A CONSUMER'S GUIDE TO TONAL UNDERSPECIFICATION[1]

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INTRODUCTION

We understand the term 'tonal underspecification' to refer to any situation in which vowels, syllables, or other tone-bearing units occur without an associated tonal target. As a term, 'tonal underspecification' is most frequently used in the context of languages with lexical and/or grammatical tone (Hyman 2001, Rolle 2018); it has also been employed in the analysis of intonational systems (e.g. Pierrehumbert & Beckman 1988). Theoretically, it is most closely associated with Autosegmental Phonology (Goldsmith 1976, 1990), though underspecification as a concept is not inherently tied to that framework.

The key insight expressed by tonal underspecification is a simple one: not every unit which *can* host a tonal target necessarily *does*. However, the actual application of underspecification to the analysis of tonal and intonational systems is often far less straightforward (e.g. Paster 2003; see also McCarthy & Taub 1992, Steriade 1995 for segmental underspecification).

The question we address in this paper is a practical one: what diagnostics can be used, with confidence, to *argue* for tonal underspecification in a particular analysis? We evaluate a range of diagnostics which have been used to identify tonal specification, both in published work and in our informal discussions with colleagues and students. Our intent is to unpack the logic of these diagnostics, to assess the conditions under which they can be successfully used to argue for tonal underspecification. In several cases, we argue that some seemingly reasonable diagnostics for tonal underspecification are not actually valid, and should be abandoned. In other cases, we suggest that even certain valid diagnostics must be applied with care. We also consider how to deal with cases in which multiple diagnostics seem to provide conflicting evidence for or against tonal underspecification. When possible, we

[1] Thanks to Ben Eischens, Shun Nakamoto, and participants at the Quinta Mesa de Trabajo del Seminario Phonologica for their feedback.

provide illustrations and case studies from languages of Mesoamerica, particularly Otomanguean languages, which often have complex tone systems.

Underspecification has proven to be a very useful descriptive tool for tonal languages. However, underspecification is ultimately a theoretical concept, and its applicability is therefore dependent on one's broader theoretical assumptions (often, but not always, the basic assumptions of Autosegmental Phonology). We think this point is sometimes lost in descriptive and analytical work on tonal languages, and so we try to highlight when particular diagnostics crucially depend on specific assumptions about tonal representations (e.g. Hyman 2001, 2011a, b) or phonological derivations (e.g. Steriade 1995, Pulleyblank 2004).

Our discussion draws heavily on prior research on underspecification and related notions like phonological markedness. We would particularly highlight Steriade (1995), Myers (1998), Hyman (2001, 2011a, b), Pulleyblank (2004), and Archangeli (2011) as important influences on our thinking, and direct readers to those sources for more detailed discussion and additional key references. For good general discussions of tone, which have also influenced the presentation here, we recommend Pike (1948), Snider (1999, 2018), Yip (2002), Gussenhoven (2004), Hyman (2006, 2009, 2011a, b), and Hyman & Leben (2021).

The title of our paper is a nod to Ohala (1986) "Consumer's guide to evidence in phonology", which provides a critical perspective on how particular types of data can and should be used to support and develop phonological theories. We hope that this paper will similarly provoke discussion about the relationship between data and theory in the domain of tonal underspecification, and underspecification more broadly.

FORMAL AND ANALYTICAL ASSUMPTIONS

Autosegmental representations

Though underspecification is not intrinsically linked to Autosegmental Phonology, tonal underspecification is commonly used in autosegmental analyses of tonal systems. For that reason, we adopt Autosegmental Phonology as a theoretical backdrop for our discussion here.

The core assumption of Autosegmental Phonology is that tones are independent phonological objects, rather than properties of individual segments (e.g. Goldsmith 1976, 1990, Hyman 2014, and references there). Tones *associate* with segments or other tone-bearing units, via association lines, in order to be phonetically realized (Fig. 1). We use the

term ‘tone-bearing unit’ (TBU) to describe the smallest phonological element which is capable of hosting its own tone in a particular language: TBUs are typically syllables, vowels, or moras, and less commonly (non-moraic) consonants (e.g. Zhang 2001, Gordon 2006).[2]

Importantly, a single tone-bearing unit may host multiple tones in some languages (Fig. 1, left). Similarly, a single tone may be associated with multiple TBUs (Fig. 1, right). These many-to-one and one-to-many associations are a crucial tool for tonal analysis in Autosegmental Phonology. For example, the association of multiple tones with the same host (Fig. 1, left) formally characterizes *contour tones* in Autosegmental Phonology, which are treated as the linking of two or more level tones to a shared position (e.g. the same TBU).[3] Similarly, the linking of a single tone to multiple TBUs (Fig. 1, right) can be used to formally represent tonal spreading or assimilation, and is important in the analysis of ‘across-the-board’ effects in tonal phonology, as we discuss below.

Figure 1. Some basic autosegmental representations for tone. ‘H’ = high tone, ‘L’ = low tone, ‘μ’ = mora. Dotted lines indicate new associations between tones and TBUs. Tonal diacritics on vowels follow standard IPA practice.

Given the formal independence of tones and TBUs in Autosegmental Phonology, so-called ‘floating tones’ may also occur: these are tones which are present in the phonological representation, but which are not linked with any TBU at all (Fig. 2, left). Similarly, not every TBU need be specified for tone: this is shown in the right panel of Fig. 2.

[2] Tone-bearing units should be distinguished from domains of association. For example, in so-called ‘word tone’ languages, words may only bear a small set of overall tonal melodies, regardless of the number of TBUs they contain (see e.g. McPherson 2022 for recent discussion). This suggests that the domain of tone *contrast* is the word rather than the TBU. However, even in these languages, tones are associated to, and realized on, TBUs of a particular size. See also Cassimjee & Kisseberth (2007), Hyman & Leben (2021).

[3] In some languages contour tones behave, phonologically, like coherent units: for example, contours may spread wholesale in processes of assimilation. However, these patterns are typically *also* analyzed with representations in which contours consist of level tones associated to a single host, called the ‘tonal node’, which can itself undergo spreading or other tonal operations (e.g. Yip 2002:47-56, Hyman 2011a, b).

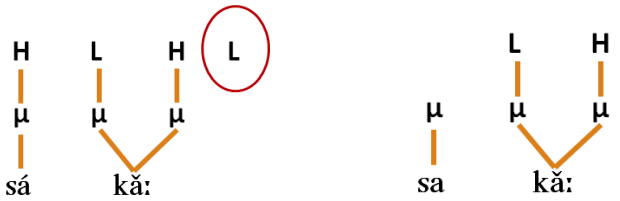

Figure 2. A floating L tone (left, circled) and a tonally-unspecified TBU (right).

The right panel of Fig. 2 thus illustrates TONAL UNDERSPECIFICATION: some, but not all TBUs are associated with tonal targets. Tonal configurations of this type are the focus of our discussion here.

At the outset, we have two minor notes about tonal underspecification. First, though tonal underspecification appears to be common, it is not a requirement of tone systems. For example, in Chicahuaxtla Triqui, every TBU is arguably specified for tone (Hernández Mendoza 2017: 37). In some languages, all lexical roots (or lexical words more broadly) have tonal specifications, but function words or morphemes may be toneless. This is the situation observed in some Zapotec varieties (Sicoli 2007: 92-94) and in many Chinese languages, in which function words and morphemes appear to be phonologically toneless, possibly because they are systematically unstressed (e.g. Yip 2002: 181-5; Duanmu 2007: 2, 131, 241-2 etc.).

Second, we use the terms 'unspecified' and 'underspecified' as essentially synonyms here. At times the term 'unspecified tone' is used to refer to the default tone which is inserted on otherwise toneless TBUs, as discussed in the next section.

How are underspecified TBUs phonetically realized?

Phonetically speaking, every voiced segment is produced with vocal fold vibration, and thus with some fundamental frequency (f0) and associated pitch. Something must therefore be said about how underspecified TBUs acquire their values for f0 in the phonetics.

An unspecified TBU may acquire its tonal target in the phonology proper. Typically, this involves the insertion of a default level tone, as in the left panel of Fig. 3 (we discuss examples below). An unspecified TBU may also receive a tonal specification via tonal spreading from an adjacent TBU (Fig. 3, center). This occurs in e.g. Huehuetepec Tlapanec (Mè'phàà) (1) (Uchihara & Tiburcio 2020).

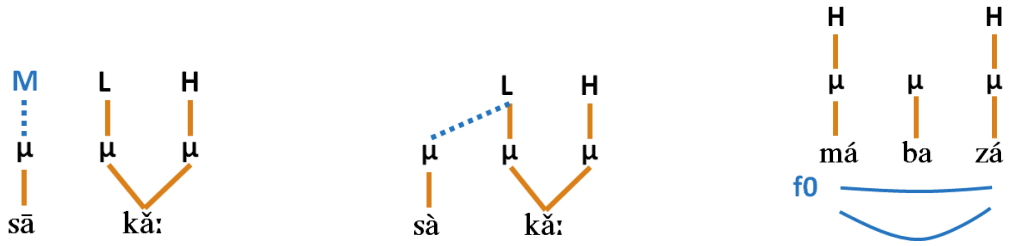

Figure 3. How unspecified TBUs acquire tonal targets: default tone insertion (left), tonal spreading (center), phonetic interpolation (right). 'M' = mid tone, f0 = fundamental frequency (≈ pitch).

(1) Tonal spreading to toneless TBUs in Huehuetepec Tlapanec (Uchihara & Tiburcio 2020)

a. /nī-tara-tsī/ (CMP-2SG-buy) → [nītārātsī] 'you bought' /<u>M Ø Ø</u> M/ → /<u>M M M</u> M/

b. /mà-tara-tsī/ (POT-2SG-buy) → [màtàràtsī] 'you will buy' /<u>L Ø Ø</u> M/ → /<u>L L L</u> M/

Lastly, if tonal underspecification persists past the end of the phonology, into the phonetics, an unspecified TBU may receive its value for f0 via *interpolation* between neighboring specified tones (Fig. 3, right; e.g. Pierrehumbert & Beckman 1988, Myers 1998; for non-tonal, segmental interpolation, see e.g. Keating 1988, Cohn 1990, 1993, Choi 1995, Shaw & Kawahara 2018). As Fig. 3 (right) shows, interpolation can be linear or non-linear. In the case of non-linear interpolation, transitions between specified targets may show a 'sagging' contour over an intervening unspecified region, among other possibilities.

