Underspecified Tone in Tommo So (Dogon, Mali)

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1. Introduction

Most available descriptions of African tone systems indicate the presence of two to four tone levels, with or without contour tones. The Bantu literature may report the existence of a privative tone system, with either H or L standing in opposition to the absence of tone (Ø), though the null tone is generally assumed to be filled in by default later (e.g. L-insertion in Chichewa, Mtenje 1987, Kanerva 1989). The result is that the surface representation is fully specified for tone. Nonetheless, recent literature has shown that this is not the full story, and that certain languages in Africa and elsewhere may retain their tonal underspecification all the way to the surface. Most relevant to the current study is Myers's (1998) paper, also on Chichewa, where he demonstrates that the H vs. Ø distinction is more than a theoretical tool used to describe the phonological behavior of H tones; Chichewa "L" is not inserted late by default, but is in fact never inserted. Instead, the F0 is filled in between H peaks by sagging interpolation, with the depth of the pitch troughs depending on the number of syllables between specified H tones. Interpolation, both sagging and linear, has been seen in both segmental and prosodic underspecification in works like Pierrehumbert (1980) on English intonation, Shih (1987) on Mandarin tone, Keating (1988) on English place of articulation, Cohn (1993) on English nasals, and Choi (1995) on Marshallese vowels, among others.

Here, I present another case of a supposedly two-level African tone system revealing surface underspecification. The language is Tommo So, a Dogon language spoken by around 60,000 people in east central Mali (Hochstetler et al. 2004). My preliminary work on the language assumed the presence of H and L, but careful phonetic analysis reveals instead a ternary contrast of H vs. L vs. Ø. That is, unlike Chichewa, L tone is contrastive with no tone. The system also differs from Chichewa in that underspecification of tone is constrained to grammatical elements like enclitics, certain suffixes, and epenthetic vowels, though it may be derived on stems by contour tone reassignment. The surface F0 is filled in by linear interpolation between surrounding specified tones, be they lexical or intonational boundary tones.

This paper gives a brief overview of tonal underspecification in Tommo So and demonstrates the need for instrumental study when doing fieldwork, which can reveal aspects of the tone system that may be difficult to discern using one's non-native ears alone. For a more detailed presentation of the data, as well as an analysis in Stratal OT (Kiparsky 2000), see McPherson (2011). The outline of the paper is as follows: Section 2 introduces the reader to the lexical tone system of Tommo So and provides background on phonetic processes that affect the pitch. Section 3 demonstrates the existence of underspecified tone and describes its distribution. Section 4 situates the Tommo So system of underspecification in our typological understanding of function words, while Section 5 draws conclusions.

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2. Tonology of Tommo So

2.1. Tonal phonology and phonotactics

All native stems in Tommo So take one of two overarching tone melodies: {H} or {LH}. There is no automatic tone mapping of {LH}, indicated by the fact that disyllabic words may be either LH or L<LH> (1a) and trisyllabic words may surface as either LLH or LHH (1b):

(1)	a.	ɲòŋóm 'camel'	sàŋǎm 'sourness'
	b.	kɛ̀bɛ̀lɛ́ 'shard'	kògódó 'shell'

The introduction of loanwords, mainly from Fulfulde and French, have introduced some {HL} and {LHL} words. {HLH} sequences are never tolerated on a single word. In sum, all words must have at least one H-toned mora (the Tommo So TBU), and all H tones must be continguous;[1] there are no all {L} stems, though words may surface as {L} in certain morphological contexts (Heath and McPherson, ms.).

Crucially to the current study, this preponderance of H-final stems makes it difficult to find naturally occurring contexts where Tommo So underspecified elements are preceded by L tone. This, combined with the high likelihood of an enclitic being followed by a phonological phrase boundary (marked by a L^- boundary tone), has yielded a total absence of L__H contexts for underspecified tones in my current data. This gap will be filled by controlled recordings in an upcoming trip to the field.

