Workshop on Variation, Gradience
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Markedness constraints on the perception of s/z-initial onset clusters

Tracy Lennertz and Iris Berent
Department of Psychology, Florida Atlantic University
tlennert@fau.edu

Do speakers possess universal sonority preferences? If so, how are such preferences shaped by the phonetic properties of acoustic inputs? We examine these questions by investigating people's sensitivity to the sonority profile of onset clusters. Across languages, onset clusters with sonority rises are preferred to onsets with plateaus, which are preferred to onsets with falling sonority. In previous work (Berent, Steriade, Lennertz & Vaknin, in press), we showed that such preferences constrain the perception of stop-sonorant clusters (*bl* > *bn* > *bd* > *lb*). Here, we seek to determine whether similar preferences apply to s/z- initial onsets--onsets that present systematic exceptions to sonority generalizations. Two experiments examine the perception of s-and z-initial onsets with either large sonority rise (*sm*) small rise (*zm*) plateau (*zb*) and fall (*nb*). For comparison, we also examine the perception of f-initial controls (e.g., *fl*, *fn*, *ft*, *mt*). Our previous results suggest that as markedness increases, onset clusters are more likely to be misperceived epenthetically: Sonority falls were more likely to be misperceived epenthetically than plateaus, which, in turn, were more likely to elicit such epenthetic misperceptions relative to rises. Of interest here is whether such misperceptions generalize to s- and z- initial onsets. This issue was tested in both a syllable judgment task (e.g., does *smuk* include one syllable or two?) and an identity task (is *smuk* identical to *semuk*?). The results suggest speakers perceive s/z- as higher in sonority than other obstruents: Items with a small sonority rise (e.g., *zmuk*) were as likely to elicit repair as items with a sonority plateau (e.g., *zbuk*). Speakers were also sensitive to aspiration as a cue to disyllabicity (e.g., *ft^{h}ek* = *fet^{h}ek*). Nonetheless, their representation of s- and z- initial clusters cannot be explained solely by the acoustic properties of s/z-initial stimuli, as similar effects were obtained in the perception of their disyllabic counterparts: Disyllabic items whose counterpart is marked (e.g., *nebuk*, counterpart of *nbuk*) were less likely to be misperceived as containing one syllable. We conclude that the s- and z- are more sonorous than other obstruents and such knowledge forms part of the phonological grammar.

Issues

- Do speakers possess universal preferences regarding onset clusters?
  - Typologically, certain clusters occur less frequently (e.g., *mt* less frequent than *ft*), and their occurrence in a language imply the occurrence of more frequent clusters (see diagram below)
  - According to OT (Prince & Smolensky, 1993/2004): the typology might reflect universal grammatical constraints, active in all grammars
- How are such preferences shaped by phonetic information?
  - Preferences reflect phonological constraints (grounded in phonetic properties)
  - Preferences directly reflect the acoustic properties of auditory inputs

Sonority restrictions in Typology

- The sonority of onset clusters
  - sonority: a scalar phonological property of sounds based on their intensity (Clements, 1990; Parker, 2002; Wright, 2004)
- Typology: onset clusters with sonority rises are preferred to onsets with plateaus, which are preferred to onsets with falling sonority *(fl > fn > ft > mt*).

fl → rise in two levels of sonority (large rise)
fn → rise in two levels of sonority (small rise)
ft → two sounds from the same sonority level (plateau)
mt → fall in sonority of one level (fall)

Are speakers sensitive to markedness of onset clusters that are unattested in their language?