Underspecification in Autosegmental Phonology

In the course of constructing a tonal analysis, two practical questions arise with respect to underspecification. First is the 'unspecified TBU' problem: how does one identify a TBU lacking a tonal specification on the surface? Second is the 'default tone' problem: how does one decide if a particular tone corresponds to the tone which is assigned, by default, to a TBU without tone?

Beginning with the 'unspecified TBU' problem, we take it as basically *definitional* of underspecification that if a TBU lacks a tonal specification, *the phonology should in some way behave as if the tone on that TBU were invisible*. We have a similar perspective on the 'default tone' problem: if a phonetic tone T_x corresponds to the *absence* of tone in the

phonology (because it's assigned by default to toneless TBUs), then again, *the phonology should systematically behave as if that particular tone T_x were invisible*.

However, an immediate complication arises. Default tones should only behave as 'invisible' in the phonology if they are assigned at the end of the phonological derivation (either in the phonology proper, or as part of the phonetic interpretation of the output of phonology). If toneless TBUs receive a default tone earlier in the derivation – for example, at the output of the stem- or word-level phonology, in the terms of Lexical Phonology (e.g. Bermúdez-Otero 2018) – then there is no guarantee that default tones will actually behave as invisible for later phonological processes (see also Steriade 1995). This is the first instance in which we can see that underspecification is not purely a descriptive tool, but a theoretical concept which can only be applied to the analysis of data in the context of particular theoretical assumptions (e.g. the timing of default tone insertion). From a practical perspective, this observation also underscores the point that diagnostics for underspecification must be applied very carefully, as part of a broad analysis of the overall tone system of a language. We now turn to an evaluation of particular diagnostics for tonal underspecification.

RELIABLE PHONOLOGICAL DIAGNOSTICS FOR TONAL UNDERSPECIFICATION

Contour tones

In Autosegmental Phonology, contour tones amount to transitions between two (or more) level tones specified on a single host. For example, a falling tone can be represented as a high target followed by a low target on the same TBU (Fig. 4.) In this framework, there is no way to represent a contour tone involving an underspecified tone on a single TBU: since underspecified tones are simply the absence of tone, this would be equivalent to a single level tone, rather than a contour (to visualize this, imagine Fig. 4 without T_y attached; see also Hyman 2001; Pulleyblank 2004; Daly & Hyman 2007: 173). This is true for phonemic (contrastive) contour tones, but also true of surface contour tones derived by the application of phonological rules.

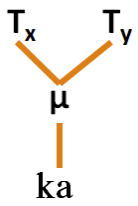

Figure 4. Representation of a contour tone.

An example comes from Peñoles Mixtec, where no monomoraic contours involve the mid tone, which is analyzed by Daly & Hyman (2007) to be underspecified /Ø/. The only monomoraic contour is /LH/. Lalana Chinantec has four level tones /1, 2, 3, 4/ in addition to underspecified /Ø/, which is realized phonetically as a low falling tone [21] on long vowels (contrasting with tone /1/, which is realized as a low-mid level [2] tone), and as a low falling tone with final aspiration [21^{h}] on short vowels (again contrasting with tone /1/, which is realized as a low level [1] tone). The only contour tones are /12, 14, 21, 23, 31, 41/ (Nakamoto 2022); thus, the underspecified tone cannot form a contour. A similar case is reported for Yoruba (Pulleyblank 2004), which has contours involving L and H tone, but not M.[4]

Contour tones provide a positive test for tonal specification: if some contour includes T_x (on the smallest TBU), then T_x must be specified. But if there are no contours including T_x, that doesn't tell us much – for example, it could be an accidental gap, or reflect an independent prohibition against contours of a particular type. For instance, Tataltepec Chatino has three tone levels, low, high and superhigh. The only underlying contour tone in Tataltepec Chatino is high-low, and surface phonetic contour tones involving the superhigh tone are at best marginal (Sullivant 2015: 200-2, 215).[5] The lack of contours involving superhigh tone is thus consistent with treating superhigh as underspecified. But as we've seen, this state of affairs is also consistent with treating superhigh as *specified*, if one is willing to assume constraints which ban contours of particular types, or just treat the lack of contours with superhigh tone as an artifact of historical change. In fact, superhigh tone is

[4] A possible counterexample is found in Chiquihuitlán Mazatec, where an underspecified tone (represented with the symbol '1' in the original source) can form a contour tone /13/ (Nakamoto 2022), such as [tʃũ$^{h13(4)}$] 'woman'. Tone /1/ in Chuiquihuitlán Mazatec otherwise shows the behavior of an underspecified tone, as we will see in the next subsection.

[5] We say that contour tones involving the superhigh tone are 'marginal' in Tataltepec Chatino because they occur in some monomoraic forms – often loans from Spanish or Coastal Mixtec – but only in certain contexts. Further, most, if not all of these forms are historically polysyllabic, and in some cases could even be analyzed as synchronically polysyllabic (Sullivant 2015: 64, 104, 199, 200-5).

clearly a specified tone, since it is phonologically active: it (i) blocks the linking of floating tones, (ii) can itself float, and (iii) contrasts with TBUs which actually do appear to be underspecified because of e.g. their invisibility for the displacement and linking of floating superhigh tones (Sullivant 2015: 197-216).

In using contour tones to assess tonal specification, it's important to know what the smallest TBU is in the language in question. For example, if the TBU is the mora, then finding contours involving a particular tone on long vowels (with two moras) doesn't tell us much. The representation could look like Fig. 5, with one tonally-specified mora (where T_x is some tone), and one tonally-unspecified mora (eventually realized with a default tone, here an M tone). This occurs in Peñoles Mixtec, where the TBU is the mora, and M tone is argued to be underspecified (Daly & Hyman 2007). In this language, 'false' contours with phonetic M tone, resembling Fig. 5, are found in bimoraic, monosyllabic forms such as [kāá] 'hatchet', [ʒóʔō] 'root' (see also Campbell 2016:146 for Zenzontepec Chatino).

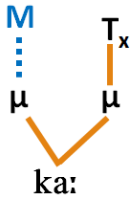

Figure 5. 'False' contour tone with an underspecified TBU = μ realized with default M tone.

Finally, this diagnostic also depends on the assumption that contour tones consist of simple (level) tones. If contour tones are analyzed to be unitary, as in Fig. 6, then we cannot apply this diagnostic. See Hyman (2001) for similar observations.

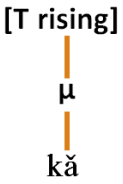

Figure 6. Non-atomic contour.

Invisibility for dissimilation and other tonal processes

Sometimes, certain tones seem to be 'invisible' for tonal dissimilation. It is common in tonal languages for tonal dissimilation to apply between adjacent tones $[T_x]+[T_x]$ of the same type

(e.g. /HH/ → [HL]). In some languages, dissimilation applies even when certain tones intervene between the dissimilating tones (Fig. 7). In such cases, it is reasonable to analyze the 'invisible' intervening tones as corresponding to phonologically underspecified TBUs, realized with a default tone on the surface.

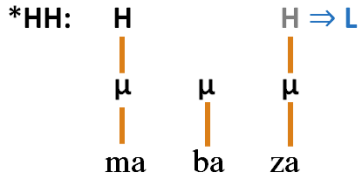

Figure 7. Toneless TBUs and invisibility for dissimilation.

For instance, Peñoles Mixtec has a dissimilation rule /LL/ → [LM] (= /LØ/), where the second /L/ is deleted when two L tones occur next to each other (Daly & Hyman 2007). This process is applied even when a surface mid tone intervenes; that is to say, the mid tone is invisible, i.e. underspecified (Fig. 8). Here, the low tone on [ndè] and the low tone on [ʧì] are separated by a surface mid tone on [kū], but the dissimilation rule still applies, and the L tone on [ʧì] is deleted, eventually surfacing as a phonetic mid tone.

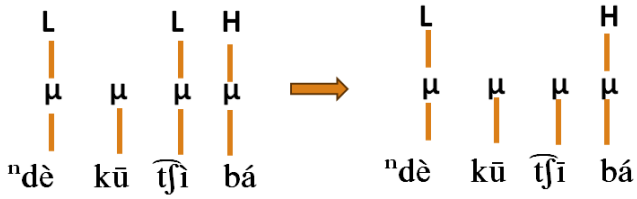

Figure 8. Peñoles Mixtec dissimilation: 'there are goats'.

Further, Daly & Hyman show that L dissimilation can apply across multiple M tones, e.g. /ⁿdù̲kū ʒ̄ʜ̄-ʃī kʷà̲ʒú/ → [ⁿdù̲kū ʒ̄ʜ̄-ʃī kʷā̲ʒú] 'her husband is looking for a horse'.

We can compare the behavior of mid tone in this context with that of high tone, which blocks the dissimilation rule applying to low tones (Fig. 9). Here, the low tone on [ʧì] is not deleted, since it is separated from the preceding L tone by the high tone on [dí]. This is because the high tone, unlike the mid tone, is phonologically specified, and thus visible for dissimilation.

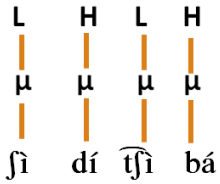

Figure 9. Peñoles Mixtec blocking of dissimilation by H: ‘goats are sleeping’.

A similar case of invisibility, involving tonal displacement rather than dissimilation, is found in Chiquihuitlán Mazatec (Nakamoto 2022). Here, an underlying tone 4 introduced in the middle of an intonational phrase is phonetically realized on the final TBU of that phrase (Fig. 10), skipping over any intervening underspecified TBUs (and ignoring some pronominal enclitics, such as [=naʔa] here). (In Chiquihuitlán Mazatec underspecified TBUs are phonetically realized, by default, with the lowest tone level [1].)

