Georgian: word stress or phrasal prosody (and how do we know?)?

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Today’s roadmap

1. Why study prosody
2. How to study prosody
3. What Georgian data tells us about prosodic theory
Introduction: basic observation

The same string of words can often be pronounced in many different ways.

• different choices of emphasis
• different pitch patterns
• different phrasings
• different patterns of timing or tempo

⇒ prosodic variation
Prosodic variation

Prosodic choices are **constrained** – it’s definitely possible to say things the wrong way.

(1) a: Why are you going to Georgia?  
    b: I like khachapuri!

(2) a: Do you like khachapuri?  
    b: I like khachapuri!
Main questions in prosodic research

• What are the ways that prosody can vary?
• What sorts of meaning differences can be conveyed through prosodic differences?
• How exactly do prosodic differences convey differences in meaning?

• Also: what kinds of meaning differences cannot be conveyed through prosodic differences?
Why study this?
Current Biology

Report
Newborns’ Cry Melody Is Shaped by Their Native Language

Birgit Mampe 1, Angela D. Friederici 2, Anne Christophe 3, Kathleen Wermke 1,*

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Summary
Human fetuses are able to memorize auditory stimuli from the external world by the last trimester of pregnancy, with a particular sensitivity to melody contour in both music and language [1–3]. Newborns prefer their mother’s voice over other voices [4–8] and perceive the emotional content of messages conveyed via
Newborns’ Cry Melody Is Shaped by Their Native Language

“Human fetuses are able to memorize auditory stimuli from the external world by the last trimester of pregnancy, with a particular sensitivity to melody contour in both music and language.

Newborns prefer their mother’s voice over other voices and perceive the emotional content of messages conveyed via intonation contours in maternal speech (‘’motherese’’).”
Newborns’ Cry Melody Is Shaped by Their Native Language

“Their perceptual preference for the surrounding language and their ability to distinguish between prosodically different languages and pitch changes are based on prosodic information, primarily melody.

Adult-like processing of pitch intervals allows newborns to appreciate musical melodies and emotional and linguistic prosody.”
Newborns’ Cry Melody Is Shaped by Their Native Language

“Here, we analyzed the crying patterns of 30 French and 30 German newborns with respect to their melody and intensity contours. The French group preferentially produced cries with a rising melody contour, whereas the German group preferentially produced falling contours. The data show an influence of the surrounding speech prosody on newborns’ cry melody [...]”
Newborns’ Cry Melody Is Shaped by Their Native Language

Figure 1. Box-Plot Diagram of the Values $t_{\text{norm}}(F_0_{\text{max}})$ and $t_{\text{norm}}(I_{\text{max}})$
Distribution of all observed melody and intensity contours in German and French newborns’ crying, displayed as box plots of the 25th to 75th percentile, with the solid vertical line inside each box representing the median and the bars outside each box representing the minimum and maximum values. The dashed vertical line represents a symmetric melody arc. The data indicate a preference for either rising (French group) or falling (German group) melodies.

Figure 2. Time Waveform and Narrow-Band Spectrograms of a Typical French Cry and a Typical German Cry
How to study prosody
Model of Intonational Phonology

3 main components

1. **phrasing**: grouping of words into closely cohering chunks;
2. **prominence**: relative salience of words and syllables;
3. **intonation**: how pitch rises and falls.

An utterance’s intonational contour can be modelled as a sequence of high (H) and low (L) **tonal targets**, **their grouping**, and **transitions** between them.
1. Prosodic phrasing

• **Phrasing**, together with **prominence** and **intonation**, is one of the main components needed for building a model of intonational phonology.

• **Prosodic phrasing** is similar (though, crucially, *not* identical to!) syntactic phrasing: smaller units combine into larger ones, which combine into still larger ones.