- Berent et al. (in press) demonstrated that speakers are sensitive to the sonority structure of unattested onset clusters
  - *bl* > *bn* > *bd* > *lb*
  - stimuli are stop-sonorant combinations, produced by a Russian speaker
- Finding: as markedness increases, people are more likely to misperceive the onset epenthetically (e.g., lbif=lebif)
- Account:
  - Marked onset clusters are repaired
  - People represent the hierarchy of sonority profiles:
    - bn > bd > lb
    - accordingly: the likelihood of repair of lb > bd > bn

The current study

- The sonority of s/z obstruents: are they special?
  - Work in syllabification suggests that s- may be an exception to a language's constraints on syllable structure (Selkirk, 1982).
  - Properties of s might extend to z
  - Is s/z- perceived as
    - other obstruents (e.g., *b, t, f*)?
    - higher sonority, distinct from other obstruents of its class?
- Why is s/z-special?
  - *Phonology*: s/z is ranked higher than other obstruents on a phonological scale of sonority
  - *Phonetics*: sonority preferences reflect directly the acoustic properties of the input

Test

- Compare sonority preferences for:
  - *sm, zm, zb, nb*
  - *fl, fn, ft, mt*
    - note: t is aspirated
- **Predictions**
  - Is s/z special?
    - If s/z is treated like other obstruents, then the perception of onset clusters should mirror the findings with stops (Berent et al. in press)
      sm / zm > zb > nb
    - If s/z is treated as a consonant with higher sonority, distinct from other obstruents then
      s/z + m (typically a rise) ~ plateau
      (sm / zm ~ zb) > nb
  - Role of phonetic cues
    - s/z-initial items
      - *phonological account*: markedness will modulate the perception of both mono- and disyllabic items
        - *nbif:* aversion of falls→errors
        - *nebif*: aversion of fall counterparts (*nbif*) improves correct disyllabic responses
      - *phonetic account*: cues associated with s/z - will only modulate the perception of monosyllabic items

- Are people sensitive to non-distinctive features?
  - Evidence from aspiration in f-items
  - ft^{h}ek excised from fet^{h}k
    - Aspiration is a strong cue to disyllabicity, even when the item is monosyllabic
    - Prediction: If speakers are able to use the phonetic cue of aspiration to signal disyllabicity, then *ft^{h}ek* should be misperceived as disyllabic relative to *zbuk* (matched on sonority profile)

Method

Participants

- Undergraduate students at Florida Atlantic University, all were native speakers of English (N=16; N=28 for Experiments 1-2, respectively)

Materials

- 12 items arranged in quartets
- all items recorded by a female native English speaker as disyllabic
- monosyllabic items were created by splicing out the initial vowel at the zero crossings (e.g., *zebuk* → *zbuk*)

	large rise	**small rise**	**plateau**	**fall**
½ **F- initial**	*flek*	*fnek*	*ftek*	*mtek*
½ **S/Z – initial**	*smuk*	*zmuk*	*zbuk*	*nbuk*

Intensity measurements

- intensity → phonetic correlate of sonority (Parker, 2002)
- measured intensity difference between C1 and C2 (mean dB)
- s- and z- were more intense than f- (see Figure 1)

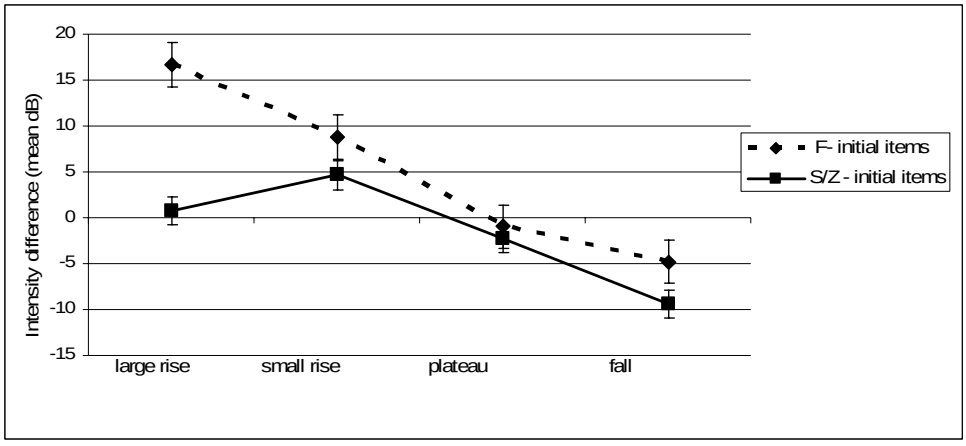

Figure 1. Mean intensity difference, measured in dB between C1 and C2 for F-initial and Z-initial items. Error bars represent the confidence interval constructed for the difference among the means.