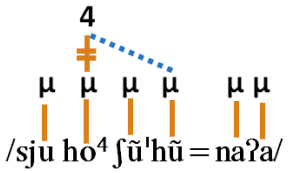

Figure 10. Displacement of 4 tone through an unspecified TBU with default 1 tone in Chiquihuitlán Mazatec: ‘my two papers are lying’. Double horizontal lines indicate removal of a tonal association.

A potential complication: invisibility for tonal spreading

A potential complication concerning tonal underspecification is that we know of no tonal pattern where an underspecified tone is totally invisible for tonal spreading. Tone spreading processes like /L H/ → [L LH], where the low tone spreads to a following TBU with a lexical high tone to form a LH contour, are quite common (Hyman & Schuh 1974, Hyman 2011a,b). But we know of no rules like /L ∅ H/ → [L ∅ LH] (Fig. 11), where the same spreading rule applies across an underspecified TBU (phonetically realized as e.g. surface [L M LH], with a default M tone).

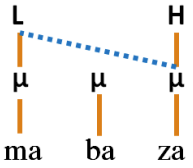

Figure 11. True invisibility for spreading.

Configurations like Fig. 11 are normally ruled out by locality constraints on spreading, which prevent the skipping of TBUs in tone spreading processes (e.g. the NoGap constraint of Yip 2002: 84; see also Hyman 2014). Such constraints may be responsible for independently ruling out configurations like Fig. 11, thus accounting for the absence of such processes.

On the other hand, tonal invisibility for non-spreading tonal processes, including dissimilation and tonal displacement, does occur in various languages, as we have seen. Other potential cases of tonal invisibility in tone displacement include San Miguel el Grande Mixtec (Goldsmith 1990:20-27; Tranel 1995, 1996, Yip 2002:221-222), some Bantu languages (e.g. Giryama, Hyman 2011a,b and references there), and Lalana Chinantec (Shun Nakamoto, p.c.), which has a displacement process similar to the Chiquihuitlán Mazatec pattern discussed above.

Multiple linking

Some tone processes suggest that certain tones are linked to multiple TBUs, as in Fig. 12. Evidence for multiple linking comes from languages like Shona (Odden 2005), which has a high tone dissimilation rule where the second H in a sequence of two H tones dissimilates to L tone, as in /né-mbwá/ → [né-mbwà] 'with dog'. When this dissimilation rule is applied to bimoraic forms with high tones on both moras such as /hóvé/ 'fish', then the high tones on both moras dissimilate to a low tone: /né-hóvé/ → [né-hòvè] 'with fish' (Fig. 11). This can be explained by assuming that the two moras are linked to one shared high tone, as in Fig. 12, and thus must dissimilate together as a unit. Assuming independent H tones on each mora would fail to explain why [hóvé] is acceptable on its own, given that sequences of H tones otherwise undergo dissimilation; it would also fail to explain why /né-hóvé/ dissimilates to [né-hòvè] (with H-LL tone) rather than *[né-hòvé] (with H-LH tone), which would also satisfy the constraint against adjacent H tones.

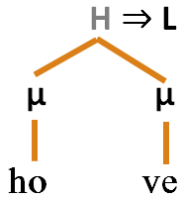

Figure 12. Multiple linking and dissimilation in Shona.

Similarly, Acatlán Mixtec (Aranovich 1994; Snider 1999, Ch. 6) has an upstepping rule, where a high tone is raised further after another high tone: H → ↑H / H__. When this rule applies to a sequence of high tones, such in [díʔí] 'mother', both high tones raise to superhigh, as in [ʔikúmí=ndá ↑díʔí] 'we have a mother'.[6]

A tone that corresponds to the lack of tone (i.e. an underspecified tone) cannot be linked to multiple TBUs. As such, when a tone manifests behavior like the H tone in Shona or Acatlán Mixtec, that tone cannot be underspecified. But like the inventory of contour tones, multiple linking cannot be used to confirm *under*specification, only to show that a particular tone must be specified. This is true of most of the diagnostics discussed in this paper. The only direct, positive tests for underspecification we are aware of concern invisibility for tone rules like dissimilation or displacement, and patterns of phonetic interpolation for pitch on toneless TBUs, discussed in the next section.

INTERPOLATION: A RELIABLE PHONETIC DIAGNOSTIC FOR TONAL UNDERSPECIFICATION

While our focus here is on the phonology of underspecification, evidence for underspecification in the *phonetics* has also provided compelling support for underspecification as a concept. The *locus classicus* for tonal underspecification is Pierrehumbert & Beckman (1988), which builds on their earlier work on the phonetics and phonology of intonation (e.g. Pierrehumbert 1980, Liberman & Pierrehumbert 1984, Beckman & Pierrehumbert 1986). We illustrate one of their key proposals with a simplified discussion of the analysis of Japanese intonation in Pierrehumbert & Beckman (1988, Ch.2).

The standard variety of Japanese, based on the Tokyo dialect, has a lexical contrast between words bearing a H*L (falling) pitch accent, and those lacking such an accent (e.g. Kubozono 2008 and many others). The position of accent is also contrastive, particularly in nouns (e.g. Kawahara 2015). The tonal specification of *unaccented* words has been the topic of some debate: phonetically, they seem to be realized with raised pitch, at least when following a High intonational tone. This has led some analyses to propose a rule of high-tone

[6] [díʔí] 'mother' is likely monosyllabic in Acatlán Mixtec, but since the TBU is the *mora*, as is typical in Mixtecan languages, our point about multiple linking still goes through (e.g. [tóʔò] 'stranger').

spreading from intonational H tones across a span of unaccented moras: ^{H}[μ μ μ μ… → ^{H}[μ́ μ́ μ́ μ́… (see e.g. Kawahara 2015 for a broad overview, and cf. Haraguchi 1999).

Pierrehumbert & Beckman (1988:26-51) argue that unaccented moras do not show the phonetic profile of moras specified for a high tone. They demonstrate this by investigating the pitch profile of unaccented moras occurring between an intonational H tone and a following intonational L tone. In this context, f0 on unaccented moras appears to be (i) predictable, but (ii) different from what would be expected for a specified H tone. Rather than being realized with a continuous H tone plateau (either flat or gradually declining), pitch on unaccented moras in this environment seems to be determined by a linear interpolation between the intonational H and L tones (Fig. 13): in a string of unaccented moras, the farther the unaccented mora is from the H tone, the lower (closer to L) its pitch is. In longer strings of unaccented moras, pitch declines more gradually than in short strings of unaccented moras, where it declines more quickly.

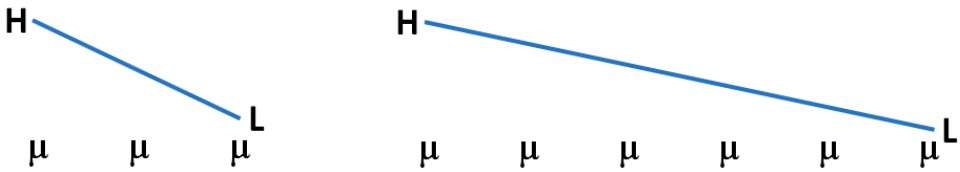

Figure 13. Schematic representation of pitch interpolation over toneless moras in Japanese (after Pierrehumbert & Beckman 1988).

Pierrehumbert and Beckman argue that the gradually lowering pitch in e.g. the righthand panel of Fig. 13 cannot be analyzed as phonetic pitch declination over a sequence of phonologically high-toned moras (e.g. Ladd 1984). Essentially, the pitch change in *short* spans of toneless moras (Fig. 13, left panel) is too large, and too quick, to be the consequence of gradual declination. Pierrehumbert and Beckman thus conclude that unaccented moras are toneless – underspecified for tone – and receive their phonetic value for f0 from their environment, according to regular and predictable phonetic principles which determine the transition between specified intonational H and L tones. This confirms the hypothesis that TBUs can remain unspecified, lacking their own tonal targets, past the end of the phonology proper, and into the phonetic implementation stage. Myers (1998) provides another excellent demonstration of this idea on the basis of phonetic data from Chichewa, arguing that TBUs

previously analyzed as bearing L tone are in fact toneless, and receive pitch values from their context. (Myers' analysis also provides an example of *non*-linear interpolation for pitch.)

Phonetic evidence for underspecification is compelling because f0 is directly measurable. Carefully-designed experiments can therefore be used to test and evaluate specific hypotheses about tonal specification. The downside, of course, is that this requires significant expertise in experimental design, data processing, and statistical analysis. Furthermore, phonetic data must still be carefully interpreted, as we discuss in more detail in a later section.

It's important to note that languages with underspecified TBUs may nonetheless provide those TBUs with specific pitch targets prior to the surface phonetics. This is schematized in the first 2 panels of Fig. 3 above. An example comes from Serbo-Croatian (e.g. Zec & Zsiga 2010, Zsiga & Zec 2013). In Serbo-Croatian, words may have a specified H tone (e.g. /parad**á**/ 'parade'), or may be toneless (e.g. /devera/ 'brother-in-law' (GEN.SG)); however, toneless words receive an H tone on their stressed syllable at the post-lexical (≈ phrasal) level of the phonology (e.g. [ˈd**é**.ve.ra] vs. [pa.ˈra.d**á**]). By the time 'toneless' words are phonetically realized, they have already received a specific H tone pitch target by default. Similarly, in Tokyo Japanese, lexically unaccented words may host phrase-level tone patterns, such as an initial LH rise (e.g. Ito & Mester 2013); here too, words lacking tonal specification at the word level nonetheless receive a certain amount of tonal specification in the post-lexical phonology.

LESS STRAIGHTFORWARD DIAGNOSTICS FOR TONAL UNDERSPECIFICATION

Allotonic rules

Tonal languages often have phonological rules which change the tonal specification of TBUs in particular contexts. These 'allotonic' rules can, in principle, be used to diagnose tonal specification (see e.g. Myers 1998). For example, in Zenzontepec Chatino, the enclitic /=ū?/ 3PL, which has an underlying mid tone, is realized with high tone after a host that has a mid tone M on its final mora, as in /nka-jny**ā=ū**?/ → [nka-jny**ā=ú**?] 'they made (something)' (Campbell 2016). This is clearly a rule of dissimilation, and it strongly implies that the mid tone M must be phonologically specified in Zenzontepec Chatino: since the M tone is

phonologically active, it cannot simply be the phonetic realization of a toneless TBU.[7] A similar case comes from downstepping in Teotitlán del Valle Zapotec, where in a sequence of two TBUs with high tone, the second high tone is downstepped, being realized with slightly lower pitch: /ʃsabáːd xwáːjn/ → [ʃsaˈbáːd ↓ˈxwáːjn] 'Juan's shoes'. Additionally, the enclitic /=ēn/ FOC, spreads its underlying M tone to the final mora of its host, if that host ends in a low tone, e.g. /gìts=ēn/ → [gīts=ēn] 'paper.FOC' (Uchihara & Gutiérrez 2019). This indicates that both H tone and M tone are specified in Teotitlán del Valle Zapotec.