• Different languages distinguish **different levels** of prosodic phrasing.
Prosodic phrasing in English

From Krivokapić (2014)
Prosodic phrasing in Georgian

There are three levels of prosodic phrasing that we will be dealing with (i.e., that are distinguished in Georgian):

• Intonational phrase (IP): = clause/sentence
• Intermediate phrase (ip): = (optional) grouping of APs, such as noun+modifying adjective
• Accentual Phrase (AP) = lexical/prosodic word

NB: the names & exact conditioning for these varies by language
Prosodic phrasing in Georgian

(based on Jun et al. 2007, Vicenik & Jun 2014)
2 & 3. Prominence & intonation

Other than phrasing, the other components of intonational phonology are prominence and intonation, which are represented by intonational pitch targets:

• **pitch accents:** pitch targets aligned with metrically strong syllables (a.k.a. syllables carrying some degree of stress); can be high (H*), low (L*), or complex (e.g., H*+L)

• **boundary tones:** targets that are aligned with the edge of a prosodic domain; also can be high, low, or complex
2 & 3. Prominence & intonation

In other words, particular tones are anchored to particular syllables.

⇒ How do we know?
Tune-Text alignment: surprisal contour

(1) A: I hear Sue’s taking a course to become a driving instructor.

\(\sim\)

B: Sue!?  

From Ladd (2008:45)
Tune-Text alignment: surprisal contour

(2) A: I hear Sue’s taking a course to become a driving instructor.

B: A driving instructor!?!?

From Ladd (2008:46)
Prominence & intonation in English

Now, let’s put phrasing, prominence and intonation together:

Every pitch target is found in a specific prosodic domain.
Prominence & intonation in English

In English:
• Pitch accents are assigned to prosodic words ($\omega$)
• Intermediate Phrases (ips) and Intonational Phrases (IPs) carry final boundary tones
Prosodic phrasing in English

From Krivokapić (2014)
Example: English

\[
\left( \left( H^* \right) \left( L^- \right)_{ip} \right)_{IP} \left( L^\% \right)_{IP}
\]

Pitch       ip-Boundary       IP-Boundary
Accent      Tone                Tone
Prominence & intonation in Georgian

In Georgian:

• Pitch accents are assigned to Accentual Phrases (APs)
• Accentual Phrases (APs), Intermediate Phrases (ips) and Intonational Phrases (IPs) carry final boundary tones

• NB: if several final boundaries coincide, only the final boundary tone of the highest phrase is realized.
Example

$\left( (L^* \quad Ha)_{AP} \quad (H^* \quad )_{ip} \quad L\% \quad )_{IP} \right.$

Pitch Boundary Pitch Boundary
Accent Tone Accent Tone
At this point, you should have some questions...

• How is placement of the *pitch accent* determined with an AP in Georgian?
Pitch accent placement

• Recall that...

• pitch accents: pitch targets aligned with metrically strong syllables (a.k.a the syllables carrying some degree of stress);

⇒ How is stress placement determined in Georgian?
Word Stress in Georgian?
Is it even there?

- Native speakers have **no consistent intuitions** about stress placement;
- No **minimal pairs** based on stress;
- No **regular variation** in stress placement in declensional or conjugational paradigms;
- No **agreement in the literature** as to the existence or location of word stress in Georgian.
Three main approaches

1. Word stress approach
2. Phrasal intonation approach
3. Mixed approach
1. Word stress approach

- Di- and trisyllabic words: initial stress
- Longer words: another stress-like target on the (ante)penultimate syllable

- No agreement about whether the default stress location is initial, antepenultimate, or penultimate.
- Some analyses allow for variation between these stress loci and/or appearance of secondary stress on one of them.
Word stress approach: examples

• Tschenkeli (1958:LX): **initial stress** in di- and trisyllabic words, in longer words also often initial, though with less certainty

• Tevdoradze (1978:40): **initial stress;** secondary stress may occur in longer words.

• Ioseliani (1840:145), Gorgadze (1912:3), Akhvlediani (1949:135) and Gudava (1969:106): **antepenultimate stress** placement
Word stress approach: examples

• Marr (1925:13), Rudenko (1940:24): initial stress in disyllables, and (ante)penultimate in longer words. In 4σ+ words, a secondary stress on the initial syllable is possible; both are obligatory in 6σ+ words.