Syllable Judgment Task

Does this auditory item contain one or two syllables?

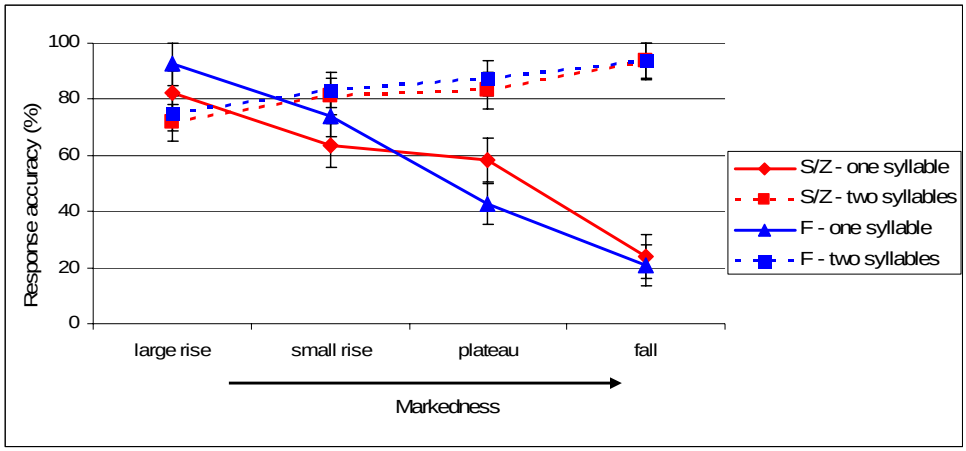

Figure 2. Mean response accuracy (%) in the syllable task as a function of initial consonant, cluster type and number of syllables. Error bars represent the confidence interval constructed for the difference among the means.

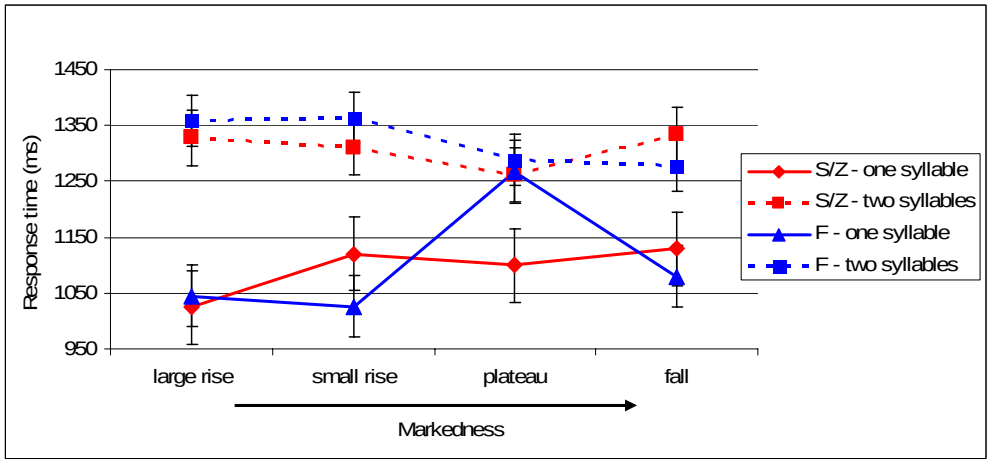

Figure 3. Mean response time (ms) in the syllable task as a function of initial consonant, cluster type and number of syllables. Error bars represent the confidence interval constructed for the difference among the means.

