to *a* in Old English:

(1) PROTO-WEST-GERMANIC   OLD ENGLISH

    dagōs   >   *dagas*   'days'

    glōfōz   >   *glōfa*   'gloves'

    wundōþi   >   *wundaþ*   'woundeth'

    tungōni   >   *tungan*   'tongue'

In the past tense forms of ō-verbs, however, both *u* and *a* are found as reflexes of the original unstressed *ō:

(2) Pret. *andswarude* ~ *andswarade* 'answered'

    Pret. *syngude*   ~ *syngade*   'sinned'

    Perf. *wundud*   ~ *wundad*   'wounded'

    Perf. *bisgud*   ~ *bisgad*   'busied'

According to van Helten (1891), the $*\bar{o}$ was raised to *u* when the following syllable also contained a $*u$:

(3) | | PROTO-WEST-GERMANIC | | OLD ENGLISH | |
|---|---|---|---|---|
| Pret.3.sg. | *wundōdē* | > | *wundade* | 'wounded' |
| Pret.3.pl. | *wundōdun* | > | *wundudun* | 'wounded' |

This process predates Old English, so it applies even if the following $*u$ should later be lost:

(4) | | PROTO-WEST-GERMANIC | | OLD ENGLISH | |
|---|---|---|---|---|
| Perf.m.nom.sg. | *wundōdaz* | > | *wundad* | 'wounded' |
| Perf.f.nom.sg. | *wundōdu* | > | *wundud* | 'wounded' |

(5) All the main grammars of Old English accept van Helten's rule (Bülbring 1902, Luick 1921, Girvan 1931, Kieckers 1935, Campbell 1959, Brunner 1965, Hogg 1992, Hogg & Fulk 2011).

(6) van Helten's rule in (3) and (4) predicts a rigid distribution of *u* and *a* in Old English. But as seen in (2), these vowels vary quite freely in the past tense forms of *ō*-verbs.

(7) The actually attested variation seen in (2) is therefore due to a later generalization of *u* and *a* within the paradigm (Luick 1921, Girvan 1931, Kieckers 1935, Campbell 1959, Brunner 1965, Hogg 1992, Hogg & Fulk 2011).

2 Testing van Helten's rule

(8) If van Helten's rule is correct, we would expect to find *u* more often in those forms where an original $*u$ followed than elsewhere.

(9) All past tense forms of *ō*-verbs (*n* = 457) were gathered from the manuscript Hatton 20 (Sweet 1871):

- Written in Old West Saxon ('standard' Old English) around 890.
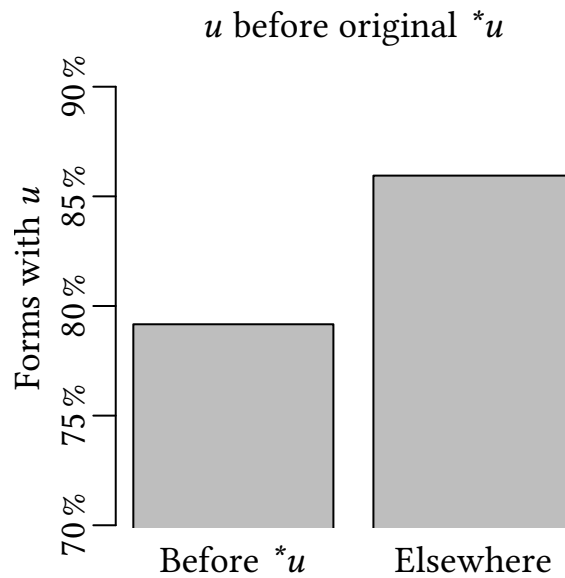- The largest early Old English text (67,835 words).

Fig. 1: Distribution of *u* by van Helten's rule

Results:

(10) The *u* is not more common before an original **u* than elsewhere. It is actually *less* common in this position.

(11) This difference is nevertheless not significant (mixed effects logistic regression, $p = .32$).

Conclusion:

(12) van Helten's rule does not explain the distribution of *u* and *a* as the reflexes of original **ō*.