As with many of the diagnostics discussed in this article, this test can be used to argue that a particular tone must be specified, but it cannot be used to confirm *under*specification. Consider a hypothetical language with surface H and L tones, but no tonal rules referring to L. It could be that L is underspecified (e.g. Myers 1998, Anttila & Bodomo 2022). Alternatively, the language could have a *specified* L tone, but simply lack any rules referring to it. There is no logical requirement that a language have tone rules referring to each of its specified tones. It could also be that there *are* such rules, but as analysts we have not yet discovered them.

The basic premise of this diagnostic is that the phonological grammar can only refer to specified tones, and cannot refer to the *absence* of tone. Once again, this underscores the fact that diagnostics for underspecification are contingent on the broader theoretical assumptions we adopt. In this case, one could argue to the contrary that the phonological grammar *must* refer to toneless TBUs. For example, many languages do not allow toneless TBUs: in Optimality Theory, this implies that a constraint like *TONELESS-TBU is high-ranked (e.g. Yip 2002:83, McPherson 2011, Anttila & Bodomo 2022). The constraint *TONELESS-TBU clearly refers to the absence of tone. In rule-based frameworks, rules of default tone insertion must also refer to toneless TBUs, e.g. Ø → L (this is also true for autosegmental rules of this type, e.g. Odden 2005: 302). But once our theory allows reference to toneless TBUs, it becomes possible to formulate phonological rules like /H/ → Ø / ___ Ø, which mimics an assimilation rule by 'spreading' tonelessness. Similarly, a rule like Ø → [H] / ___ Ø can be formulated which mimics dissimilation by eliminating sequences of

[7] Assuming, that is, that default tones are inserted relatively late in the derivation; see our earlier discussion above.

toneless TBUs.[8] In this theoretical context, the inventory of phonological rules no longer serves as a valid diagnostic for tonal specification vs. underspecification.

Without doubt, the inventory of tonal rules in a given language can be *suggestive* as to tonal specification. In that sense, examining a language's tone rules can be a very useful exercise when reasoning about underspecification. However, this diagnostic is crucially dependent on particular theoretical assumptions about the grammar, which need to be carefully scrutinized. For that reason, the inventory of tonal rules in a given language seems somewhat less reliable to us for identifying tonal underspecification than other diagnostics discussed above.

Floating tones

In Autosegmental Phonology, the independence of tones from segments and TBUs has an interesting consequence: tones may be present in the phonological representation without being hosted by a TBU at all (Fig. 14). Such 'floating' tones may be present in either underlying or surface representations, depending on the language.

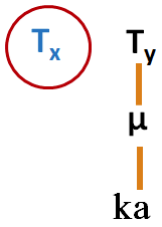

Figure 14. Schematic example of a floating tone (circled).

The motivation for positing floating tones comes from several empirical phenomena (see also Pulleyblank this volume). We focus first on the use of floating tones as a tool for analyzing *morpheme-specific tonal effects*.[9] For example, in Yucuquimi de Ocampo Mixtec

[8] Sullivant (2015: 214-6) identifies a potential case of dissimilation between toneless TBUs in Tataltepec Chatino, /∅ ∅/ → [∅ HL]. Evidence for the tonelessness of the TBUs involved comes from their transparency to a process of superhigh tone displacement, and their susceptibility to overwriting by L-tone spreading (*ibid.*, pp.206-16). Sullivant notes that this dissimilation process is lexically restricted, and may be amenable to a different type of analysis, pending more investigation.

[9] The standard understanding of floating tones as tones which are not linked to a particular TBU (e.g. Goldsmith 1990: 20) allows for the possibility of floating tones which are phonologically general, rather than morpheme-specific. For example, in Teotitlán del Valle Zapotec, the mid tone is *always* associated with a floating high tone (Uchihara & Gutiérrez 2019). However, we are not sure that such cases should be analyzed by means of underlying floating tones, rather than tonal rules, constraints, or other grammatical mechanisms which force surface mid tones to be followed by a high tone.

(León Vázquez 2017:107), [θỳkỳ] ‘niece’ and [θỳkỳ] ‘neck’ are homophonous in isolation, but ‘niece’ has an idiosyncratic tonal effect on the following noun: the first mora of the following noun has to be realized with high tone (see also Pike 1948, Goldsmith 1990, and below for related discussion of San Miguel el Grande Mixtec).

(2) Idiosyncratic tonal phonology in Yucuquimi de Ocampo Mixtec

a. [θỳkỳ b**a̲**ʔā] ‘good neck’ (with underlying tone on [bàʔā] ‘good’)

b. [θỳkỳ b**á̲**ʔā] ‘good niece’

A standard analysis of this pattern is to assume that the underlying representation of the word ‘niece’ includes a floating high tone, /θỳkỳ, H/, which is not associated to any TBU or segment. This high tone then docks to the first mora of the following word, overwriting its original tone, e.g. /θỳkỳ, H # b**a̲**ʔā/ → [θỳkỳ b**á̲**ʔā]. This use of floating tones thus attributes exceptional tonal behavior to the *representations* of individual morphemes: the noun [θỳkỳ] ‘niece’ idiosyncratically affects the tone of the following word because it is underlyingly represented with an extra, unassociated tone that other morphemes lack.

Floating tones can be used as a diagnostic for tonal specification. Floating tones are phonological objects, which the grammar can manipulate in various ways. Almost by definition, then, a tone which is floating as in Fig. 14 must be a specified tone which is present in the phonology proper.

The primary complication with this diagnostic is a theoretical one. Floating tones can be useful for analyzing morpheme-specific tonal effects like (2). However, there are other theoretical and analytical tools for analyzing morpheme-specific phonological behavior (see also Pulleyblank this volume). In Optimality Theory, morpheme-specific behavior has sometimes been analyzed by assuming that different morphemes may belong to different phonological sub-systems, which have different phonological requirements (see e.g. Kenstowicz & Kisseberth 1979, Ch. 10 for earlier rule-based precedents). This can be accomplished using constraints which are indexed to particular morphemes (e.g. Pater 2010), or constraint rankings which are associated with particular morphemes or morphological contexts (e.g. Anttila 2002, Sande 2022, and references there). To illustrate, we reproduce here a simplified version of Inkelas & Zoll’s (2007) analysis of morphologically-conditioned tone in Hausa (Newman 2000). In Hausa, imperative constructions replace the tone of the

verb stem with an LH melody aligned to the right edge, e.g. [kárántáː] ‘read’ (H L H) → [kàràntáː] ‘read!’ (L L H). This pattern of tonal overwriting could be analyzed with floating tones, treating the underlying form of the imperative morpheme as simply /LH/, without any segmental content at all (see also the next section on grammatical tone). This /LH/ would then dock to the right edge of the word, spreading L leftward (Newman 2007:678-9). In Mesoamerica, similar cases have been reported for Temalacayuca Popoloca where the tonal melody /L/ is assigned in augmentative forms (Nakamoto in press); Ayautla Mazatec where animal names have tonal melodies /3.3/ or /4.2.4/ (Nakamoto 2020: §4.2.3), and in Malinaltepec Tlapanec where the tonal template L.H.H.H is assigned to diminutives (Carrasco 2006:129).

However, Inkelas & Zoll (2007) adopt a different analysis for Hausa: they propose that imperative constructions are associated with a high-ranked constraint TONE = LH, which imposes an LH tonal melody on imperative verbs (see also Pulleyblank this volume). It is this constraint – and *not* an underlying floating tone – which is responsible for tonal overwriting in the imperative. This analysis extends to suffixes which also overwrite the tone of their bases, e.g. [d͡ʒàːkíː] ‘donkey’ (L H) → [d͡ʒáːk-únàː] ‘donkeys’ (H - H L) (Newman 2007:679): these can be analyzed using constraints like TONE = HL which are high-ranked in the context of specific morphological constructions, e.g. plurals of a particular noun class (Newman 2007:680). In contrast with the use of floating tones, this analysis assumes that exceptionality is a property of the *grammar* associated with particular morphemes (or morphological constructions), and not just their underlying representations.

We can apply the same basic logic to the analysis of [θỳkỳ] ‘niece’ in Yucuquimi de Ocampo Mixtec. Schematically, if the construction [θỳkỳ] ‘niece’ + ADJECTIVE is associated with a constraint like FIRST-σ = H (or FIRST-μ = H), then we expect that [θỳkỳ] ‘niece’ will trigger a high tone on the following word, as in (2).

To be clear, we are not advocating for a grammar-centric view of morpheme-specific tonal behavior. We simply intend to illustrate the fact that morpheme-specific tonology can be analyzed in various ways, which somewhat limits the use of morpheme-specific tonal patterns as diagnostics for floating tones, and thus for tonal specification.

That said, floating tones have also been used to analyze other phonological patterns which seem harder to re-analyze in terms of morpheme- or construction-specific grammars.

For example, in Efik, the first vowel in hiatus deletes (Clements 1979, Yip 2002: 149), /àkámb**á ù**b**ó**m/ (L H H # L H) → /àkámb **ú**b**ó**$^{\downarrow}$m] (L H # H H$^{\downarrow}$) 'large canoe'. As the transcription indicates, the second high tone on [úb**ó**$^{\downarrow}$m] is downstepped, being realized lower than otherwise expected for a high tone in this context. Clements (1979) analyzes this by assuming that the H tone on the deleted final vowel of /àkámb**á**/ associates to the initial vowel of /**ù**bóm/. As a consequence, the surface tonal pattern of [úb**ó**$^{\downarrow}$m] is actually H^{L}H, where superscript ^{L} indicates a 'hidden' floating tone sandwiched between the high tones realized on the two vowels, which has been displaced by the anchoring of the H tone to the first vowel of /**ù**bóm/. This floating tone then triggers downstep of the second high tone in a phonologically predictable way. As far as we know these alternations are phonologically general, and so it seems inappropriate to analyze them using morpheme- or construction-specific phonological grammars.

