Ágnes Benkő

A typological review of the phonetic characteristics of neutral vowels[*]

0 Introduction

This paper discusses the behaviour of neutral vowels in various types of vowel harmony languages. A cross-linguistic look at vowel harmony languages allows us to identify tendencies and factors influencing neutral behaviour. Neutral vowels are usually defined by their failure to participate in harmony; however, recent phonetic findings show that neutral vowels do participate in vowel harmony at a phonetic level. The paper discusses recent experiments which call for a finer distinction of neutral and non-participating vowels.

1 Neutrality in vowel harmony

Vowel harmony processes require that vowels within a domain agree in some feature(s). The harmonic feature(s) may involve the height, backness, roundedness or tongue root position of the vowel. Languages may show harmony with respect to one or more features, or they may exhibit complete harmony, in which all features of a vowel need to agree. While harmony is supposed to apply to all vowels of a vowel system, many vowel harmony languages have one or more vowels which do not behave in the same way as other participating vowels, and display neutral behaviour.

Neutrality manifests itself in several different ways. In languages in which affixes do not show harmony, neutral vowels combine with both harmonic sets in stems. In languages with harmonising affix vowels, neutrality covers two types of behaviour: vowels may stop propagating the harmonic feature and initiate their own domain instead (opaque vowels) or they may propagate the harmonic feature but fail to take the same value of the harmonic feature (transparent vowels). Examples for opaque and transparent vowels are given in (1). In (1a) [iː] behaves transparently in Hungarian as a preceding back vowel determines the backness of the suffix. Opacity is attested in (1b): [øː] in disharmonic stems appears as opaque since it propagates its own front harmonic feature regardless of the preceding back vowel.

(1)

a. papír+nak ‘paper’ DAT
b. sofőr+nek ‘chauffeur’ DAT

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In many languages, neutral vowels show other peculiar behaviour (e.g., antiharmony in Hungarian). Other complicating factors include degrees of neutrality (vowels identified as neutral may show neutral behaviour to different degrees), and positional neutrality (vowels may show neutral behaviour only in certain positions and behave harmonically in others). A phonological typology of neutral vowels in backness harmony languages is provided by Kiparsky and Pajusalu (2003), which classifies languages according to three characteristics of neutral vowels: whether they transmit front harmony, whether they transmit back harmony and whether they can trigger front harmony. Their account shows the different types of phonological behaviour that neutral vowels display with respect to backness harmony.

2 Vowel harmony typology and neutral vowels

To get an overview of how neutral vowels typically behave and what kind of vowel systems they appear in, a brief typological description introduces vowel harmony types. A typological perspective highlights several issues with neutral vowels, such as the appearance of a neutral vowel in a harmony language. As not all vowel harmony languages have neutral vowels, the question arises what motivates a vowel to show neutral behaviour. A related issue concerns the choice of the neutral vowel: languages with the same harmonising feature may select different neutral vowels.

While a typological perspective may give us valuable insights into neutrality related questions, caveats are due with respect to typological generalisations. As not all languages are adequately described, the workings of vowel harmony in certain languages may not be sufficiently understood. Another problematic issue concerns related languages. Many languages belonging to the same language family may lead us to consider certain patterns pervasive although they are rare in unrelated languages. In what follows, a quick typological survey of vowel harmony languages and neutral vowels will be presented.

Vowel harmony may be related to well-established categories, such as the tongue body position (backness and height), the advancement/retraction of the tongue root or the rounding of the lips. In backness harmony languages, agreement is found in the horizontal position of the tongue body. Well-known backness harmony languages are Altaic (e.g., Turkish or Mongolian) and Uralic languages (the most often cited examples are Finnish and Hungarian). In these languages vowel harmony is usually pervasive and involves a large set of vowels. Many other backness harmony languages (such as Kera, or Tunica) are much more limited in scope and pose certain restrictions on vowel harmony processes (Linebaugh 2007).

