Is markedness a confused concept?

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Abstract

It is well known that, across languages, certain features are more frequent than others. But whether these facts reflect abstract universal markedness constraints or functional pressures (auditory and articulatory difficulties and lexical frequency) is unknown. Romani, Galuzzi, Guariglia, and Goslin, (in press) report that the putative markedness of phonological features captures their order of acquisition and their propensity to elicit errors in patients with an apraxia of speech (but not in phonological aphasia). The authors believe these results challenge the existence of abstract markedness constraints. They also raise some concerns about the explanatory utility of the markedness hypothesis. This commentary demonstrates that markedness is not inherently vague or vacuous nor is it falsified by Romani et al.'s empirical findings. As such, these results leave wide open the possibility that some phonological markedness constraints are abstract.

Not all phonological structures are created equal. Some syllables (e.g., *blog*), for instance, are systematically preferred to others (e.g., *lbog*)—they are more likely to be generated by productive phonological processes, they are more frequent across languages, and they are easier for individual speakers to acquire and process (Greenberg, 1978;Berent, 2013a).

A long line of linguistic research has attributed such facts to universal markedness constraints. Markedness constraints are further believed to shape not only the mature grammar but also its acquisition, in early childhood, and its preservation, in aphasia (Jakobson, 1968). But whether markedness constraints exist remains the topic of an ongoing controversy.

Romani and colleagues (Romani et al., in press) seek to advance this debate by considering evidence from language development and neurodevelopmental disorders. These authors should be commended for bringing the investigation of phonological markedness back to the forefront of aphasia research, and for enriching this discussion by the perspective from language acquisition. But it is unclear whether their results indeed challenge the existence of universal markedness constraints. Their analysis is ultimately unable to answer this question because it lacks a coherent formal account of markedness, and the empirical tests do not dissociate formal markedness from its sensorimotor correlates.

1. What is markedness?

It goes without saying that, in order to determine whether markedness constraints exist, one must depart from a specific formal definition of markedness. This is no easy task given the multiple contradictory notions of markedness found in the linguistic literature (e.g., Rice, 2007). Markedness has been linked to factors ranging from abstract structure to cross-linguistic frequency, perceptual salience, articulatory complexity, order of acquisition, and preservation in aphasia (Rice, 2007).

Recognizing this state of affairs, Romani and colleagues choose to bypass the controversy by equating markedness with a seemingly neutral notion of "complexity"––a term that, in their view, could have either abstract or "articulatory underpinnings" (p. 8). It is their hope that the empirical evidence will help adjudicate between the competing notions of "complexity", and in so doing, elucidate the fleeting construct of "markedness".

This scientific strategy is quite sensible. But the problem is that the concept of "complexity" is not clearly defined, and its structural and articulatory variants are not differentiated from each other. Consequently, the discussion of markedness vacillates between conflicting notions. On the one hand, the authors' intention to dissociate markedness from frequency and articulatory difficulty implies that markedness is abstract, *distinct* from its articulatory underpinnings (which are not). But on the other hand, markedness and articulatory demands are constantly

conflated. This conflation begins with the definition of unmarked feature values in phonology as ones which "require a position of the articulators closer to their position at rest" (p. 5) and concludes with the assertion that markedness constraints are "grounded in articulatory complexity", rather than abstract (on p. 39). These suggestions imply that markedness and articulatory pressures ***are*** one and the same. In fact, this conclusion appears inevitable given the absence of a coherent formal alternative. As Romani et al. put it: "if we do not invoke articulatory principles, there is no reason *why,* for example, some contrasts are simpler than others" (p. 39).

Romani and colleagues are right to raise these concerns, as the markedness literature is fraught with ambiguities. But markedness is not inherently a confused concept. One prominent linguistic theory, Optimality Theory (OT, Prince & Smolensky, 1993/2004;de Lacy, 2006) does provide a clear formal definition of markedness and presents a principled explanation for the notion of structural complexity as well as other markedness correlates. Thus, the markedness hypothesis is neither vacuous nor vague.