Morpheme-specific grammars are also quite powerful, and can produce many more types of morpheme-specific phonological patterns than floating tones can. Whether that is a virtue or a vice of such theories remains to be determined (see also Zimmermann to appear).

Grammatical tones

As seen in the preceding section, certain morphological constructions often involve predictable tonal changes. For example, in San Martín Peras Mixtec, verb inflection may be expressed exclusively by tonal changes in certain contexts (3) (Eischens 2022).

(3) Grammatical tone in San Martín Peras Mixtec

a. [nd**á**^{h}t͡ʃ͡ʃ sāà] 'the bird flies' (**H** H # M L)

b. [nd**à**^{h}t͡ʃ͡ʃ sāà] 'the bird flew' (**L** H # M L)

c. [nd**ǎ**^{h}t͡ʃ͡ʃ sāà] 'the bird doesn't fly' (**LH** H # M L)

We take the term 'grammatical tone' to refer to any pattern in which particular tone changes or tone patterns are associated with a specific morphological category or construction, as part of word-building processes (e.g. Rolle 2018:2). We use the term 'grammatical tones' to refer to those tones which are introduced by morphologically-conditioned tonal processes of this type, as illustrated by the grammatical H, L, and LH tones in (3).

Grammatical tones as floating tones

It is sometimes assumed that grammatical tones, like the aspectual and negative tones in (3), must be phonologically-specified tones. The logic is essentially the same as outlined for floating tones above, because grammatical tones are commonly analyzed as the result of floating tones associated with derivational or inflectional morphemes (see e.g. Rolle 2018). For that reason, the caveats we express above for floating tones often apply equally to the use of grammatical tone as a diagnostic for tonal specification.

Grammatical tones as tonal processes or paradigms[10]

There are also cases of grammatical tone which are difficult, if not impossible to analyze using floating tones. Chain shifts involving tone provide one example. In Guébie, imperfective aspect is marked by lowering the tone of the verb stem along a scale, so that e.g. high 4 tones lower to 3, 3 tones lower to 2, and 2 tones lower to 1 (simplifying somewhat; see Sande 2022 for details). This cannot be straightforwardly analyzed by means of a floating tone, since there isn't any phonetic consistency in the surface tones associated with imperfective aspect. Similarly in Ozumacín Chinantec the tones /2, 3, 4, 5, 24, 35, 31, 41, 51/ are lowered by one level to /1, 2, 3, 4, 13, 24, 21, 31, 41/, respectively, in certain constructions: following the polar question proclitic [chi^{3}=] or the counterfactual proclitic [jwa^{3}=]; following a fronted constituent; in a subordinate clause; etc. (Nakamoto 2023).

A similar point can be made with paradigmatically-organized grammatical tone systems. Kim (2016) argues that verbs in San Pedro Amuzgos Amuzgo must be organized into dedicated inflectional classes, in part because there are no consistent tonal exponents of inflectional categories (see also Palancar 2021). Kim suggests that 3SG verb forms correspond to the underlying lexical tone of the verb stem. However, the lexical tone of the stem does not predict its inflectional patterning. Stems with underlying /12/ tone may be marked with either /53/ tone or /12/ tone in 1SG forms, and either /31/ or /12/ tone in 2SG forms, depending on the verb in question. In contrast, stems with underlying /53/ tone may only be marked with /53/ in 1SG forms, and either /31/ or /53/ tone in 2SG forms. This is only

[10] This concept roughly corresponds to what Palancar & Leonard (2016) call 'inflectional tone' and Woodbury (2019) calls 'tone ablaut'.

a partial overview of inflectional patterns in Amuzgo verbs, and Kim shows that similar variation occurs for other lexical tones, and for other aspects of verbal morphology.

In sum, the choice of inflectional pattern for any given verb stem in San Pedro Amuzgos Amuzgo appears to be largely arbitrary. We see here an utter lack of any predictability between underlying tones, inflectional categories, and corresponding surface tones. It would be dubious to use floating tones to analyze these patterns, given that there is essentially no phonetic consistency in the tonal expression of person-number categories. Similar cases of grammatical tone that are not amenable to a floating tone analysis include exponents of the agent person categories in Mazatec (K. Pike 1948, Nakamoto 2020, Ch. 8), Popoloca (Nakamoto 2016), Chinantec (Merrifield 1968; Baerman and Palancar 2015; Castellanos Cruz 2021), Otomí (Palancar 2004, Hernández-Green 2021) and Teotitlán del Valle Zapotec (Uchihara & Gutiérrez 2020).

A related complication is that there appear to be 'grammatical tones' which are expressed by the *deletion* of tone. For example, in Tokyo Japanese, the genitive marker /=no/ deletes H*L accent from any (polysyllabic) host which has an accent on its final mora, e.g. /atama^{H*L}=no/ → [atama=no] 'head=GEN' (e.g. Kawahara 2015). The result of deletion is an unaccented word, which as argued above, corresponds to a word consisting exclusively of tonally-underspecified moras at the word level (at least in the analysis of Pierrehumbert & Beckman 1988). In this case 'grammatical tone' – in the broad sense of tonal changes associated with particular derivational or inflectional categories – is a bad diagnostic for tonal specification.

Zenzontepec Chatino (Campbell 2016, 2019) provides an example of tonal inflection involving both (i) paradigmatic organization, and (ii) the apparent deletion of tone in certain grammatical categories. Similar to Amuzgo, verbs in Zenzontepec Chatino are organized into different inflectional classes for aspect marking, with tonal alternations across aspect categories that are at best semi-predictable. Campbell (2016) argues that the L tone corresponds to the absence of tone in Zenzontepec Chatino. Verbs which have HM tone in the completive aspect are realized with either HM or ØØ (phonetic [LL]) tone in the potential aspect (Campbell 2016:158). If tone in the completive aspect corresponds to the underlying lexical tone, as Campbell (2019:54) argues, then potential marking for /HM/ verbs sometimes involves tonal deletion, /HM/ ⇒ /ØØ/ (phonetic [LL]). Again, this suggests that grammatical

tone is a poor diagnostic for tonal specification, especially when morphological tones are organized into complex paradigms.

For theoretical frameworks which treat grammatical tone as the outcome of rules or constraints applying in particular morphological contexts – and not as the expression of morphologically-assigned floating tones – see e.g. Anderson (1992), Sande (2022) and references there.

UNDERSPECIFICATION VS. FAITHFULNESS AND MARKEDNESS SCALES

When a particular tone is uniquely susceptible to tone spreading or overwriting in a given language, that tone may be underspecified. The logic is that tone should be easier to change on an underspecified TBU (Fig. 15, left) than a TBU which already has a specified tone (Fig. 15, right). In Optimality Theoretic terms, changing tone on an underspecified TBU should incur fewer violations of faithfulness constraints.

Figure 15. Targets for spreading, with and without underspecification.

However, the selective overwriting of certain tones does not *require* underspecification. It can also be achieved by assuming that certain tones are relatively marked – that is, phonologically dispreferred – and therefore can be eliminated from surface forms more easily (e.g. Pulleyblank 2004). More or less equivalently, it could instead be assumed that certain tones are more protected than other tones, and thus more resistant to change. We demonstrate this in the following section, then show that the same logic applies to certain other putative diagnostics for underspecification as well.

Susceptibility to tone spreading

We begin with data from Zacatepec Chatino, where low tone L is uniquely susceptible to high tone spreading (Villard 2015, §4.5.1). Example (4) shows a sentence where all words are unspecified for tone – realized phonetically with L tone on the surface – following

Villard's (2015) analysis. Underlining in (4)-(6) indicates a string of TBUs which are underlyingly toneless according to Villard, and thus potentially affected by high tone spread when preceded by an underlying H tone.

(4) Tonally unspecified string (phonetically L) in Zacatepec Chatino
[kwiton nkayako tsaka likya kula ndyikaa tsaan]
bee ate one sugarcane old every day
'The bee ate an old sugarcane every day.'

When the first word of (4) is replaced by [kwīná] 'snake', with a M.H melody, the high tone on the second mora spreads to all subsequent words (5).

(5) H tone spreading across unspecified string in Zacatepec Chatino
[kwīná nkáyákó tsáká líkyá kúlá ndyíkáá tsáán]
snake ate one sugarcane old every day
'The snake ate an old sugarcane every day.'

Unlike the L tone (5), mid tone M blocks spreading of high. In (6), high tone spreading is applied up to [lyūwā] 'annona', which blocks further spreading because of the M tone on the initial mora.

(6) Blocking of H tone spreading by specified M tone in Zacatepec Chatino
[kwīná nkáyákó tsáká lyūwā kula ndyikaa tsaan]
snake ate one annona old every day
'The snake ate an old annona every day.'

This asymmetry in spreading may suggest that low tone is underspecified, while mid tone is specified. Underspecification has been employed to account for similar patterns in various Otomanguean languages, such as Tataltepec and Zenzontepec Chatino (Sullivant 2015:206, Campbell 2016), Chalcatongo Mixtec (Buckley 1991, Swanton & Mendoza Ruiz 2022), Acatlán Mixtec (Méndez Hord 2017, §3.9), Villa Alta Zapotec (Pike 1948), Chiquihuitlán Mazatec (Nakamoto 2018, 2022) and Huehuetepec Tlapanec (Uchihara & Tiburcio 2020).

However, the susceptibility of L tone in Zacatepec Chatino to tonal spreading and overwriting is also compatible with the effects of the faithfulness scale {IDENT[H],

IDENT[M]} ≫ IDENT[L] (Pulleyblank 2004). In Optimality Theory (Prince & Smolensky 1993/2004), IDENT constraints prohibit changing tonal specifications on TBUs (e.g. Yip 2002:79-81). The faithfulness scale {IDENT[H], IDENT[M]} ≫ IDENT[L] therefore asserts that changing tone on a TBU with L tone is less costly than changing tone on a TBU hosting H or M tone. This is illustrated in the following schematic tableaux (Fig. 16), where the constraint SPREAD! is a placeholder for whatever constraint drives rightward tonal spreading.