In vowel height harmony languages, vowels need to agree in the vertical position of the tongue. Vowel height harmony is usually associated with the Bantu language family, although other languages may also exhibit some kind of height harmony pattern (e.g., Buchan Scots English or Pasiego Montañes Spanish). While height harmony is cross-linguistically rare, it is

possible to find languages with an opaque vowel (in any Bantu language), as well as with a transparent vowel (Pasiego Montañes Spanish) (Rhodes 2010).

In [ATR] harmony languages, one set of vowels is produced with retracted tongue root and another set of vowels is pronounced with advanced tongue root. ATR harmony languages show the most typological diversity, and it is possible to find systems with opaque vowels, such as Akan, Assamese, or Wolof, and languages with transparent vowels, such as Menominee, Khalkha, or Oroch (Rhodes 2010).

In rounding harmony languages, the sets of rounded and unrounded vowels do not combine within the harmonic domain. Rounding harmony is special in that it often appears together with some other harmonising feature. Languages with rounding harmony often display restrictions on tongue body position too, that is, rounding harmony only applies when the height or backness conditions are met (Kaun 2004). Rounding harmony is most often found in Altaic languages. Languages which show backness and rounding harmony include Turkish, Tuvan, Tunica or Hungarian. Rounding harmony may also occur together with pharyngeal or ATR harmony (Rose and Walker 2011). In the Altaic languages surveyed by Rhodes (2010), at least one opaque vowel appears in every language. Two of the languages, Khalkha and Buriat, also have transparent vowels.

3 Factors influencing neutrality

The following section examines what factors influence the choice of the neutral vowel. While there is a large amount of variation with respect to neutral vowels, a few tendencies may be noted. An examination of different languages with the same vowel harmony type shows that neutral vowels in many languages share some characteristics.

3.1 Vowel inventory

It has often been noted that the vowel inventory of a language bears on the presence of a neutral vowel and also influences which vowel will show neutral behaviour. Neutral vowels often do not have harmonic counterparts in the vowel inventory. Instances may be found in any type of vowel harmony regardless of what the harmonising feature is.

In many backness harmony languages, (some of) the front unrounded vowels display neutral behaviour. In languages such as the Khalkha dialect of Mongolian, the vowel system contains 7 vowels and does not include the back unrounded counterpart of /i/. In Khalkha, /i/ is considered neutral and behaves transparently (Walker 1993). Another backness harmony language, Uyghur, has a vowel inventory in which /i/ and /e/ have no back unrounded counterparts. These vowels are also described as neutral and behave transparently (Vaux 2000). A typical inventory of a backness harmony language is provided in (2). Finnish does not have back unrounded

counterparts of /i/ and /e/; therefore, these vowels show neutral behaviour (Ringen and Heinämäki 1999).

(2) *Finnish vowel inventory* (Ringen and Heinämäki 1999: 304)

Front		Back	
Unrounded	Rounded	Unrounded	Rounded
/i/	/y/		/u/
/e/	/ø/		/o/
/æ/		/ɑ/	

The typologically common seven- or nine-vowel ATR systems usually have one or more vowels which do not participate in harmony. The most common of these vowels is the low vowel /a/, as a [+ATR] counterpart is not part of the vowel systems. In [ATR] harmony languages which have a ten-vowel system, all vowels participate in vowel harmony. Such languages are cross-linguistically rare (Morton 2012).

While neutral vowels are often attested in asymmetrical vowel systems, neutral behaviour is not the only possibility if a vowel does not have a counterpart in the vowel inventory. Boyd (2015) examines Mbam languages (Bantu language family), which show [ATR] harmony. In those languages which have a seven- or nine-vowel system, the low central [−ATR] vowel /a/ does not have a harmonic counterpart. The languages examined show different types of behaviour. In certain languages the vowel appears on the surface as [a] and behaves either transparently or opaquely. As another possibility, some languages have a predictable non-contrastive [+ATR] variant as a surface realisation. A further possibility is that a mid front or back [+ATR] vowel ([e] or [o]) functions as the counterpart of /a/.