In what follows, I first discuss the formal definition of markedness. I then explain how (abstract) markedness might be linked to the sensorimotor system and evaluate the empirical predictions of this hypothesis.

1.1. Markedness defined

Put simply, markedness constraints are well-formedness conditions on phonological representations. The OT grammar consists of a universal set of ranked violable markedness conditions (e.g., "avoid velars"). Marked structures are "those that violate these structural constraints" (Prince & Smolensky, 1997, p. 1604). For example, /g/ violates the "avoid velars" constraint, so /g/ is more marked than the labial /b/.

1) The place of articulation (PoA) hierarchy (de Lacy, 2006):
*velars>> *labials>>*coronals>>*glottals

In OT, no phonological form is "perfect"—every phonological representation inevitably violates *some* markedness constraints. Certain forms, however, are more marked than others, either because they violate more constraints or because they violate constraints that are highly ranked. For example, in the PoA hierarchy (in (1)), the ban on velars (* velars) is ranked above the ban on labials (* labials), which, in turn, outranks the ban on coronals (*coronals); least marked are glottals (*glottals; ranking is indicated by >>). Accordingly, when considering PoA, the velar /g/ is more marked than the labial /b/, yet /b/ is more marked than /d/ (a coronal).

(2) Constraint violations in two languages (A and B)

Language A:	*velars>> *labials>>*coronals>>*glottals	
	Faithfulness	
Language B:	*velars>>	*labials>>*coronals>>*glottals
		Faithfulness

Whether or not marked structures are tolerated depends on the ranking of the relevant markedness constraints relative to ***faithfulness*** constraints in that grammar—constraints that require phonological outputs to preserve the input. In the above example (2), language A ranks faithfulness over *velars, so velars are allowed; in language B, *velars outranks faithfulness, so velars are banned. Critically, the hypothesis that PoA is subject to a scalar markedness hierarchy predicts that, if a language allows a marked structure, it will necessarily allow less marked ones. For example, since *velar outranks *labials, language A must allow not only velars but also labial, coronal, and glottal features. This property, known as ***implicational asymmetry*** (3), carries direct consequences for the empirical evaluation of markedness.

> (3) *Implicational asymmetry*. If the grammar tolerates a marked structure, it will also tolerate less marked structures.

Finally, Optimality theory, asserts that markedness constraints are universal—they are active in the brain of each and every speaker, irrespective of whether the relevant structure is present in their language or absent. This markedness hypothesis is summarized in (4).

> (4) *The markedness hypothesis*. The grammars of every (typical) speaker includes a universal set of abstract markedness constraints.

1.2. *Markedness, abstraction, and the sensorimotor system*

In the OT grammar, phonological markedness constraints are abstract formal conditions––they operate on discrete digital representations by virtue of their formal combinatorial structure (Smolensky & Legendre, 2006). Since most markedness constraints ban the addition of structure (e.g., * velars), the more complex the phonological form is structurally (e.g., the larger the number of its features or syllables), the more marked it typically is. In addition, markedness is associated with numerous functional characteristics (e.g., velars will be less frequent across languages and harder to acquire). By hypothesis, however, these characteristics are all *consequences* of markedness, not its cause (Prince &

Smolensky, 1997). Accordingly, functional characteristics play no role in the formal evaluation of markedness by the grammar. Velars, for instance, will always be more marked than coronals, irrespective of the acoustic and articulatory characteristics that happen to define a specific velar speech token.