2.2. Tonal phonetics

The surface realization of tone in Tommo So is subject to typologically normal phonetic processes (Gussenhoven 2004), such as consonant and vowel effects, declination, and near-total downdrift, whereby the second H in a HLH sequence is pronounced at nearly the same pitch as the preceding L. Of interest is the fact that declination and downdrift are operative in different phrasal domains. Declination is reset by an intonational phrase boundary, while downdrift is reset by a phonological phrase boundary. For pitch tracks demonstrating these two processes, see McPherson (2011: 54-56).

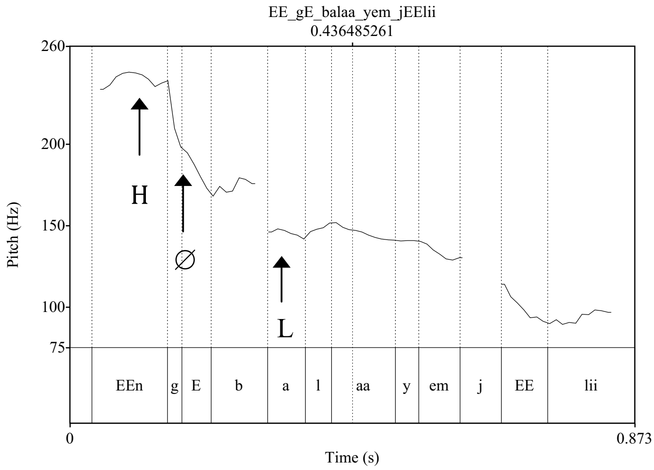
3. Tonal underspecification

In addition to H and L syllables, which maintain a more or less uniform realization in all phonological contexts, a third class of syllables exists whose realization depends entirely on the surrounding tones. These are the underspecified, or Ø, tones, and at an underlying level they only exist on enclitics, human suffixes, and epenthetic vowels. In the interest of space, I will focus on enclitics, only bringing in data from the other classes where it is significantly different.

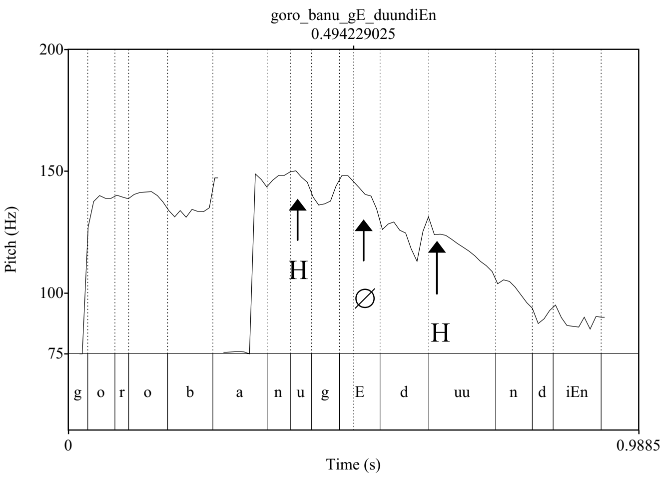
3.1. Ternary contrast: H, L, Ø

Tommo So nominal morphology is largely isolating, and enclitics are used to mark everything from definiteness to plurality. In addition, all postpositions in the language are enclitics. The following list summarizes the main enclitics, all of which are very common in texts:

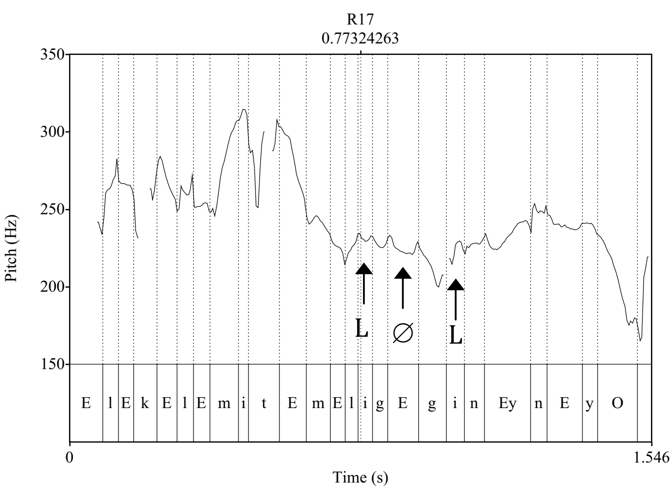
[1] This behavior could be derived by a constraint against more than one H tone per word, which would then assume that any sequence of H tones is the result of spreading of a single autosegment. It could be equally captured by a constraint *HLH (McPherson 2011), such that the analysis does not hinge on the underlying number of autosegments.