Asymmetric vowel systems have been shown to influence the appearance of a neutral vowel. In symmetrical inventories, there is no motivation for a segment to show neutral behaviour. Rhodes (2010) describes several vowel harmony systems which have a symmetrical vowel inventory. In height harmony languages, such as Desano and Kera, low vowels all have a higher counterpart; therefore, no vowel shows neutral behaviour. His survey also includes 8 ATR harmony languages with a symmetrical inventory (e.g., Koromfe, Lango, Somali), which do not have neutral vowels.

3.2 Inherent characteristics

Typological examinations demonstrate that different languages showing the same type of vowel harmony often have the same neutral vowel. Backness harmony languages often have front unrounded vowels as neutral, while in ATR harmony languages the low vowel /a/ shows neutral behaviour. Hansson (2008) notes that /a/ in height harmony or tongue root harmony is a commonly attested neutral vowel, and /i/ is often found in backness or rounding harmony languages.

As neutral behaviour is related to asymmetrical vowel systems, we need to explore why certain vowels are often missing from languages with the same harmony type. Lack of certain vowels in the inventory may be due to inherent phonetic characteristics of vowels. For example, articulatory difficulties of certain feature combinations may result in the absence of a vowel otherwise predicted to occur. The [+ATR] counterpart of the low vowel /a/ is often missing in ATR harmony languages. Archangeli and Pulleyblank (1994) claim that [+ATR] and [+low] are incompatible gestures as tongue root raising is necessary for [+ATR] and tongue body lowering is required for [+low]; thus, the tongue is expected to move in opposite directions.

Non-low front unrounded vowels are often neutral in backness harmony languages. Their tendency to behave as neutral may also be due to phonetic factors. Gafos and Dye (2011) claim that articulation and acoustics do not have a linear relation, and retraction in tongue body position has very little effect on the acoustic signal in the case of these vowels. Retraction to a large degree is required so that the vowel is perceived as a back one. Thus, non-low front unrounded vowels may be retracted to some degree without being perceived as back and more articulatory effort may be required in the case of non-low back unrounded vowels. They stress that this is a language-independent finding which may be behind the observation that many backness harmony languages have non-low front unrounded neutral vowels.

After examining a number of rounding harmony languages, Kaun (2004) notes that non-high vowels are often preferred as triggers, and high vowels as targets. Kaun also notes that lip rounding on back vowels is acoustically more salient than lip rounding on front vowels, and rounding on high vowels is also more salient than on mid vowels. The acoustic differences give rise to perceptual differences; thus, experiments show that non-high vowels and front vowels are perceived as less rounded. Kaun argues that those vowels which show salient effects of rounding are often the preferred targets in many languages.

4 Recent findings

The phonetic characteristics of neutral vowels in vowel harmony languages have received considerable attention in recent years. Several experiments have been conducted which examine the articulatory, acoustic or perceptual characteristics of neutral (predominantly transparent) vowels in different harmonic contexts.

In backness harmony languages, vowels which may be followed by either front or back vowels are traditionally thought not to be participating in vowel harmony, since they do not determine the backness or frontness of the following vowel. It is either the preceding vowel which determines the backness or frontness of the vowel following a neutral vowel, or if the stem contains neutral vowels only, it is lexically determined whether such stems take front or back suffixes. While such neutral vowels are perceived identically regardless of whether they precede or follow front or back vowels,

their phonetic characteristics are found to be different depending on the environment.

Several experiments have been done to explore how exactly harmony affects neutral vowels in backness harmony languages. Gordon (1999) tested the phonetic realisation of neutral vowels (/i/ and /e/) in Finnish. The vowels were included in front and back contexts produced by two native speakers. Gordon found phonetic evidence for the direction of harmony as neutral vowels in stems with a NB structure compared to stems with a NF structure did not show significant F2 differences, while neutral vowels in stems with a BN structure differ from stems with an FN structure. As vowel harmony is progressive in Finnish, a following vowel does not influence the realisation of a preceding neutral vowel. On the other hand, a preceding harmonic vowel influences the frontness or backness of the following neutral vowel. The fact that harmonic vowel influence on neutral vowels is not bidirectional may indicate that these differences are not merely coarticulatory effects but low level effects of vowel harmony.