To further illustrate the notion of abstraction in phonology, consider IDEN. IDEN bans identical phonological elements (e.g., identical consonants), such as the identical consonants in /pip/. IDEN defines an abstract formal *relation* (identity) that applies equally to any member of the relevant class, such as "any consonant". For example, IDEN will apply equally to phonological forms such as /pip/ and /xix/, even though the latter consists of a phoneme that is foreign to English. The relevant class ("any consonant") is thus potentially open-ended. Furthermore, the class consists of abstract discrete phonemes, not specific articulatory speech acts. In fact, once a phonological form (e.g., /pip/) is realized as a specific speech act, the two consonant tokens will likely differ from each other. In English, for example, the first will be likely aspirated, whereas the second will not [p^hip]. But since IDEN applies to the phonological level (to /pip/), English speakers still considers [p^hip] as violating IDEN (i.e., as marked). In fact, English speakers demonstrably extend IDEN even to sign language (Berent, Bat-El, Brentari, Dupuis, & Vaknin-Nusbaum, 2016). These considerations suggest that markedness constraints, such as IDEN, are combinatorial processes that apply to representations that are discrete and digital. As such, markedness constraints differ from sensorimotor pressures, which typically elicit blending, and apply to representations that are analog and continuous (e.g., Keating, 1984). Markedness and sensorimotor pressures are distinct because their representational formats differ.

Now, the hypothesis that markedness is distinct from the sensorimotor system does not mean that markedness constraints are arbitrary. Indeed, many phonological processes "conspire" to improve speech perception and articulation (Hayes, Kirchner, & Steriade, 2004). The correlation is only expected by the view of phonology as an adaptive biological system (Berent, 2013b). But correlation does not indicate conflation. For example, the observation that marked structures tax articulation does not necessarily mean that markedness constraints *are* articulatory.

To use an analogy, the fact that the cardinal value of a set ("three cookies") correlates with its analog magnitude (e.g., three cookies typically weigh more than two cookies) does not mean that number and magnitude are one and the same. Obviously, they are not-- the cardinal value of a set is a discrete value defined by the abstract combinatorial principles of algebra; magnitude is defined in analog continuous terms. Number and magnitude are not one and the same.

By the same token, neither are markedness and sensorimotor pressures, and it is unfortunate that Romani and colleagues blur the very distinction they seek to explore. The markedness hypothesis in (4) may be true or false, but markedness and sensorimotor pressures cannot be one and the same.

1.3. The empirical consequences of markedness

The above discussion of feature markedness predicts that, if people are sensitive to markedness, *then all things being equal*, the presence of a marked element in perception/production should imply the presence of an unmarked element.

The qualification of "all things being equal" is critical. Although markedness is a formal feature, its evaluation is typically based on specific speech acts that carry distinct functional demands. The critical question, then, is ***not*** whether the processing of marked structures is modulated by the sensorimotor properties of their speech tokens (e.g., are articulatory-demanding gestures harder to produce); such effects are trivially true. Rather, at stake is whether the formal markedness of features plays a role. Specifically, (a) do marked features imply unmarked features; (b) does markedness affect both the probability of correct responses and their repair; and (c) can one reasonably dissociate the effect of markedness from the effect of its functional correlates (frequency of use and sensorimotor pressures)?

2. Does feature markedness affect language acquisition and aphasia?

Armed with the above-mentioned definition of markedness, we can now turn back to the findings of Romani and colleagues to evaluate the extent these results are in line with the markedness hypothesis (4).

I suggest we proceed in two steps. First, we should examine whether the pattern of results is ***consistent*** with the markedness hypothesis. If consistency is found, we can next ask whether the results are truly ***due*** to markedness (as opposed to frequency of use or sensorimotor pressures).

Romani and colleagues' reply to these two questions are likely "yes (mostly)", and "no (probably)", respectively. In line with the markedness hypothesis, Romani and colleagues, note that feature hierarchies predict the age of acquisition and the probability of errors in AoS. Critically, since markedness appears to have stronger effect on AoS than on "phonological aphasia", the authors conclude that these results are due to articulatory, rather than "central" sources. Let us revisit these two conclusions, in turn.

*2.1. Are the behavioral findings **consistent** with the markedness hypothesis?*

Romani and colleagues suggest that their results are mostly consistent with feature markedness hierarchies. But a closer inspection reveals important discrepancies. For example, consider the manner of articulation hierarchy.

Linguistic research demonstrates that the markedness of onsets depends on their manner of articulation (see (5[1])): most marked are glides, least marked are stops (Clements, 1990; Prince & Smolensky, 1993/2004; Smolensky, 2006).

(5) The markedness of manner features in onset positions:
*glides>>*liquids >>* nasal>*affricate>*fricative>*stops.