/HLLL/	**IDENT[H]**	**IDENT[M]**	**SPREAD!**	**IDENT[L]**
[HLLL]			*!	
⇒[HHHH]				***
[HHLL]			*!	*

/HMMM/	**IDENT[H]**	**IDENT[M]**	**SPREAD!**	**IDENT[L]**
[HHHH]		***!		
⇒[HMMM]			*	

/LHHH/	**IDENT[H]**	**IDENT[M]**	**SPREAD!**	**IDENT[L]**
[LLLL]	***!			
⇒[LHHH]			*	

Figure 16. Tone spreading asymmetries as a faithfulness scale.

Importantly, the faithfulness scale {IDENT[H], IDENT[M]} ≫ IDENT[L] (i) allows for spreading to L-toned TBUs, but not other TBUs (Fig. 16, top two panels); (ii) produces spreading of H tone, but not L tone or M tone (Fig. 16, bottom panel); and (iii) does so without assuming any kind of tonal underspecification. In this analysis, L could be susceptible to tonal overwriting, while still being present and active for other phonological

processes (e.g. dissimilation or contour tone formation). For instance in Huehuetepec Tlapanec, L can be overwritten by both M and H tones, but it can form a contour (LH and ML are attested; Tiburcio Cano 2017:60) and can float (for examples see below), and so is likely a specified tone. Hence, susceptibility to tonal overwriting cannot be used as a foolproof diagnostic for tonal underspecification.

The same effect can, in principle, be produced with the markedness scale *[L] ≫ {*[H], *[M]}. This scale asserts that L tone is more marked – more dispreferred – than H or M tone. This scale can be also be used to produce selective overwriting of TBUs with L tone, under a schematic ranking like *[L] ≫ DON'T SPREAD ≫ {*[H], *[M]}; for reasons of space we omit a full explanation of this style of analysis here, as it makes essentially the same point as the faithfulness scale shown above.

Susceptibility to floating tone docking

In some languages, floating tones may selectively dock to TBUs bearing a particular tone. As with tonal overwriting, one might be tempted to assume that this is a diagnostic for tonal underspecification. The logic is that it should be easier for a floating tone to dock to a TBU without tone than to a TBU which already has a tone of its own (Fig. 17).

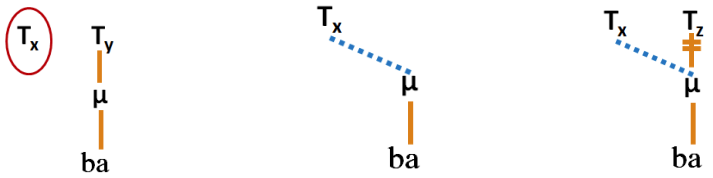

Figure 17. Anchoring of floating tones.

In Huehuetepec Tlapanec (Uchihara & Tiburcio 2020), for instance, a floating low tone associated with the 3PL agentive prefix /ni-, L/ docks to a toneless syllable in the stem, if there is one (Fig. 18, left), while it docks to the prefix itself when both syllables of the stem are tonally specified (Fig. 18, right) (underspecified TBUs are otherwise realized with a default M tone). A similar analysis has been proposed for Chiquihuitlán Mazatec (Nakamoto 2018, 2022), Temalacayuca Popoloca (Nakamoto 2016: §3.2.3, §3.3), Huehuetepec Tlapanec (Uchihara & Tiburcio Cano 2020), San Lucas Quiaviní Zapotec (Uchihara 2016), and proto-Zapotec (Beam de Azcona 2023).

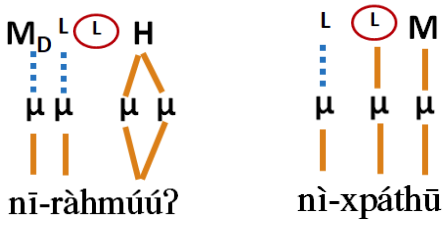

Figure 18. Floating tone docking in Huehuetepec Tlapanec [nīràhmúú?] 'they hobbled (CMP.3PL-hobble)' and [nìxpáthū]'they hit (CMP.3PL-hit)' (Uchihara & Tiburcio 2020). 'M_D' indicates a default mid tone inserted on otherwise toneless TBUs, circled superscript '^{L}' marks an underlying floating L tone.

However, as with tonal overwriting in spreading, this asymmetry could instead be attributed to a faithfulness scale like {IDENT[H], IDENT[L]} ≫ IDENT[M], without assuming tonal underspecification.[11]

Tones on epenthetic vowels and reduplicated vowels

Sometimes tones that appear on epenthetic vowels are argued to be underspecified. For instance in Navajo, an epenthetic vowel receives a low tone by default, as in /t-nìʃ/ → [tìnìʃ] 'open-N.IMP.1ST' (McDonough 2003:45-7). One could argue that the low tone in Navajo is underspecified, based on such data.[12] However, such a situation can alternatively be analyzed with markedness scale, *[H] ≫ *[L] (Pulleyblank 2004). Furthermore, in Ayutla Tlapanec there is evidence that even epenthetic vowels are tonally specified. In Ayutla Tlapanec the progressive aspect prefix is zero when the stem is disyllabic ([Ø-bìjàʔ] 'I am crying (PROG:1SG-cry)'), while a prothetic initial vowel [e] is inserted when the stem is monosyllabic, to satisfy a prosodic minimality requirement (Cornelio 2022:171). As can be seen in (7), the 1SG forms in (a,b) have a low tone on this epenthetic vowel (which spreads to the stem vowel), while the 3SG forms in (c,d) have a mid tone. The tone on this epenthetic vowel cannot be due to spreading from the stem tone, since the underlying lexical tones of the stems are not low, as can be observed from the 3SG forms (c,d), which involve a tonally-

[11] Uchihara & Tiburcio (2020) argue that surface M tones may reflect either underlying /M/ or /Ø/, based on the fact that not all surface /M/ tones show the same phonological behavior. A faithfulness scale like {IDENT[H], IDENT[L]} ≫ IDENT[M] would not, on its own, be able to reproduce this contrast.

[12] McDonough (1999, 2003) analyzes low L as a 'default' tone, but argues that L tone is not *phonetically* unspecified.

specified mid-tone prefix [ē-], rather than an epenthetic vowel. Thus, because the L tone on the epenthetic [e] in 1SG forms spreads, it is phonologically active, and must be specified.

(7) Spreading of specified L tone on epenthetic vowels in Ayutla Tlapanec

	1SG	3SG
'say'	a. è-tàn	c. ē-ʔ-tán
'do'	b. è-nì	d. ē-ʔ-nī

Similar observations hold for tones on reduplicated vowels. For instance in Yala Ikom (Armstrong 1968, Pulleyblank 1986:106-8) verbal nouns are formed by reduplicating the verb stem and prefixing [ò-/ɔ̀-]. The reduplicated portion of this construction always has mid tone (8), argued to be an underspecified tone.

(8) Default M tone on reduplicants in Yala Ikom

a. ò-nyī-nyì 'burying'	b. à-nyì 'you buried'
c. ò-bī-bī 'carrying'	d. à-bī 'you carried'
e. ɔ̀-hārā-hàrà 'accompanying'	f. à-hàrà 'you accompanied'

As argued in Alderete *et al.* (1999), fixed segmental or tonal patterns on reduplicated material can reflect markedness hierarchies like {*[H], *[L]} ≫ *[M], rather than underspecification as such. The assumption here is that reduplicated material is not included in the input, and so markedness alone can determine some of the phonological content of the reduplicant.

Stability of tones

Another situation where it can be challenging to distinguish underspecification from markedness or faithfulness scales concerns the stability of tones resulting from the elision of a TBU (Pulleyblank 2004). For instance in Yoruba, when hiatus is resolved by vowel deletion, the mid tone in a high-mid sequence is deleted, as in /rí īg͡bá/ → [rí g͡bá], *[rī g͡bá] 'see squash' (Akinlabi & Liberman 2000, Pulleyblank 2004). Similarly in Alcozauca Mixtec, the tone 3 in a sequence of tones 3 and 4 is deleted when a hiatus is resolved, as in /sa^{4}ta^{3}=e^{4}/ → [sas^{4}te^{4}] 'she buys' (Uchihara & Mendoza Ruiz 2022). This could be because the mid tone

and 3 tone are underspecified (and therefore impossible to retain following deletion), or because of a faithfulness hierarchy like Max[H] ≫ Max[M] or Max[4] ≫ Max[3] (where Max[T] constraints penalize deletion of particular tones).

Tonal neutralization

Lastly, the problem of distinguishing underspecification from markedness or faithfulness scales also arises with respect to tone in neutralization contexts. For instance, Teotitlán Zapotec contrasts 5 tones on stressed syllables (low L, mid M, high H, rising MH, falling HL) but only two tones, L (reflecting neutralization of L and M) and H (reflecting neutralization of H, MH and HL), can occur on pre-tonic syllables (see also Pride 1984, DiCanio 2008, Hernández Mendoza 2017 for similar cases in other Otomanguean languages). Such a situation can be accounted for by treating tone on pretonic syllables as underspecified, and determined from context. Alternatively, a markedness hierarchy like {*[M], *[MH], *[HL]} ≫ {*[L], *[H]} could be responsible for limiting the possible tones in pretonic position, with tones in stressed syllables being protected by a high-ranked faithfulness constraint like IDENT-TONE-ˈσ (e.g. Beckman 1998).

AN UNRELIABLE DIAGNOSTIC FOR TONAL UNDERSPECIFICATION: BROAD PHONETIC VARIABILITY

Level tones are not always phonetically level: indeed, it is quite common for level tones to gradually rise or fall over the course of a TBU, or sequence of TBUs. For example, Campbell (2016) observes that 'level' L tone tends to decline across the length of the mora in Zenzontepec Chatino. The H and M tones in Zenzontepec Chatino gradually rise across the mora, though perhaps not as sharply as the L tone falls.