3 Vowel reduction

3.1 Vowel duration & position

(13) Unstressed vowels are shorter than stressed vowels (Fry 1955).

(14) Unstressed vowels are shorter in medial syllables than in final syllables (Lindblom 1968, Oller 1973) :

   • ['mak<u>a</u>t] > ['mak<u>a</u>tan]

3.2 Vowel duration & vowel height

(15) Low vowels are longer than high vowels (Lehiste 1970):

   • [a] > [u]

(16) Low vowels are produced by lowering the articulators (Parmenter & Treviño 1932).

(17) This movement takes time, so low vowels are longer because the articulators need to travel further than for high vowels (Jespersen 1913, Lindblom 1967).

3.3 Vowel duration & vowel raising

(18) Shortened non-high vowels undergo raising (Lindblom 1963).

(19) The shorter the vowel, the less time the articulators have to reach their targets.

(20) Low vowels require more time to be articulated, and when there is not enough time available, the articulators do not reach their targets in time (Lindblom 1963).

(21) The acoustic correlate of undershooting the targets for a vowel is vowel raising (Lindblom 1963) :

- $$\xrightarrow{\text{Less time}}$$
$$[\textipa{A}] > [\textipa{O}] > [o] > [u]$$

3.4 Summary of vowel reduction patterns

(22) Unstressed vowels are shorter in medial syllables than in final syllables.

(23) Shortened vowels tend to raise.

Connecting the two:

(24) Unstressed vowels in medial syllables are more likely to raise than unstressed vowels in final syllables.

4 New hypothesis

(25) Long unstressed vowels shorten in pre-Old English (Luick 1921, Campbell 1959, Brunner 1965, Hogg 1992).

(26) Original *$\bar{o}$ shortens to *o (Luick 1921, Kieckers 1935).

Proposal:

(27) Based on the reasoning in (24), pre-Old English *o raises to Old English u in unstressed medial syllables.

Raising of /o/ as a function of duration

F_{1t}

350 Hz

/u/

400 Hz

450 Hz

F_1 value

500 Hz

/o/

550 Hz

final

medial
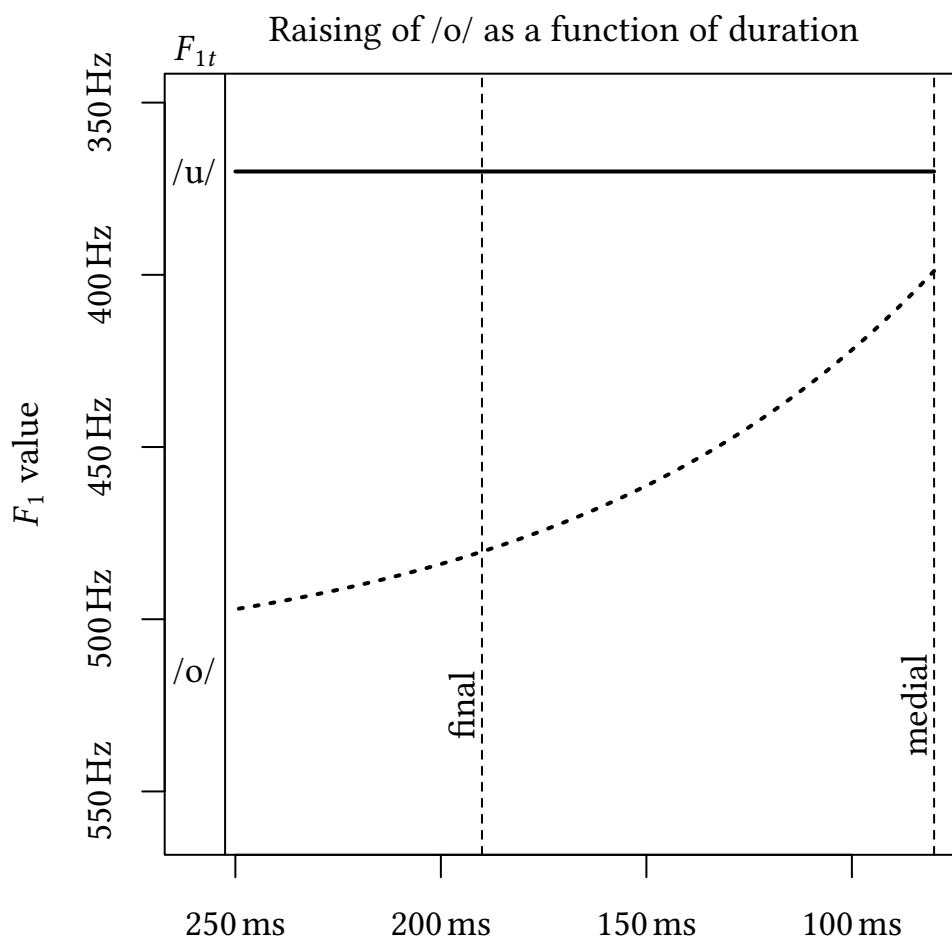
250 ms   200 ms   150 ms   100 ms