Romani and colleagues, however, evaluate the markedness of manner features separately for obstruents and sonorants. This approach ignores the fact that overall, sonorant onsets are more marked than obstruents (Clements, 1990; Smolensky, 2006). In so doing, they obscure several of the inconsistencies between the empirical findings (in Table 1) and the manner scale. For example, nasals (in the middle of the scale) should be far more marked than stops and fricatives, but their token frequency is higher than fricatives and affricates, their age of acquisition is earlier, and their propensity for errors in AoS is far lower than obstruents of any kind.

	Token frequency			***AoS Aphasics***		
	RAW	LOG	AoA	N err	N stim	% err
STOPS	388,004	5.42	2.5	1283	19,907	6.4
FRICATIVES	228,124	5.17	3.5	818	7,154	11.4
AFFRICATES	77,643	4.75	5	511	3,576	14.3
NASALS	309,652	5.23	3	367	7,917	4.6
LIQUIDS	334,219	5.34	3	751	9,494	7.9

Table 1. The effect of manner on token frequency age of acquisition and errors in AoS (based on Table 7 in Romani et al. (in press)).

There are also a number of broader conceptual challenges to the evaluation of the markedness hypothesis. Recall that markedness scales predict implicational asymmetries: the presence of marked features implies the presence of unmarked features. An evaluation of this hypothesis thus requires a demonstration that the occurrence of unmarked segments within any given individual is ***contingent*** on the occurrence of marked segments; the frequency of feature production across participants does not fully address this issue. Relatedly, the avoidance of marked segments should determine not only the probability of their production but also their repair. Without information concerning the nature of the substitutions (e.g.,

[1] Following Clements (1990), Smolensky (2006) considers obstruents as a single class. But in keeping with Romani and colleagues' analysis, here I provide the internal ranking of obstruent segments.

are velars substituted by labials?), one cannot determine whether participants are sensitive to markedness. In light of these considerations, the link between markedness and speech production is far from clear.

This situation is open to multiple interpretations. One possibility is that markedness plays no role in AoS and language acquisition (at least with respect to the manner feature). Alternatively, markedness might affect other aspects of performance. For example, research on language acquisition (Bat-El, 2012) suggests that feature markedness strongly affects the probability that the child ***attempts*** to produce a given structure (rather than successful productions). While children may not necessarily be successful at the correct production of a segment, they are nonetheless reliably more likely to attempt the production of unmarked feature values compared to marked ones. One thus wonders whether measures of "attempted productions" (by Italian children and patients) would yield a stronger link to markedness. Another possibility is that the pattern of errors in production is shaped by abstract markedness constraints, but the contribution of markedness is masked by articulatory difficulties. Finally, the possibility exists that markedness effects might be evident in speech perception. Whether such effects will be found remains to be seen. But at present, the link between the putative markedness of phonological features and their role in language acquisition and aphasia remains tentative.

*2.2. Are the findings likely **due** to markedness?*

Given the uncertainty as to whether behavior is even ***associated*** with feature markedness, a consideration of its ***cause*** (i.e., is behavior caused by abstract markedness constraints) is clearly premature. But there are also other reasons to question the conclusions of Romani and colleagues.

The authors seek to dissociate the formal effects of markedness from feature frequency using a regression analysis. To gauge the role of articulatory factors, the authors compare sensitivity to markedness in two sub-types of aphasia––AoS and "phonological aphasia. They attribute AoS and "phonological" forms of aphasia to articulatory vs. "central" origins, respectively. Since their analysis show a strong association between markedness scales and AoS (but not in phonological aphasia), they conclude that feature hierarchies are governed solely by articulatory pressures, not abstract markedness constraints.