Campbell (2016) argues that this pattern of pitch lowering for L is consistent with the phonological evidence for treating L tone as essentially unspecified in Zenzontepec Chatino. The logic here is that unspecified TBUs lack a pitch target, and so should show greater phonetic variability, and greater contextual influence on f0, than specified tones and TBUs.

We strongly support the use of phonetic evidence as a diagnostic for underspecification. However, phonetic evidence of this type must be carefully interpreted. In our view, phonetic variability in and of itself is not sufficient to diagnose tonal

underspecification. The problem is that there are *many* phonetic factors which go into determining f0 on TBUs, most of which are independent from questions of phonological specification. We can illustrate this point with several counterexamples to the claim that phonological underspecification is correlated with phonetic variability, at least in a broad sense.

In Yoruba, sentences consisting of only L tone show a gradual decline in f0 over the course of the sentence (at least for some speakers; Connell & Ladd 1990). In contrast, sentences consisting of only H tones or only M tones display relatively level f0. This is at least roughly parallel to what Campbell (2016) reports for Zenzontepec Chatino. However, in Yoruba, the best candidate for an unspecified tone is the M tone, not the L tone (e.g. Pulleyblank 2004). Therefore phonetic variability, in a broad sense, does not correlate with tonal underspecification in this language.

In Kaifeng Mandarin (Wang *et al.* 2020), the phonetic realization of low tone is quite variable across speakers: some speakers realize L as phonetically dipping, others as phonetically falling, and still others as phonetically falling with additional lengthening. The phonetic realization of H, LH, and HL tones is relatively consistent across speakers, at least when compared to the L tone. However, the L tone must be phonologically specified, because it participates in dissimilatory tonal rules, e.g. /H H/ → [HL H], /L L/ → [LH L]. Again, phonetic variability does not correlate with tonal underspecification in this language.

Lastly, in Yucatec Maya, the phonetic realization of H tone on long vowels varies with context: it is high-rising in phrase-initial position, and high-falling in phrase-final position (e.g. Fisher 1976, Kügler & Skopeteas 2006, Gussenhoven & Teeuw 2008, Sobrino Gómez 2010, and references there). However, there is no phonological evidence whatsoever to treat H tone as an underspecified tone in Yucatec Maya. Furthermore, Gussenhoven & Teeuw (2008) argue that both L and H tones are downstepped after H tones, which implies that H tones are phonologically represented (see also Pike 1946). Similarly, they propose a phrase-level rule inserting L tone on a toneless TBU between two H tones; if correct, this would appear to be a dissimilatory rule which again implies that the H tone must be specified, despite its phonetic variability.

In short, phonetic variability in and of itself is not sufficient to diagnose tonal underspecification. Instead, it must be shown that toneless TBUs interact phonetically with

their *environments* in a way that is (i) predictable, (ii) context-dependent, and (iii) distinct from the behavior of specified TBUs in the same environments. This can be accomplished by showing that toneless TBUs receive their phonetic values for f0 via phonetic interpolation from neighboring lexical or intonational tones (e.g. Pierrehumbert & Beckman 1988, Myers 1998). Alternatively, toneless TBUs might be better hosts for intonational tones than specified TBUs (e.g. Gussenhoven 2004, Ch. 11.4, Kawahara 2015: 449; though see above on alternative explanations for tonal overwriting). In Mesoamerica, such an analysis has been proposed for Otomían languages (E. Pike 1951, Bernard 1974), and above Mesoamerica, for Northern Tepehuan (Gil Burgoin 2021). Lastly, unspecified TBUs might behave differently when general phonetic parameters associated with pitch, such as overall pitch range, are adjusted as the result of information-structural effects like topic or focus (e.g. Bennett *et al*. 2022).

DIAGNOSTICS WHICH ARE NOT VALID FOR IDENTIFYING TONAL UNDERSPECIFICATION

In this section, we will look at some diagnostics which have been employed to establish tonal markedness, and show that they are invalid for identifying tonal underspecification.

Tone category

It has been argued that phonetically central tones (like mid M) are unmarked, while peripheral tones (like H, L) are relatively more marked (Maddieson 1978). If 'unmarked' tones are also taken to be underspecified tones – a position which we do *not* agree with – then one might expect that only non-peripheral tones should pattern as underspecified.

However, the pitch level associated with a particular tone does not determine whether or not that tone behaves as an underspecified tone. Thus, in a system with phonetic [H, M, L] tones, not only the intermediate M tone, but also *any* tone can be underspecified. For instance, the mid tone M appears to be underspecified in Yucatec Maya, a language with a four-way [HL, H, M, L] surface phonetic contrast (see Bennett 2016:498 for references). Zenzontepec Chatino has three tone levels, but here the lowest level L is arguably underspecified on phonological grounds (Campbell 2016). Similarly, Chiquihuitlán Mazatec has four tone levels, and the lowest is underspecified (Nakamoto 2022), and Lalana Chinantec has five tone levels, with the lowest again underspecified (Nakamoto 2022).

Finally, in the Bantu language Engenni, H is underspecified (Hyman 2001), while in other Bantu languages L is unspecified (Myers 1998), even though the surface phonetic inventory may be [H, L] in both cases. Similar patterns of variation occur in Athabaskan languages (Leer 2001), where surface two-tone systems differ in which tone patterns as default or underspecified.

Frequency

The frequency of occurrence of certain tones, whether token or type, is sometimes considered an index of their phonological status (Maddieson 1978). The assumption appears to be that tones which are more frequent in a given language are 'unmarked', and so should pattern as underspecified. However, neither type nor token frequency is a valid diagnostic for tonal underspecification. First, there is no logical connection between any type of frequency and the specification of tone on a particular TBU. Perhaps more importantly, there are counterexamples to the claim that more frequent tones pattern as underspecified. For instance, in Ganda, high tones are more frequent than low tones, but it is the low tone that is underspecified according to its phonological behavior (Hyman 2001). Another such example is Kaifeng Mandarin, where high tone is more frequent than low tone, but both high and low tones must be specified, as they participate in dissimilation rules (e.g. /H H/ → [HL H], Wang *et al.* 2020).

Nor is the frequency with which a certain tonal melody occurs in inflectional or derivational paradigms an index of underspecification. For instance, in San Pedro Amuzgos Amuzgo (Kim 2016, Palancar 2021), the tone 53 (high-mid) is assigned by default to verbs in the 1st or 2nd person singular (60% of all the verbs for 1SG and 61% for 2SG). But since the tone 53 can occur on short vowels (e.g. [n̥ɛ^{53}] 'sell.CPL.1SG'), neither tone 5, tone 3, nor tone 53 can be considered underspecified, given that underspecified tones cannot form part of a contour. This constitutes a counterexample to the claim that tones which are more common in particular morphological paradigms correspond to underspecified tones. Similar logic would apply to e.g. a language in which particular tones are the most common tones found in verbs or nouns: here too, there is no logical connection between that notion of frequency and the formal, analytical concept of underspecification.

Loanword adaptation

The frequency with which particular tones occur in loanwords is not a valid diagnostic for underspecification. Nor is the observation that certain tones are assigned 'by default' in loanwords. Again, there is no logical connection between tone in loanword adaptation and tonal underspecification, and further, there are clear counterexamples. In Tokyo Japanese, loanwords from English tend to be assigned a specified H*L tone, as in *Ánderson* → [an.dáà.son] (Kubozono 2008).[13] In Uspanteko (Mayan), loans from Spanish tend to be assigned a specified high tone, as in *cruz* → [kú.ris] (Can Pixabaj 2007, Bennett *et al.* 2022). In many Otomanguean languages, certain uncommon, highly marked tones are assigned to loanwords. For instance in Teotitlan Zapotec high, falling or rising tones are rare lexically on native words, and must be specified tones because e.g. they form contours on monomoraic syllables, trigger tonal processes, and resist being replaced when tonal processes apply. But loans are generally assigned one of these specified tones, e.g. [duˈrăːznn] 'peach (< Spanish *durazno*)'; [ˈllíːbr] 'book (< Spanish *libro*)'; [ˈtrâːlj] 'loom (< Spanish *telar*)'. In Ayutla Tlapanec, an H.H pattern on disyllables is very limited in the native lexicon, and the H tone is clearly specified since e.g. all tonal contours involve a high tone (MH, LH, HM, HL; Cornelio 2022), H tone can float, etc. However, specified H.H is the default pattern for loans: [kwété] 'fireworks' (< Spanish *cuete*); [láʃá] 'orange' (< Spanish *naranja*), etc.[14]

ADDRESSING CONFLICT BETWEEN DIAGNOSTICS

In some cases, diagnostics for tonal underspecification may provide conflicting evidence. We illustrate with an example from Leggbo (Hyman *et al.* 2002, Paster 2003). In Leggbo, low tone is overwritten by tonal spreading in certain morpho-syntactic contexts, e.g. [l**ì**-tɔ́ɔ́l] 'ear' vs. [āw**ā** l**ī**-tɔ́ɔ́l] 'of an ear'. High tone resists overwriting, e.g. [l**í**-d͡zīl] 'food' vs. [āw**ā** l**í**-d͡zīl] 'of food'. This might imply that low tone corresponds to a tonally-underspecified TBU. However, low tone can also function as a grammatical tone, analyzable as a floating tone,

[13] Kubozono (2023: 43) argues that the default pitch-accent pattern in Tokyo Japanese assigns H*L pitch-accent to the rightmost, non-final foot of the prosodic word, and that the default accentuation pattern discussed here would represent the emergence of the unmarked.

[14] Many tonal patterns in loanwords in Mesoamerican languages can be accounted for by the reinterpretation of stress accent in the donor language (often Spanish) as an H tone or H-containing contour, particularly since stressed syllables in Spanish are frequently realized with an H* or LH* pitch accent (e.g. Ortega-Llebaria & Prieto 2011).

e.g. [bā m**a̲**nā] ‘they trapped’ vs. [bā m**à**ná] ‘they have trapped’. This might imply that low tone must be a specified tone in Leggbo. Here, our diagnostics for tonal specification appear to be in conflict (see also Pulleyblank this volume on phonological differences between underlying vs. floating and/or morphologically-introduced tones).