Benus and Gafos (2007), and Szeredi (2012) examined the phonetic characteristics of Hungarian neutral vowels. Benus and Gafos (2007) studied the articulation of neutral vowels in two sets of words. They tested stems with a back vowel followed by a neutral vowel suffixed with a back suffix and compared them to stems with two neutral vowels followed by a suffix with a neutral vowel (e.g., *buli+val* 'party' Instrumental vs. *bili+vel* 'pot' Instrumental). They also tested unsuffixed monosyllabic stems with neutral vowels, which may show harmonic (e.g., *hír+nek* 'news' DAT) or antiharmonic behaviour (e.g., *ír+nak* 'they write'). Results suggest that neutral vowels are influenced by the harmonic type of the stem and neutral vowels in antiharmonic stems are slightly more back even when no suffix follows. In his study, Szeredi (2012) could not find corresponding acoustic and perceptual effects. He did not find statistically significant differences in backness in unsuffixed monosyllabic stems with neutral vowels and the results of his perceptual study also suggest that native speakers do not use fine phonetic differences in the categorisation of harmonic and antiharmonic items.

Hansson and Moore (2011) explore the relatively little studied vowel harmony processes of Kaska. Certain dialects of Kaska exhibit alternations in many prefix vowels depending on the vowel of the stem. This phenomenon involves a peculiar set of triggers and targets, which makes it difficult to determine what kind of vowel harmony is at work and what the harmonising feature is. While many characteristics are yet unsettled, a notable feature of Kaska vowel harmony is the long-distance character of this process. The alternating prefix may be separated from the stem vowel governing harmony and the intervening vowels (/iː/ /ʉː/ /ɛ/) seem to be transparent.

A phonetic examination was conducted based on data from one Kaska speaker. The study sheds light on the exact nature of harmony and also tests whether intervening (transparent) vowels show backing in harmonic environments. The realisation of vowels and the position of the vowels in the

vowel space suggest that Kaska harmony is a kind of backness harmony process. Due to data restrictions, it was only possible to compare two intervening vowels (/iː/ and /ɛ/) in different harmonic environments; thus, /ʉː/ was discarded from the test. Results show that /iː/ does not differ in backness in harmonic and non-harmonic contexts. Results for /ɛ/, however, indicate a clear and significant difference in different contexts. The different behaviour of the two vowels may be due to length difference and the authors also suggest that /i/ is more resistant to the influence of neighbouring segments.

Neutral vowels in other harmony types have also been tested. Kinande, a Bantu language, exhibits an intricate cross-height harmony system, with analyses assuming the harmonising feature to be either height or ATR. Accounts generally assume an underlying 7 vowel system (/i u ɪ ʊ ɛ ɔ a/), where the low vowel is variably described as a target that undergoes harmony or as a transparent vowel depending on the analysis. Gick et al. (2006) examine the articulation of vowels with ultrasound imaging and also conduct an acoustic experiment to find out – among other questions – what the phonetic realisation of the low vowel is in different environments. The authors test whether there is a weakening effect on consecutive low vowels. If different realisation is simply the result of coarticulation, low vowels farther away from the trigger are supposed to be less affected. Their results suggest that the low vowel also participates in vowel harmony.

Moro is a height harmony language, where high triggers cause lower vowels /e a o/ to change to their high counterparts /i ʌ u/. The vowel system also includes schwa, which can appear with both sets of vowels. An experiment was designed to examine the acoustic characteristics of schwa in different harmonic environments (Ritchart and Rose 2015). Monosyllabic roots containing schwa and CəCVC roots were selected and tested with one speaker. As roots do not appear without affixes in the language, test words contained affixes with either the lower set of vowels or the higher set. The statistical analysis shows that schwa is produced significantly higher in high environments. Results may indicate that there are two different schwas and evidence is found for the participation of transparent vowels in vowel harmony. Findings are not conclusive though: the acoustic measurements show that schwas also significantly varied in backness in different environments, which indicates that height differences may also be partly due to the influence of neighbouring vowels.