Romani and colleagues, however, present no evidence that the difficulties of AoS patients are specifically due to the articulatory demands of marked features (as opposed to their phonological markedness). First, there is no evidence that "marked" features present greater articulately demands. One cannot simply infer the articulatory demands of marked structures from their surface phonological forms because a single surface form (e.g., *bla*) can give rise to radically different articulatory plans even in typical participants (Shaw & Gafos, 2015). Second, the authors provide no evidence that the errors in production are articulatory. The

classification of AoS as an "articulatory" disorder and its propensity to elicit simplification errors (Galluzzi, Bureca, Guariglia, & Romani, 2015) do not directly demonstrate that errors in the present experiment have an articulatory origin (for demonstrations of such phonology/phonetic dissociations in aphasia see Buchwald, Rapp, & Stone, 2007; Buchwald & Miozzo, 2011). In short, the link between the performance of these groups and an articulatory deficit is far from obvious.

But even if the link to articulation were clearly established, this would not, in and of itself, show that AoS patients are not sensitive to phonological markedness. As noted, phonological markedness and articulatory pressures often correlate, so the observation of one does not necessarily preclude the other. To reiterate, it is unclear whether the results reported by Romani and colleagues are even consistent with the markedness hypothesis. However, the finding of an intact sensitivity to markedness in AoS coupled with full sensitivity (in phonological aphasia) does not necessarily falsify the markedness hypothesis.

3. Summary

Romani and colleagues submit that their results support "theories which see phonological constraints and universal principles of complexity as grounded in articulation (…) and are contrary to views which see these principles as abstract" (p. 39). This commentary addressed both the empirical and conceptual basis of these assertions.

At the empirical level, the support for the articulatory basis of markedness hierarchies remains tentative, as the findings presented by Romani and colleagues do not clearly establish that markedness is only associated with articulatory demands (not formal markedness) or that the difficulties in AoS are articulatory in nature. Had the authors established this result, however, the invited conclusion should have been that the markedness hypothesis is false, not that it is articulatory. The conflation of (abstract) markedenss with (sensorimotor) articulatory pressures does not advance our understanding of markedness.

This is not to say that feature markedness plays no role in phonology, and it certainly does not mean that the markedness hypothesis is false. Evidence from the syllable hierarchy suggests that marked syllables exert a cost on behavior (Berent, Lennertz, Jun, Moreno, & Smolensky, 2008) and on brain hemodynamic response (Berent et al., 2014) that are evident already at birth (Gómez et al., 2014), well before the onset of articulation. Furthermore, sensitivity to the syllable hierarchy is maintained when the motor system is suppressed, either mechanically (Zhao & Berent, 2017) or via transcranial magnetic stimulation of the lip motor area (Berent et al., 2015). Other results suggest that the putatively phonological constraints on doubling generalize across language modalities that drastically differ on their sensorimotor demands––speech and sign (Berent et al., 2016). These findings open up the possibility that people are sensitive to certain aspects of phonological

markedness. Whether these conclusions extend to the feature level remains to be seen.

References

Bat-El, O. (2012). The Sonority Dispersion Principle in the acquisition of Hebrew word final codas. In S. Parker (Ed.), *The Sonority Controversy* (pp. 319-344). Berlin: Mouton de Gruyter.

Berent, I. (2013a). The phonological mind. *Trends in Cognitive Sciences, 17*(7), 319-327. doi: 10.1016/j.tics.2013.05.004

Berent, I. (2013b). *The phonological mind*. Cambridge: Cambridge University Press.

Berent, I., Bat-El, O., Brentari, D., Dupuis, A., & Vaknin-Nusbaum, V. (2016). The double identity of linguistic doubling. *Proceedings of the National Academy of Sciences, 113*(48), 13702-13707. doi: 10.1073/pnas.1613749113

Berent, I., Brem, A.-K., Zhao, X., Seligson, E., Pan, H., Epstein, J., . . . Pascual-Leone, A. (2015). Role of the motor system in language knowledge. *Proceedings of the National Academy of Sciences, 112*, 1983-1988. doi: 10.1073/pnas.1416851112

Berent, I., Lennertz, T., Jun, J., Moreno, M. A., & Smolensky, P. (2008). Language universals in human brains. *Proceedings of the National Academy of Sciences, 105*(14), 5321-5325. doi: 10.1073/pnas.0801469105

Berent, I., Pan, H., Zhao, X., Epstein, J., Bennett, M. L., Deshpande, V., . . . Stern, E. (2014). Language universals engage Broca's area. *Plos One, 9*(4), e95155.