A similar situation is found in Huehuetepec Tlapanec, where low tone is more susceptible to overwriting: both mid and high tones can spread to a mora with a low tone, while mid tone and high tone cannot be overwritten by tone spreading. This is illustrated in the following set of examples. In (9a), the second syllable has an underlying low tone, which surfaces in suffixed forms as in (9b). This underlying low tone is overwritten in bare forms by a high tone that spreads from the first syllable (9a). When the second syllable has a lexical mid tone, then high tone cannot spread to this syllable, as in (9c).

(9) H tone spreading overwrites L tone in Huehuetepec Tlapanec

a. /húbà/ → [húbá] ‘hill’

b. /húb(à)-uū/ (hill-3SG.B) → [hóbòō] ‘his hill’

c. /tʃágā/ → [tʃágā] (*tʃágá) ‘dewlap’

Similarly, mid tone can spread progressively to a following syllable with an underlying lexical low tone (10a), justified by the suffixed form (10b). Again, mid tone cannot spread to a syllable with a high tone, as observed in (10c).

(10) M tone spreading overwrites L tone in Huehuetepec Tlapanec

a. /ītsù/ → [ītsū] ‘bone’

b. /īts(ù)-uū/ (bone-3SG.B) → [ītsūù] ‘his bone’

c. /nī-yáʃī/ (CMP:3SG-pick.up) → [nīyáʃī] (*nīyāʃī) ‘he picked it up.’

However, low tone can still spread and float, suggesting that low tone is in fact specified in Huehuetepec Tlapanec. In (11), low tone on the potential prefix /mà-/ spreads to the 2SG agentive prefix /tara-/ which is tonally unspecified. In (12), the 3PL agentive prefix /ni, L-/ is associated with a floating low tone, which docks to the first syllable of the stem. The (b) forms justify the underlying tones of the affected syllables.

(11) L tone spread in Huehuetepec Tlapanec

a. /mà-tara-tsī/ (POT-2SG-buy) → [màtàràtsī] ‘you will buy’

b. /nī-tara-tsī/ (CMP-2SG-buy) → [nītārātsī] ‘you bought’

(12) Floating L tone in Huehuetepec Tlapanec
a. /ni^{L}-jahũ̄/ (CMP:3PL-work) → [nīŋàhũ̄] ‘they worked’
b. /nī-jahũ̄/ (CMP:3SG-work) → [nīŋāhũ̄] ‘he worked’

In such a situation, several responses are possible. The first response is to reject the validity of at least one of the conflicting diagnostics. For example, we have suggested above that both tonal overwriting and grammatical tones are less reliable diagnostics for tonal (under)specification, largely because they can be analyzed without assuming underspecification or floating tones. If correct, then the apparent conflict observed for Leggbo or Huehuetepec Tlapanec may just be the result of using diagnostics for underspecification which are not particularly reliable in the first place.

Secondly, it could be that different levels of representation are involved for each of the diagnostics in question. For example, a particular tone T_x might correspond to an unspecified TBU at one level of the derivation (e.g. the word level phonology), but correspond to a specified tone at a different level of the derivation (e.g. the phrase level phonology; e.g. Zec & Zsiga 2010, McPherson 2011). In such a case, there would be no conflict between diagnostics, because each diagnostic refers to a different component of the phonological grammar.

Third, an apparent conflict between diagnostics might reflect a pattern of neutralization which masks underlying tonal differences. For example, imagine a language in which TBUs may be underlyingly /H/, /L/, or toneless /∅/. Now, imagine that toneless TBUs are realized with a default L tone on the surface, /∅/ → [L]. The result of this default tone rule is that there are two types of surface [L] tones, one corresponding to underlying /L/, and other corresponding to underlyingly toneless TBUs. Surface [L] tones corresponding to underlying /L/ tones might show the behavior of specified tones, while surface [L] tones inserted by default on toneless TBUs would show the behavior of *unspecified* tones. This scenario would lead to a conflict of diagnostics, somewhat like the Leggbo case outlined above. (Conceptually, it is also related to the possibility that different diagnostics might refer to different levels of representation.)

Analyses of this type have been proposed for tonal languages. For example, McKendry (2018) proposes that SE Nochixtlán Mixtec has underlying /H, M, L/ tones, as well as underlyingly toneless TBUs. Those underlying toneless TBUs receive a default M tone, thus neutralizing an underlying /M ∅/ to surface [M]. Underlying [M] shows the behavior of a specified tone – for example, it can form part of a contour tone on short vowels, as in [ī ðō̰] 'rabbit', which McKendry analyzes as underlyingly /∅ ML/ (see also Uchihara & Tiburcio 2020 on Huehuetepec Tlapanec, and Cornelius 2018 on Oklahoma Cherokee). McKendry also argues that underlying /∅ M/ → [M] show different phonological and morphological behavior: for example, underlying /H L M/ sequences surface as [H M M], while underlying /H L ∅/ surfaces, opaquely, as [H L M].

Lastly, in cases of disagreement between diagnostics, it may be that we are learning something deeper about what underspecification actually *means*. More specifically, it may be that underspecification is a graded, continuous notion, rather than a binary and categorical one. We have in mind here research in the framework of Gradient Symbolic Representations (e.g. Smolensky & Goldrick 2016, Zimmerman 2018, among others). In the GSR framework, phonological objects may have different levels of 'activity' encoded as part of their representations. The notion of 'activity' here is continuous and numerical, with values ranging between 0 and 1. Activity is, intuitively, something like 'strength'. Objects specified with lower activity are easier to change, because changing them violates faithfulness constraints to a lesser degree. Low-activity objects also provoke fewer phonological processes, because they violate markedness constraints more weakly than highly active objects.[15]

We can illustrate this general proposal using the Leggbo data described above. To capture the fact that low tone can serve as a (floating) grammatical tone, we assume that low tone is in fact specified in Leggbo and Huehuetepec Tlapanec. However, it is only *weakly* specified: it has an activity value of 0.5 (for example), while other tones have activity values of 1. This difference in activity explains why low tones are susceptible to overwriting, but

[15] Gradient activity thus has similar effects to markedness and faithfulness scales, which we discuss in an earlier section. However, there are differences: for example, a ranking of markedness constraints *L ≫ {*H, *M} would predict that low tones should be easiest to change, being most marked. But using GSRs, the same effect can be achieved by giving low tones a low activity value, so they violate faithfulness constraints to a relatively low degree. But in the GSR framework, that would also imply that low tones are *least* marked, being least active, rather than most marked.

high tones are not: high tones are more strongly specified than low tones are, and thus more resistant to change. This analysis depends on the assumption that tonal specification is not all-or-nothing: it is a *graded* notion, such that tones may be specified to greater or lesser degrees (see also Inkelas 2015).

Gradiently active representations have also been used to analyze exceptional tonal behavior. For example, Zimmermann (2018) uses gradient activity to analyze tonal patterning in San Miguel el Grande Mixtec (drawing on McKendry 2013). In this variety of Mixtec, the emphatic marker /βáá^{n}/ is analyzed as having an unassociated floating /H/ tone, /βáá^{n}, H/ (the superscript /^{n}/ marks nasality in McKendry's notation, p.17). This floating /H/ tone is posited to account for the fact that certain enclitics are realized with high tone after /βáá^{n}/, as in (13a) (McKendry 2013: 92).

(13) Morpheme-specific tonal exceptionality in San Miguel el Grande Mixtec

a. /βáá^{n}, H - t**i̱**, H/ → [βáán-t**í̱**] '3AN.EMPH'

b. /βáá^{n}, H - ð**ē**/ → [βáán-ð**ē**] '3MASC.HON.EMPH'

However, as (13b) shows, the enclitic /ðē/ retains its mid tone on the surface, rather than hosting the floating tone associated with /βáá^{n}/. Zimmermann analyzes this, and other aspects of San Miguel el Grande tonology, using GSRs. Simplifying her proposal for the purposes of illustration, we can assume that the enclitic /ti̱, H/ comes with a low tone that is specified only weakly, e.g. $L_{Activity} = 0.5$. In contrast, the enclitic /ðē/ has a mid tone which is more strongly specified, e.g. $M_{Activity} = 1$. This accounts for the different tonal behaviors of these two enclitics: the weakly active L tone on /ti̱, H/ should be easier to change than the more strongly active M tone on /ðē/.

Gradient Symbolic Representations can thus be used to express the intuition that tones may be more-or-less specified, in a continuous way. As we have seen, gradient tonal specifications may help reconcile conflicting diagnostics for tonal (under)specification, and also offer a useful perspective on morpheme-specific tonal behavior. (For similar ideas, see also work in 'Canonical Typology', e.g. Brown *et al.* 2013.)

CONCLUSION

In our view, the evidence for tonal underspecification is sufficiently strong that underspecification can and should continue to be used as a tool in the phonological analysis of tone systems. Cases like Peñoles Mixtec, in which a pair of L tones dissimilate across a potentially unbounded series of M tones, provide compelling support for underspecification in phonology. The phonetic evidence for surface-level tonal underspecification is also an important confirmation that tone-bearing units need not come with a tonal target of their own. On the view that phonological representations are *interpreted* by the phonetics (e.g. Pierrehumbert 1990 and many others), it seems reasonable to infer that surface phonetic underspecification ultimately reflects underspecification in the phonology as well (e.g. Myers 1998). That is, phonetic underspecification is likely *inherited* from underspecified phonological representations.

Evidence for underspecification is strongest when several distinct (and ideally, robust) diagnostics converge on the conclusion that a particular tone or TBU lacks a tonal specification of its own. We thus encourage researchers to search for convergent evidence in any analysis in which tonal underspecification is assumed.

At the same time, we have argued that underspecification is ultimately a theoretical concept, and not merely a descriptive tool. Tonal underspecification can be difficult to establish with certainty, in part because not all diagnostics for underspecification are equally effective or valid. This is due, in part, to the fact that many diagnostics are inextricably tied up with particular theoretical assumptions, beyond the basic representational commitments of Autosegmental Phonology. Those underlying theoretical assumptions may or may not be valid themselves, and at a minimum, should be carefully scrutinized. Overall, we are positive about the use of tonal underspecification in phonetic and phonological theory, but hope to have made the case that linguists should be meticulous in evaluating the evidence for tonal underspecification in any particular case.

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