4.1 Opaque vowels are different?

The phonetic experiments described above include neutral vowels showing transparency. The studies imply that transparent vowels also participate in vowel harmony: they not only propagate the harmonic feature(s) but also undergo harmony to some extent, although it may not be perceptible to speakers. As opaque vowels are also considered neutral, the question arises whether they show the same phonetic effects. Since opaque vowels block

harmony and initiate a new domain, they are not expected to show the same kind of low level harmony effects.

Boyd (2015) examines whether there are fine phonetic differences in transparent and opaque neutral vowels. Yangben and Maande have rounding harmony, and in both languages the high vowels are neutral. In Yangben, high vowels show transparent behaviour, in Maande high vowels are opaque. Acoustic measurements were taken to see whether the neutral vowels in rounding harmony contexts have lower formant values. Results indicate that transparent as well as opaque vowels have slightly lower formant values and differences in the lowering of frequencies are not found. Results do not support the hypothesis that transparent vowels participate in vowel harmony at a low level while opaque vowels do not.

5 Neutral or non-participating?

Neutral vowels are often defined by claiming that they fail to participate in vowel harmony. Accordingly, phonological analyses are designed so that harmonic processes do not apply to them. In certain traditional rule-based accounts, however, neutral vowels also undergo harmony. In such analyses, vowel harmony affects neutral vowels in the same way as non-neutral segments and as a result a non-existent sound is created, which is not part of the vowel inventory. Another rule then changes all instances of the non-existing vowel back to the neutral segment.

Examinations of neutral vowels in different vowel harmony languages show that the phonetic characteristics of neutral vowels are different depending on the harmonic environment, which may indicate that neutral vowels also participate in vowel harmony at a low level. While not all of the experiments had a conclusive result, the assumption that neutral vowels are non-participating segments needs to be revised and a finer distinction may be necessary.

A distinction between neutral and non-participating vowels has already been proposed (Linebaugh 2007) and it is worth examining if all neutral vowels show harmony at the phonetic level. Among the studies reviewed, not all experiments ended with a positive result, which may be simply because not all neutral vowels show harmonic effects, or it may be the case that tiny differences are not registered due to shortcomings of the experiments, such as methodological problems or lack of data.

Another relevant question concerns the possible differences between transparent and opaque vowels. Although differences between transparent and opaque vowels with respect to harmonic effects have not been found by Boyd (2015), due to the limited number of experiments with opaque vowels, the possibility that there may be cases where opaque vowels do not show harmony at the phonetic level cannot be excluded.

Many experiments have been conducted with a focus on the phonetic characteristics of transparent vowels, which may provide grounds for a finer distinction of transparent vowels. Rose and Walker (2011) thus distinguish

perceptual transparency and genuine transparency. In the case of perceptual transparency, the harmonising feature is actually present in the transparent vowel, but it is not perceived by listeners. In languages which present cases of genuine transparency, the harmonising feature is not present in transparent vowels.

6 Conclusion

The paper presented a review of experiments focussing on the phonetic characteristics of neutral vowels in different vowel harmony languages. As opposed to the traditional view of neutral vowels, recent findings indicate that (some of the) neutral vowels also participate in vowel harmony at the phonetic level. However, there are still many open questions about which neutral vowels participate in harmony.

The results of Boyd (2015) imply that the distinction between participating and non-participating vowels is not simply a question of whether the vowel shows transparent or opaque behaviour, but a more intricate pattern is detected. While many experiments have been directed at the phonetic characteristics of transparent vowels, not much data is available in the case of opaque vowels. More work on neutral vowels is necessary to decide whether there are participating and non-participating transparent vowels as well as participating and non-participating opaque vowels.

If both options are possible, a further question concerns the motivation behind phonetic participation. Other potential factors need to be taken into consideration, such as the role of phonological behaviour. Kiparsky and Pajusalu (2003) showed that even transparent vowels do not have a unified phonological behaviour and different behaviour may cause different phonetic characteristics. Further experiments are necessary to completely understand this phenomenon.

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Ágnes Benkő
Eötvös Loránd University
bagnes@infornax.hu