• Dirr (1904:3), Janašvili (1906:5), Akhvlediani (1949:132): initial stress in disyllables and trisyllables, antepenult in longer words;
Word stress approach: examples

• Aronson (1990:18): in words of 2-4σ, stress falls on the antepenult or the initial syllable; in longer words, both the initial syllable and the antepenult are stressed.

• Hewitt (1995:28), in trisyllabic words the antepenult takes the stress; in longer words, stress is either antepenultimate or initial.
Word stress approach: overall

There is something stress-like on the initial and/or the (ante)penultimate syllable in Georgian...
2. Phrasal intonation approach

The domain of “stress” assignment is larger than a prosodic word.

“Stress” found in such a larger domain is a pitch target that is part of the intonational make-up of a phrase – not word-level stress.

The right edge of a prosodic word serves as the locus for such pitch targets.
Phrasal intonation approach: examples

• Stress in Georgian is a property of a ‘syntactic group’ (Gorgadze 1912:13), ‘accentual complex’ (Marr 1925:14) or ‘rhythmic group’ (Zhghenti 1953:162) – not an individual word.

• Zhghenti (1963:144): individual words lose their stress when they become part of an intonational phrase, like in French or Ossetic.

• Zhghenti (1963:144): Georgian stress can only be accounted for if it is recognized as a property of prosodic phrases and not individual words.
Phrasal intonation approach: examples

- ‘Subject’ phrases have an overall rising intonational pattern and initial stress.
- In ‘predicate’ phrases, there is more variability: both initial and antepenultimate syllables can be identified as stressed by speakers.
3. Mixed approach

Word stress and pitch targets attributable to phrasal prosody co-exist in Georgian, but their loci do not necessarily coincide.

Phrasal prosody is overall more prominent, and changes to it lead to changes in meaning. Word stress is not nearly as important.
Mixed approach: examples

• Čikobava (1942:302): in contemporary Georgian, word stress is considerably weaker than phrasal stress.

• Jun et al. (2007), Vicenik & Jun (2014:156): the initial syllable is characterized by higher intensity and longer duration = a manifestation of word stress. An HL tonal contour spans the antepenult and penult = a manifestation of phrase accent.
Experiment 1
Methodology

Stimuli:
• Georgian words: n=179
• 1-6 syllables long
• CV structure: C = nasal, liquid or voiced stop or fricative; V = any vowel)
• 3 iterations per word (1 type = 3 tokens)

Carrier phrases:

Me sit’q’va ‘[stimulus]’ vimghere/vixmare/davts’ere.
‘I sang/used/wrote the word ‘[stimulus]’.”
## Stimuli

<table>
<thead>
<tr>
<th>Syllable Count</th>
<th>Sample Stimuli</th>
<th>N (types)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 σ</td>
<td><em>bu</em> ‘owl’</td>
<td>9</td>
</tr>
<tr>
<td>2 σ</td>
<td><em>mama</em> ‘father’</td>
<td>30</td>
</tr>
<tr>
<td>3 σ</td>
<td><em>malamo</em> ‘balm’</td>
<td>52</td>
</tr>
<tr>
<td>4 σ</td>
<td><em>monazoni</em> ‘monk’</td>
<td>53</td>
</tr>
<tr>
<td>5 σ</td>
<td><em>ramodenime</em> ‘multiple’</td>
<td>31</td>
</tr>
<tr>
<td>6 σ</td>
<td><em>gadavadebuli</em> ‘rescheduled’</td>
<td>4</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td><strong>179</strong></td>
</tr>
</tbody>
</table>
Participants

• Four native speakers of Georgian from Tbilisi, living in the US
• Age range: 24-40
• Three females: LK, NP, NA
• One male: ZA
Data

• Resulting dataset, after elimination of disfluent tokens (due to pauses, creaky voice, etc.):

<table>
<thead>
<tr>
<th></th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>types</td>
</tr>
<tr>
<td>LK (f)</td>
<td>174</td>
</tr>
<tr>
<td>NP (f)</td>
<td>179</td>
</tr>
<tr>
<td>NA (f)</td>
<td>179</td>
</tr>
<tr>
<td>ZA (m)</td>
<td>127</td>
</tr>
<tr>
<td>Total:</td>
<td>659</td>
</tr>
</tbody>
</table>
Results: duration, aggregated