Fig. 2: Vowel raising as a function of duration
(data from Lindblom 1963, Oller 1973)

Proposed development of original unstressed *ō in Old English:

(28) Proto-West-Germanic   Pre-Old-English   Old English
      *wund<u>ō</u>dē   > *wund<u>ŏ</u>de   > wund<u>u</u>de
      *wund<u>ō</u>du   > *wund<u>o</u>d   > wund<u>a</u>d

Contrast (28) with van Helten's rule in (3–4):

(29) Proto-West-Germanic   Old English
      *wund<u>ō</u>dē   >   wund<u>a</u>de
      *wund<u>ō</u>du   >   wund<u>u</u>d

New hypothesis:

(30) The vowel *u* should be more common in medial syllables than in final syllables.

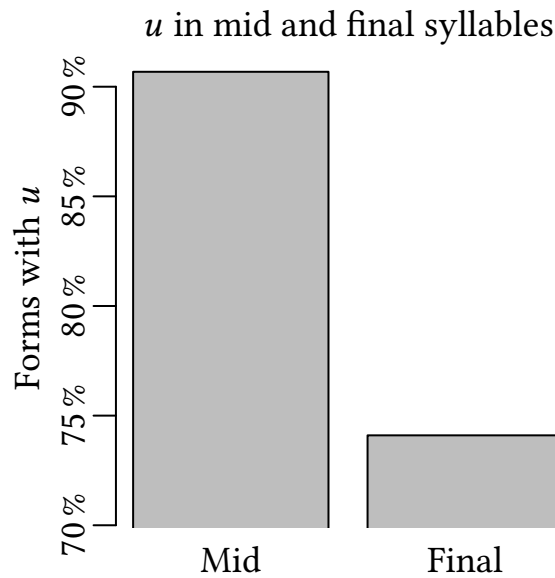(31) Distribution of *u* according to syllable position in the same corpus as in (9):

Fig. 3: Distribution of *u* by syllable position

Results:

(32) The *u* is significantly more common in medial syllables than in final syllables ($p < .0001$).

Conclusion:

(33) The distribution of *u* lends support to the hypothesis that it is the result of vowel raising in shortened medial syllables.

5   Vowel raising from phonetic error

5.1   Vowel raising by articulatory error

The articulators undershoot their targets for low vowels when time is reduced (20). Why is that?

(34) When a segment is shortened, the articulators need to move faster (Ostry & Munhall 1985).

(35) Faster movements result in decreasing accuracy in hitting the intended target, and this inaccuracy increases with the distance to the target (Woodworth 1899, Schmidt et al. 1979).

(36) Low vowels are further away (17), so when the speed of the articulators increases, there will be a higher error rate in hitting their targets.

(37) Human motion is biased towards undershooting a target (Elliott et al. 2004).

(38) The tendency to undershoot targets follows from the general neuromuscular principle to optimize the trade-off between speed, accuracy, and motor expenditure (cf.

Todorov 2004).

(39) The expected result is therefore that shortened low vowels suffer from more artic-
      ulatory undershoot than longer or higher vowels, which is precisely the finding in
      Lindblom 1963.

(40) Articulatory undershoot does not mean that speakers have shifted their targets (Lind-
      blom 1963). The undershoot is an error – a failure to reach the intended target –
      resulting from the neurological and biomechanical properties of motion.

5.2   Vowel raising by perceptual error

(41) Low vowels are longer than high vowels (15). Listeners know this (Gussenhoven
      2004).

(42) As a result, listeners misperceive shortened low vowels as being raised vowels (Stevens
      1959, Daniloff et al. 1968, Hillenbrand et al. 2000).

5.3   From error to grammar

(43) Phonetic error explains how vowel raising in unstressed medial syllables is initiated.
      But at some point it has become part of the grammar. The raised vowel is then no
      longer an error, it is the target output.

(44) Through perceptual reanalysis by the listener (Ohala 1981) and articulatory and au-
      ditory self-feedback by the speaker (Perkell 2012), language users conceive of the
      raised vowel as being the intended grammatical output. The target vowel thus shifts
      from *o to u.

6   Vowel raising by grammar

(45) The general neuromuscular principle of effort minimization has been duplicated and
      restated inside the grammar (Flemming 2001, 2004).

(46) The grammar thus shifts the target from *o to u in unstressed medial syllables as it
      decides that *o is too 'effortful' to produce in this context (Flemming 2004).

(47) It is, however, not clear what the benefit is of stating the same principle twice – both
      inside and outside of the grammar.

(48)   This machinery appears to be redundant, since stating the principle only once predicts the same result (section 5.1).

7   Conclusion

(49)   An original unstressed *ō generally develops to *a* in Old English. In some cases, however, it gives *u* in variation with *a*.

(50)   The traditional explanation (van Helten's rule) is that *ō developed to *u* when another *u followed in the next syllable.

(51)   I have suggested that the development to *u* is the result of vowel raising in shortened medial syllables.

(52)   A statistical analysis of Old English forms strongly supports my hypothesis, and finds no support for the traditional explanation.

(53)   Vowels raise in shortened medial syllables as the result of phonetic errors in articulation and perception.

(54)   The exceptional development of *ō to *u* in Old English can thus be explained by a well-established connection between vowel shortening and vowel raising.

(55)   Phonological change can often be accounted for by properly understanding the fundamental properties of human motion and perception.

References

Brunner, Karl. 1965. *Altenglische Grammatik*. Dritte, neubearbeitete Auflage. Sammlung kurzer Grammatiken germanischer Dialekte. A. Hauptreihe 3. Nach der angelsächsischen Grammatik von Eduard Sievers. Tübingen: Max Niemeyer.

Bülbring, Karl D. 1902. *Altenglisches Elementarbuch. Lautlehre*. Sammlung germanischer Elementarbücher. I. Reihe: Grammatiken 4. Heidelberg: Carl Winter's Universitätsbuchhandlung.

Campbell, A. 1959. *Old English grammar*. Reprinted from corrected sheets of the first edition. 1969. London: Oxford University Press.

Daniloff, Raymond G., Thomas H. Shriner, & Willard R. Zemlin. 1968. Intelligibility of vowels altered in duration and frequency. *The Journal of the Acoustical Society of America* 44(3): 700–707.

Elliott, Digby, Steven Hansen, Jocelyn Mendoza, & Luc Tremblay. 2004. Learning to optimize speed, accuracy, and energy expenditure: A framework for understanding speed-accuracy relations in goal-directed aiming. *Journal of Motor Behavior* 36(3): 339–351.

Flemming, Edward. 2001. Scalar and categorical phenomena in a unified model of phonetics and phonology. *Phonology* 18(1): 7–44.

———. 2004. Contrast and perceptual distinctiveness. *Phonetically based phonology*. Ed. by Bruce Hayes, Robert Kirchner, & Donca Steriade. Cambridge: Cambridge University Press, 232–276.