Results: Syllable Task

- ***S/Z – initial onsets***
  - *One syllable: sm > (zm = zb) > nb*
  - *Two syllables: sm < nb*
- ***F – initial onsets***
  - *One syllable: fl > fn > ft^h > mt^h*
    - but: longer RT for *ft^h*
  - *Two syllables*: *ft^h < mt^h*

Identity Judgment Task

Are these two auditory items identical or not identical?

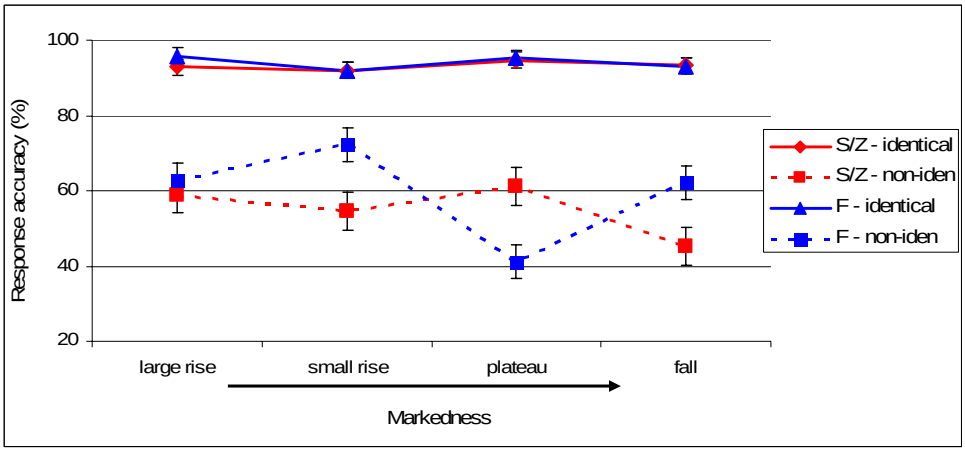

Figure 4. Mean response accuracy (%) in the identity task as a function of initial consonant cluster type and identity. Error bars represent the confidence interval constructed for the difference among the means.

Results : Identity Task (non-identical items)

- ***S/Z – initial onsets***
  - *(sm = zm = zb) > nb*
- ***F – initial onsets***
  - *ft^h < zb*

Discussion

Is s/z special?

- **Yes – speakers perceive s/z as higher in sonority than other obstruents**
- *zmuk = zemuk* was as likely as *zbuk = zebuk*
- Note: people also prefer *sm > zm*--this might be due to attestation

Why ?

- *s-* and *z-* are more intense than other obstruents and are perceived as higher in sonority: People did not differentiate among *zm* (small rise) and *zb* (plateau) in either task
- intensity difference between C1 and C2 (see measurements)
  - s/z- initial rises – about equal, ~ similar to a plateau
  - f- initial rises – sharper increase
- In addition, speakers are sensitive to non-contrastive phonetic cues:
  - aspiration as a cue to disyllabicity
  - aspiration interfered with performance when the target was one syllable
    - syllable task: longer RT that *ft^{h}ek* was one syllable
    - identity task: *ft^{h}ek - fet^{h}ek* were more likely misperceived to be identical
- Nonetheless, the sonority of s/z does not directly reflect the acoustic properties of the stimulus directly
  - Evidence: the effect of sonority on disyllabic forms (Experiment 1):
    - Speakers are less accurate responding to disyllabic items whose counterpart is unmarked
    - This effect is not due to phonetic properties of vowels
      - Vowel duration is comparable

        - The effect of markedness remained significant even after vowel length was controlled for in a linear stepwise regression with sonority entered as the last predictor (R^2 Change - .311, df (1,45), F – 26.173, p <.001)
- Conclusion: such sonority knowledge reflect phonological, not phonetic knowledge

- Take home:
    - Speakers are sensitive to sonority profile of unattested onsets
    - S/z are perceived as more sonorous than other obstruents
    - Knowledge regarding the special status of s/z is grounded in their phonetic properties, but is not limited to their acoustic properties of the stimulus

References

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