a. SO: [ɛ́ɛ́^{n} = gɛ bàláá][yém jɛ́ɛ̀lìì] ‘she swept up the ashes and brought them like that’



b. EO: gòrò bánú = gɛ dúùndìɛ̀^{n} ‘they put down the red hat’



c. RO: [ɛ̀lɛ̀kɛ̀lɛ̀][mí témɛ̀-lì = gɛ][gìnɛ̀-ý = nɛ yɔ̂] ‘the peanuts I didn’t eat are in the house’

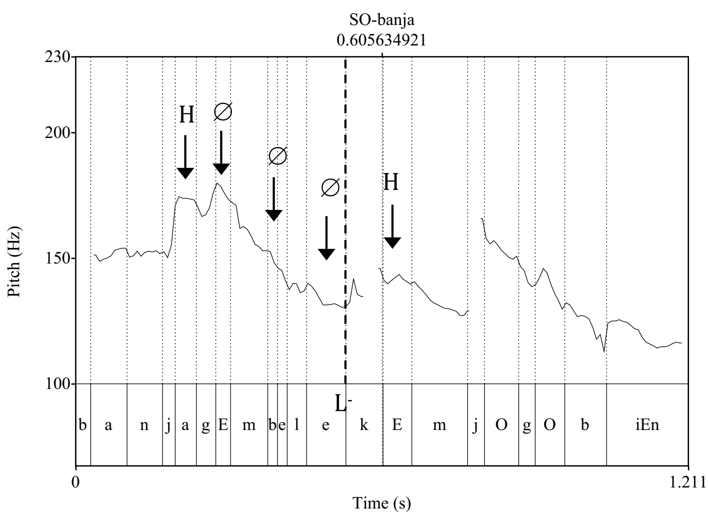
Figure 1: Definite *gɛ* in the contexts a) H__L, b) H__H, and c) L__L

(2) gɛ definite
le associative
mbe plural
mɔ possessive
nɛ locative

The tonal realization of the enclitics depends on the phonological context. Unlike phonological tone spreading, the clitic does not simply take on the tone of the preceding word. Instead, pitch tracks reveal that the F0 interpolates between the specified tones on either side. Figure 1 illustrates the definite enclitic *gɛ* in three different tonal contexts: a) between H and L, b) between H and H, and c) between L and L. As I mentioned in section 2, no L__H contexts could be found.

In the pitch track in (a), the F0 falls steadily from the specified H of *εε*^{n} 'ash' to the L tone of *bàláá* 'swept'; that is, it interpolates between the two points. Notice also the downdrift on the H of 'swept'. In (b), the F0 on the definite is similarly an interpolation between the two Hs on either side. There is still downward pitch movement on the enclitic since the second H tone is lower than the first due both to final lowering and to the fact that it is the beginning point of a falling tone, but the interpolation on the underspecified syllable is generally linear from one H to the next. Finally, in (c), the F0 on the definite remains a level L between the two surrounding L tones. Thus we have the same enclitic carrying three different "tones" depending on the phonological context. Truly specified tones do not behave this way.

To further the point, consider the pitch track in Figure 2, with three underspecified enclitics in a row before a phonological phrase boundary, marked by a L$^-$ boundary tone indicated in the pitch track at the bottom of the dashed line. Interpolation cannot pass over a phrase boundary, and so the underspecified elements interpolate to the boundary tone instead. This interpolation is linear across all three syllables.