Fry, D. B. 1955. Duration and intensity as physical correlates of linguistic stress. *The Journal of the Acoustical Society of America* 27(4): 765–768.

Girvan, R. 1931. *Angelsaksisch handboek*. Oudgermaansche handboeken 4. Haarlem: H. D. Tjeenk Willink & Zoon.

Gussenhoven, Carlos. 2004. Perceived vowel duration. *On speech and language. Studies for Sieb G. Nooteboom.* Ed. by Hugo Quené & Vincent van Heuven. LOT occasional series 2. Utrecht: Netherlands Graduate School of Linguistics (LOT), 65–71.

van Helten, W. 1891. Grammatisches. *Beiträge zur Geschichte der deutschen Sprache und Literatur* 15: 455–488.

Hillenbrand, James M., Michael J. Clark, & Robert A. Houde. 2000. Some effects of duration on vowel recognition. *The Journal of the Acoustical Society of America* 108(6): 3013–3022.

Hogg, Richard M. 1992. *A grammar of Old English.* Vol. 1: *Phonology.* Oxford: Blackwell.

Hogg, Richard M. & R. D. Fulk. 2011. *A grammar of Old English.* Vol. 2: *Morphology.* Chichester: Wiley-Blackwell.

Jespersen, Otto. 1913. *Lehrbuch der Phonetik.* 2nd ed. Leipzig: B. G. Teubner.

Kieckers, Ernst. 1935. *Altenglische Grammatik.* Huebers kurze Grammatiken. München: Max Hueber.

Lehiste, Ilse. 1970. *Suprasegmentals.* Cambridge, MA: The M.I.T. Press.

Lindblom, B. 1963. Spectrographic study of vowel reduction. *The Journal of the Acoustical Society of America* 35(11): 1773–1781.

———. 1967. Vowel duration and a model of lip mandible coordination. *Speech Transmission Laboratory – Quarterly Progress and Status Report* 8(4): 1–29.

Lindblom, B. E. F. 1968. Temporal organization of syllable production. *Speech Transmission Laboratory – Quarterly Progress and Status Report* 9(2–3): 1–5.

Luick, Karl. 1921. *Historische Grammatik der englischen Sprache.* Vol. 1.1. Leipzig: Chr. Herm. Tauchnitz.

Ohala, John J. 1981. The listener as a source of sound change. *Chicago Linguistic Society (CLS)* 17(2): 178–203.

Oller, D. Kimbrough. 1973. The effect of position in utterance on speech segment duration in English. *The Journal of the Acoustical Society of America* 54(5): 1235–1247.

Ostry, David J. & Kevin G. Munhall. 1985. Control of rate and duration of speech movements. *The Journal of the Acoustical Society of America* 77(2): 640–648.

Parmenter, C. E. & S. N. Treviño. 1932. Vowel positions as shown by X-ray. *The Quarterly Journal of Speech* 18(3): 351–369.

Perkell, Joseph S. 2012. Movement goals and feedback and feedforward control mechanisms in speech production. *Journal of Neurolinguistics* 25(5): 382–407.

Schmidt, Richard A., Howard Zelaznik, Brian Hawkins, James S. Frank, & John T. Quinn Jr. 1979. Motor-output variability: A theory for the accuracy of rapid motor acts. *Psychological Review* 86(5): 415–451.

Stevens, K. N. 1959. The role of duration in vowel identification. *Massachusetts Institute of Technology Research Laboratory of Electronics – Quarterly Progress Report* 52: 136–139.

Sweet, Henry, ed. 1871. *King Alfred's West-Saxon version of Gregory's Pastoral Care. With an English translation, the Latin text, and an introduction.* Early English Text Society 45. London: N. Trübner.

Todorov, Emanuel. 2004. Optimality principles in sensorimotor control. *Nature Neuroscience* 7(9): 907–915.

Woodworth, R. S. 1899. The accuracy of voluntary movement. *Psychological Review. Series of Monograph Supplements* 3(3).