<table>
<thead>
<tr>
<th>p-value, paired t-test</th>
<th>2nd σ</th>
<th>3rd σ</th>
</tr>
</thead>
<tbody>
<tr>
<td>1st σ/2 σ</td>
<td>&lt; 0.01</td>
<td></td>
</tr>
<tr>
<td>1st σ/3 σ</td>
<td>&lt; 0.01</td>
<td>&lt; 0.01</td>
</tr>
<tr>
<td>1st σ/4 σ</td>
<td>&lt; 0.01</td>
<td>&lt; 0.01</td>
</tr>
<tr>
<td>1st σ/5 σ</td>
<td>&lt; 0.01</td>
<td>&lt; 0.01</td>
</tr>
<tr>
<td>1st σ/6 σ</td>
<td>&lt; 0.01</td>
<td>0.02</td>
</tr>
</tbody>
</table>
Results: F0, aggregated

Two-factor ANOVA:

Effect of syllable count: $p = 0.057$
Effect of syllable number: $p < 0.01$
Experiment 1: conclusions

• Notably greater duration of the first syllable is consistent with the hypothesis that the initial syllable carries stress, for which duration is the primary acoustic cue. Its tonal specification can vary.

• The penult and ultima carry pitch targets: a low one on the penult followed by a high one on the ultima.
Experiment 2
Methodology

Data set 2:

• Stimuli: Georgian verbs
• Extracted from yes/no questions (YNQ; n=30) and wh-questions (WHQ; n=50)
• 2-6 syllables long, variable syllable structure.
• After elimination of disfluent tokens, n=27 and n=46, respectively.
Stimuli

(1) Mebadur-ma zvigeni da-i-č’ir-a šaršan zapxul-ši?
fisherman-ERG shark.NOM PRV-VER-catch-3SG last summer-LOC
‘Did the fisherman catch a shark last summer?’

(2) Ra da-i-č’ir-a mebadur-ma šaršan zapxul-ši?
what PRV-VER-catch-3SG fisherman-ERG last summer-LOC
‘What did the fisherman catch last summer?’

(Borise & Zientarski 2018)
# Stimuli

<table>
<thead>
<tr>
<th>Syllable Count</th>
<th>Sample Stimuli (Data set 2)</th>
<th>n (YNQ)</th>
<th>n (WHQ)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 σ</td>
<td>moxda ‘happened’</td>
<td>-</td>
<td>3</td>
</tr>
<tr>
<td>3 σ</td>
<td>ip’ova ‘found’</td>
<td>9</td>
<td>18</td>
</tr>
<tr>
<td>4 σ</td>
<td>daič’ira ‘caught’</td>
<td>13</td>
<td>23</td>
</tr>
<tr>
<td>5 σ</td>
<td>nerviulobda ‘was nervous’</td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td>6 σ</td>
<td>učinardeboda ‘disappeared’</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>
Results: predicates in YNQs

<table>
<thead>
<tr>
<th>p, paired t-test</th>
<th>preceding σ</th>
<th>following σ</th>
</tr>
</thead>
<tbody>
<tr>
<td>2nd σ/3 σ</td>
<td>&lt; 0.01</td>
<td>&lt; 0.01</td>
</tr>
<tr>
<td>3rd σ/4 σ</td>
<td>&lt; 0.01</td>
<td>&lt; 0.01</td>
</tr>
<tr>
<td>4th σ/5 σ</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>5th σ/6 σ</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>
Results: predicates in WHQs

<table>
<thead>
<tr>
<th>p, paired t-test</th>
<th>preceding σ</th>
<th>following σ</th>
</tr>
</thead>
<tbody>
<tr>
<td>1st σ/2 σ</td>
<td></td>
<td>0.01</td>
</tr>
<tr>
<td>2nd σ/3 σ</td>
<td>&lt; 0.01</td>
<td>&lt; 0.01</td>
</tr>
<tr>
<td>3rd σ/4 σ</td>
<td>&lt; 0.01</td>
<td>&lt; 0.01</td>
</tr>
<tr>
<td>4th σ/5 σ</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>5th σ/6 σ</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>
Experiment 2: results

• Penultimate and ultimate syllables of predicates in YNQs and WHQs are the loci of pitch targets.