Buchwald, A., & Miozzo, M. (2011). Finding Levels of Abstraction in Speech Production: Evidence From Sound-Production Impairment. *Psychological Science, 22*(9), 1113-1119. doi: 10.1177/0956797611417723

Buchwald, A. B., Rapp, B., & Stone, M. (2007). Insertion of discrete phonological units: An articulatory and acoustic investigation of aphasic speech. *Language and Cognitive Processes, 22*, 910-948.

Clements, G. N. (1990). The role of the sonority cycle in core syllabification. In J. Kingston & M. Beckman (Eds.), *Papers in laboratory phonology I: Between the grammar and physics of speech* (pp. 282-333). Cambridge: Cambridge University Press.

de Lacy, P. (2006). *Markedness: reduction and preservation in phonology*. Cambridge, New York: Cambridge University Press.

Galluzzi, C., Bureca, I., Guariglia, C., & Romani, C. (2015). Phonological simplifications, apraxia of speech and the interaction between phonological and phonetic processing. *Neuropsychologia, 71*(Supplement C), 64-83. doi: https://doi.org/10.1016/j.neuropsychologia.2015.03.007

Gómez, D. M., Berent, I., Benavides-Varela, S., Bion, R. A. H., Cattarossi, L., Nespor, M., & Mehler, J. (2014). Language universals at birth. *Proceedings of the National Academy of Sciences, 111*(16), 5837-5341. doi: 10.1073/pnas.1318261111

Greenberg, J., H. (1978). Some generalizations concerning initial and final consonant clusters. In J.H. Greenberg, C.A. Ferguson & E.A. Moravcsik (Eds.), *Universals of Human Language* (Vol. 2, pp. 243-279). Stanford, CA: Stanford University Press.

Hayes, B., Kirchner, R. M., & Steriade, D. (2004). *Phonetically based phonology*. Cambridge ; New York: Cambridge University Press.

Jakobson, R. (1968). *Child language aphasia and phonological universals*. The Hague: Mouton.

Keating, P. A. (1984). Phonetic and Phonological Representation of Stop Consonant Voicing. *Language, 60*(2), 286-319.

Prince, A., & Smolensky, P. (1993/2004). *Optimality theory: Constraint interaction in generative grammar*. Malden, MA: Blackwell Publishing.

Prince, A., & Smolensky, P. (1997). Optimality: From neural networks to Universal Grammar. *Science, 275,* 1604-1610.

Rice, K. (2007). Markedness in phonology. In P. de Lacy (Ed.), *The Cambridge handbook of phonology* (pp. 79-97). Cambridge: Cambridge University Press.

Romani, C., Galuzzi, C., Guariglia, C., & Goslin, J. (in press). Comparing phoneme frequency, age of acquisition and loss in aphasia:

Implications for phonological universals. *Cognitive neuropsychology*.

Shaw, J. A., & Gafos, A. I. (2015). Stochastic Time Models of Syllable Structure. *Plos One, 10*(5), e0124714. doi: 10.1371/journal.pone.0124714

Smolensky, P. (2006). Optimality in Phonology II: Harmonic completeness, local constraint conjunction, and feature domain markedness. In P. Smolensky & G. Legendre (Eds.), *The harmonic mind: From neural computation to Optimality-theoretic grammar* (Vol. 2: Linguistic and philosophical implications, pp. 27-160). Cambridge, MA: MIT Press.

Smolensky, P., & Legendre, G. (2006). Harmony optimization and the computational architecture of the mind/brain. In P. Smolensky & G. Legendre (Eds.), *The harmonic mind: From neural computation to optimality-theoretic grammar* (Vol. 1, pp. 3-58). Cambridge: MIT Press.

Zhao, X., & Berent, I. (2017). The basis of the syllable hierarchy: articulatory pressures or universal phonological constraints? *Journal of Psycholinguistic Research*. doi: https://doi.org/10.1007/s10936-017-9510-2