MM: [bànjá = gɛ = mbe = le][kɛ́m][jɔ́gɔ̀ bì-ɛ̀^{n}] 'and they used to break all of the bowls'

Figure 2: Linear interpolation across more than one underspecified enclitic.

For more pitch tracks demonstrating that H and L are not likewise affected by surrounding tones, see McPherson (2011).

To capture numerically what the pitch tracks show visually, I calculated the number of semitones between any two given tones in a certain context to compare the behavior of H, L and Ø. I took the average F0 over the vowels of two tones being compared, then calculated the number of semitones between them using the formula (log(T1)-log(T2))/log($2^{1/12}$). For example, if we want to determine if Ø is distinct from H and L between two Hs, then we must average the F0 of H (T1) and the following tone (T2) followed by another H (T3, not required in the calculation but necessary to control for in comparisons) and plug these averages into the formula given above. This yielded the following results:

(3) *Distance between the two tones HH, HØ, and HL followed by H*

	Mean Δ Semitones	# of tokens
HH(H)	0.43	12
HØ(H)	0.65	21
HL(H)	3.73	25

All HH sequences in this data set were within the same word and all HØ sequences consisted of a H-final word followed by an enclitic. Given the paucity of L-final words, the HL category included both HL sequences within a word as well as H-final words followed by a L-initial word within the same phrase.

Running an unpaired T-test on these numbers reveals that in the H__H context, the difference between HH and HØ is not significant ($p = .27$). This is to be expected, since in a context where Ø is surrounded by identical tones, the interpolation will be level, yielding an F0 contour that is indistinguishable from the fully specified tone. The difference between Ø and L in this context, however, is highly significant ($p < .001$). This confirms that L and Ø derive from two distinct underlying representations.

H and Ø must also be distinct, as shown when we look at the context H__L:

(4) *Distance between the two tones HH, HØ, and HL followed by L*

	Mean Δ Semitones	# of tokens
HH(L)	0.71	12
HØ(L)	1.80	11
HL(L)	3.19	4

The difference here between HH and HØ is significant ($p < .01$), as is the difference between HØ and HL ($p < .01$), though the dataset for HL is preliminary. The results make sense in this context if we consider that the average of linear interpolation from H to L will be an F0 roughly halfway between the two tones, distinct from both H and L. In short, the context H__L brings out the ternary distinction in Tommo So tone between H, L and Ø.

We have already seen that Ø between two Hs is indistinguishable from H, due to the flat interpolation between identical surrounding tones. The same is true for Ø between two Ls; in this context, Ø and L merge. The majority of cases found of this context use the L^- boundary tone of the phonological phrase as the second tone rather than a lexical L, summarized in the following table:

(5) *Distance between the two tones LL and LØ followed by* L^-

	Mean Δ Semitones	# of tokens
LL(L^-)	0.52	8
LØ(L^-)	0.51	24

These averages are practically identical ($p = .96$), and so statistically there is no difference between L tone and underspecified tone when flanked by two Ls.

Epenthetic vowels and the human singular and plural suffixes are similarly underspecified, and their surface realization abides by the same rules.

3.2. Tone shift

Further evidence that enclitics are underspecified for tone comes from the process of tone shift, where in certain circumstances a tone from the preceding word is shifted onto the enclitic. This happens when a word with an underlying contour tone on a light syllable (surface illicit) is followed by a toneless element. To resolve the tone crowding, the second tone is simply pushed over onto a new host. This is schematized in (6) for the phrase *nàà nɔ̀=mbé yàà bé-m* 'I saw those cows', wherein the underlying form of the demonstrative is *nɔ̌* with a contour tone on a light syllable:

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(6)  a. /naa  nɔ=mbe yaa be-m/
         | |   Λ         | |   |
         LL LH          LL  H

     b. [naa nɔ=mbe yaa be-m]
         | |   |       |  | |   |
         LL  L      H  LL  H
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The underlying contour on the demonstrative in (6a) is resolved by shifting the H onto the plural clitic *mbe* in (6b). If this clitic were already specified for tone, tone shift could not occur, since doing so would simply create another light contour tone. Furthermore, we see no cases of tone shift involving anything but toneless elements: enclitics, human suffixes, and epenthetic vowels. Full tone specification blocks the process.

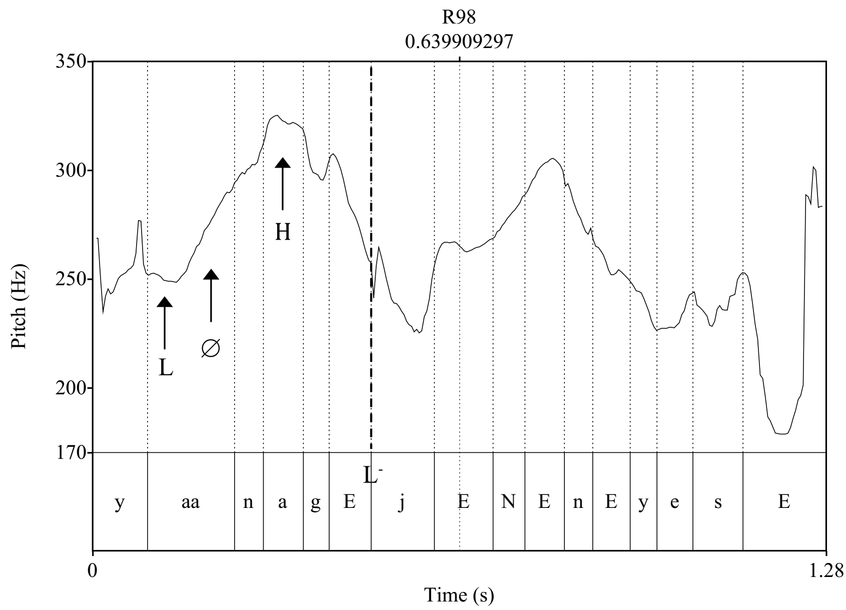
If a light contour tone is unable to resolve the crowding by tone shift, it has a couple of options available: it can either delete the L, simplifying to all H (recall that native words cannot end in L-tone unless they are subject to a grammatical overlay), or it can lengthen the vowel. Sometimes an intermediate fix takes place, where the vowel lengthens to a length between a short and long vowel and the tone is somewhere between a true rise and a H tone, a compromise situation reminiscent of the work of Flemming (2001).

It is in the details of tone shift that enclitics and the other underspecified elements, particularly human suffixes, diverge. While enclitics are the landing site of tone shift only after a contour tone on a light syllable, a human suffix or epenthetic vowel will also cause tone shift when added after a contour tone on a heavy syllable. For example:

(7) /yàá-na/ → [yàaná] 'woman'

The interesting thing about this tone shift is that it actually derives underspecification on a stem. Recall that, lexically, all stems must be fully specified, so this makes a single-level analysis difficult. For all stems to be fully specified, we must assume that Rich Base candidates with underspecification are repaired, but derived underspecification is not repaired. I resolve this problem in McPherson (2011) using Stratal OT, with *Ø undominated at the stem level but very lowly ranked subsequently, allowing the derivation of underspecification on stems that would otherwise require full tonal specification.

The pitch track in Figure 3 demonstrates the derived underspecification on 'woman':



[yàa-ná = gɛ][jɛ̀ŋɛ́-nɛ ye-sɛ]

Figure 3: Derived underspecification on the stem *yàá* as the result of tone shift.

What motivates this heavy contour tone shift is a constraint in Tommo So against non-final contour tones. That is, a contour tone must be at the right edge of a prosodic word. The reason that enclitics do not trigger this tone shift is that as clitics, they are outside of the prosodic word, so they do not reassign the prosodic word boundary.

The following summarizes the tone shifting behavior of enclitics and suffixes:

(8)	Enclitic	Human suffix
v̌	v̀=x́	v̀-x́
v̀v́	v̀v́=x	v̀v-x́

4. Typological implications of Tommo So underspecification

While Tommo So allows tonal underspecification to persist to the surface, it is not unbounded. Underlyingly, only grammatical elements like clitics and suffixes, as well as epenthetic vowels added later, can be underspecified. This fits in with the typology of stress for this same set of elements.

First, take clitics. A common diagnostic of whether something is a clitic or an affix is to look at its behavior with regards to stress, with clitics usually stressless or bearing only secondary stress (Aikhenvald 2002). If stress is assigned, it is typically done at a later level than the prosodic word, of which the affix forms a part, the result being that the stem receives higher prosodic prominence (e.g. Hayes 1995 on Central Alaskan Yupik). Given this distribution of stress for clitics, it is unsurprising that the tonal parallel in Tommo So is the lack of tone assignment on clitics; they do not participate in the same prosody as stems and at least some affixes.

Next, affixes may pattern either way with regards to stress. For instance, English has Level 1 affixes, which can either take stress or shift stress, while Level 2 suffixes do not (Kiparsky 1982). Stress splits can also be between derivational affixes and inflectional affixes, with derivational affixes more tightly tied to the word and more likely to interact with stress, as is the case in Persian (Kahnemuyipour 2003). Since the human suffixes in Tommo So express number, they fall more in the inflectional camp, and thus it is not surprising that they are toneless, if tone in Tommo So is the prosodic parallel of stress, nor is it surprising that other affixes, specifically verbal ones, do take tone.

Finally, epenthetic vowels are unstressed in many languages. A particularly prominent case in the literature is the behavior of epenthetic vowels in many varieties of Arabic. In Palestinian Arabic, for instance, the epenthetic vowel [i] is differentiated from lexical /i/ by the fact that it is not stressed, which results in opacity (Brame 1994, Kager 1999, Kiparsky 2000). The fact that epenthetic vowel [u] in Tommo So does not receive tone while lexical [u] does is parallel to this; the status of [u] as an epenthetic vowel is further corroborated by its failure to participate in normal processes of vowel harmony.

Summing up, given the fact that Tommo So has both H and L in addition to unspecified, the distribution of the unspecified tone falls into line nicely with what we know to be true of stress systems cross-linguistically. This is in contrast to Myers's (1998) Chichewa underspecification, which can occur on any word, content or function, seeing as the opposition there is a binary one between H and null. The tonal options in that language are more limited, and hence underspecification must be allowed on stems in order for tone to play a lexical role at all. It remains to be seen whether the Tommo So distribution of null is the norm for underspecified systems with a ternary distinction, or whether unbounded underspecification existing alongside H and L is also attested.

5. Final remarks

This paper has given a brief introduction to and summary of the system of tonal underspecification found in Tommo So. A more complete treatment can be found in McPherson (2011). I have shown that not only does Tommo So have a three-way distinction between H, L and Ø, but that this Ø persists into the phonological output only in certain classes of grammatical elements. The F0 on these syllables is then filled in by linear interpolation between specified tones on either side.

The existence of this system escaped my notice for two years. Enclitics and suffixes were audibly different from other tones and hard to categorize, but it took systematic investigation of pitch tracks to determine that this difference lay in underspecification. This raises questions about the existence of underspecification especially in other Dogon languages, but also in other tone languages across Africa and elsewhere.

When one sets out to do fieldwork in Africa, there are certain expectations about the kinds of tonal systems one will see. As I mentioned in the introduction, most descriptions of African languages refer to the existence of between two and four tones. If underspecification is even mentioned, it is generally in reference to the underlying representation and not to the surface realization. With this paper, I hope to highlight the important role instrumental analysis can play in decoding a tone system. It can never fully replace the need for careful listening, but it is just about the only way to confirm the existence of tonal interpolation arising from underspecification, since such interpolation passes quickly and often does not correspond nicely to a phonemic level or contour tone. It is my belief that using such methods will reveal more languages like Chichewa or Tommo So that demonstrate a clear need for surface underspecification in our theories of phonology and tonology.

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