• YNQs: low tone on the penult, high tone on the ultima
• WHQs: low tone on the penult, still lower tone on the ultima

• In contrast with declaratives (Experiment 1), in questions there is a steep fall to the low tone on the penult from a high tone on the antepenult
From SCCC 1 in Paris in 2016...
Bringing everything together
Prosodic phrasing in Georgian

There are three levels of prosodic phrasing that we will be dealing with (i.e., that are distinguished in Georgian):

• **Intonational phrase (IP):** = clause/sentence
• **Intermediate phrase (ip):** = (optional) grouping of APs, such as noun+modifying adjective
• **Accentual Phrase (AP)** = lexical/prosodic word

NB: the names & exact conditioning for these varies by language
Prominence & intonation in Georgian

In Georgian:

• Pitch accents are assigned within Accentual Phrases (APs)
• Accentual Phrases (APs), Intermediate Phrases (ips) and Intonational Phrases (IPs) carry final boundary tones
Initial syllable

- Consistently greater duration on the initial syllable
- Found in words of different morphological types and different syllable counts

⇒ The initial syllable carries word stress, for which duration is the main acoustic cue.

⇒ The pitch targets that are found on the initial syllable (high or low) are pitch accents, anchored to the stress syllable.
Ultima

- Consistently high pitch on the ultima in declaratives (Experiment 1) and verbs in YNQs (Experiment 2)
- Consistently low pitch on the ultima in WHQs (Experiment 2)

⇒ Supports the idea that the final syllable in Georgian carries a final boundary tone, primarily cued by pitch.
Penult

- Consistently low pitch on the penult
- Source of this low pitch is hard to identify...
2 & 3. Prominence & intonation

Intonational pitch targets:

- **pitch accents**: pitch targets aligned with metrically strong syllables (a.k.a syllables carrying some degree of stress); can be high (H*), low (L*), or complex (e.g., H*+L)

- **boundary tones**: targets that are aligned with the edge of a prosodic domain; also can be high, low, or complex
Penult

• Consistently low pitch on the penult

⇒ Pitch accent? But there is one already, on the initial syllable...
⇒ Boundary tone? But there is one on the ultima...
A hypothesis: phrase accent

• Assigned in an Accentual Phrase/Intermediate Phrase
• Optional
• Found *between* the syllable carrying the pitch accent and the syllable carrying the boundary tone.
A problem with the hypothesis...

• Typically described as stretches of pitch, *not* rigidly aligned pitch targets (Grice et al. 2000, i.a.)

• In Georgian, however, the low tone is rigidly aligned with the penult.
A problem with the hypothesis...

“... it is the timing of the low tone that troubles us. <...> the penultimate syllable of the question is always low, followed by the rise on the final syllable.

This rise does not appear to ever start on the penultimate syllable. It appears that we need some way of saying explicitly that the low tone must be associated with the penultimate syllable. Within our theory this cannot be done directly.” (Bush 1999:7)
A different type of a phrase accent?

• Possibly, phrase accent as a category is non-homogenous, and includes more than one phenomenon.

• Georgian data reveals that there exists yet another type of a phrase accent
Overall

• The initial syllable carries word stress, cued by duration; the tonal specification of the pitch accent varies

• The ultima carries a boundary tone (typically high in declaratives & YNQs, low in WHQs)

• The penult carries a low pitch target, likely a novel type of a phrase accent

• The findings are consistent with the mixed approach (as opposed to the word stress approach or the phrasal intonation approach) to Georgian prosody.
დიდი მადლობა!
References
Akhvlediani, Georgij S. 1949. Zogadi ponet’ik’is sapudzvlebi [Introduction to general phonetics]. Tbilisi: Tbilisi State University Publishing.


Preliminary results of the current study have been published as:
