Harmony in sight or how vowel harmony modulates visual word recognition in Turkish

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Vowel Harmony

- It is a *phonological phenomenon* that occurs in several families of languages (e.g., Altaic languages [Turkish, Mongolian], Uralic languages [Finnish, Hungarian], and others).

- In these languages, vowels within a word share certain phonetic features (**frontness vs. backness harmony**, roundness harmony, among others).

- It may help speech production by having consistent articulatory gestures.

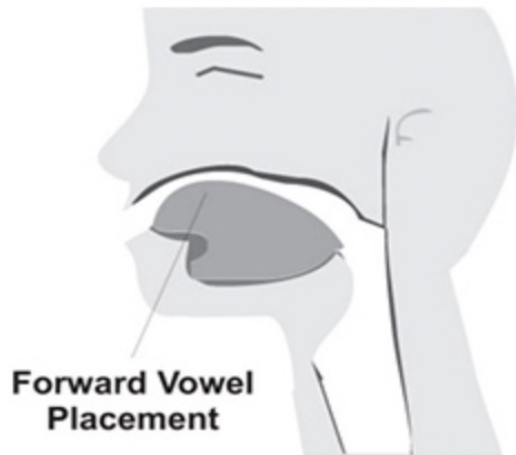- It also affects morphological processes (e.g., suffixes) and word formation.

Vowel Harmony in Turkish

Frontness and backness harmony:

*Words contain either **front** vowels or **back** vowels.*
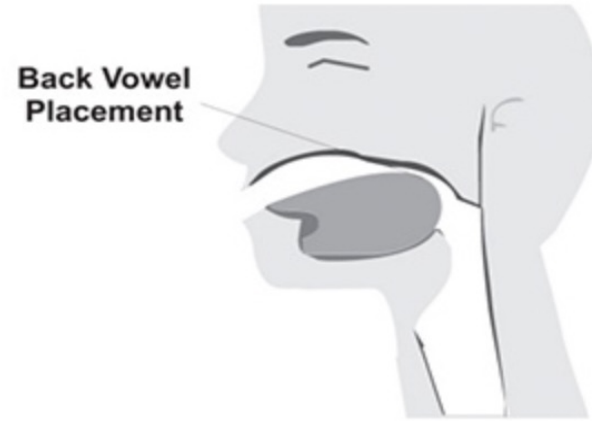
Turkish Vowels

Front

e (/e/)

i (/i/)

ü (/y/)

ö (/ø/)

Forward Vowel Placement

güven [trust]

Back

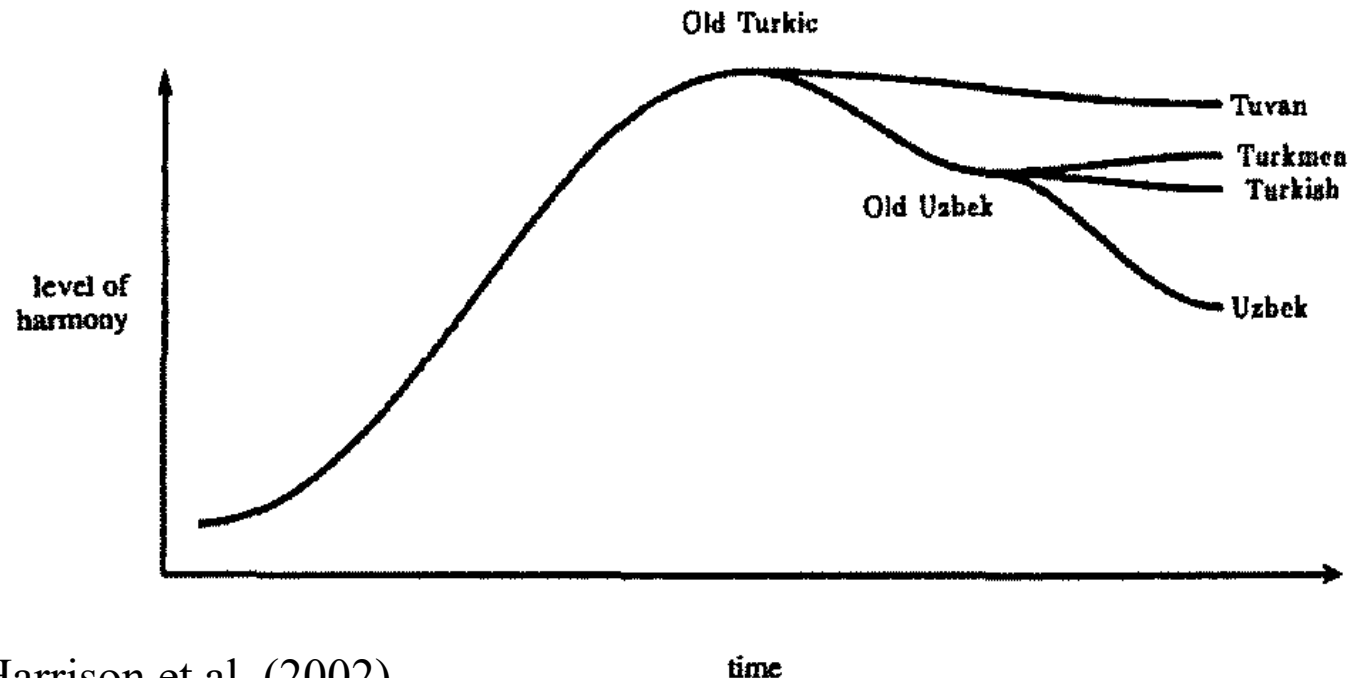Back Vowel Placement

a (/a/)

ı (/ɯ/)

u (/u/)

o (/o/)

kabul [accept]

Vowel Harmony in Turkish

Old Turkic had full consistent word harmony. Modern Turkish still keeps 75% of this pattern despite cultural influences over time.

(3)   Schematic evolution of Turkic backness harmony systems[3]

Mucize [miracle] Arabic

Egzotik [exotic] French

Efsane [legend] Persian

Harrison et al. (2002)

Vowel Harmony and speech segmentation

Vowel harmony facilitates speech segmentation in infants and adults.

• 7-month-old infants from UK can detect vowel harmony patterns without language exposure.

• Vowel harmony patterns aid infants in segmenting continuous speech into proto-word forms (Mintz et al., 2018).

In adults of languages with vowel harmony:

• They use vowel harmony as a cue when segmenting words in disharmonious spoken nonword strings (Suomi et al., 1997; Vroomen et al., 1998)

What about the visual domain?

Vowel Harmony when reading compounds

Bertram et al. (2004) investigated the effect of vowel harmony on the parsing of compound words in Finnish.

*sähkö**asentaja* [electricity expert]; disharmonious

*satu**olento* [fairytale creature]; harmonious

They found shorter eye fixation times when the constituents of the compound word were harmonically dissonant.

And what about the role of vowel harmony during visual word recognition?

Theoretical framework
Global coherence hypothesis in a lexical decision (word/nonword) task

Orthographic and phonological codes from a visually presented word can be combined into a single measure of "quality of evidence" in a lexical decision task, as a measure of *coherence*—the higher the coherence, the faster their identification (Van Orden & Goldinger, 1998).
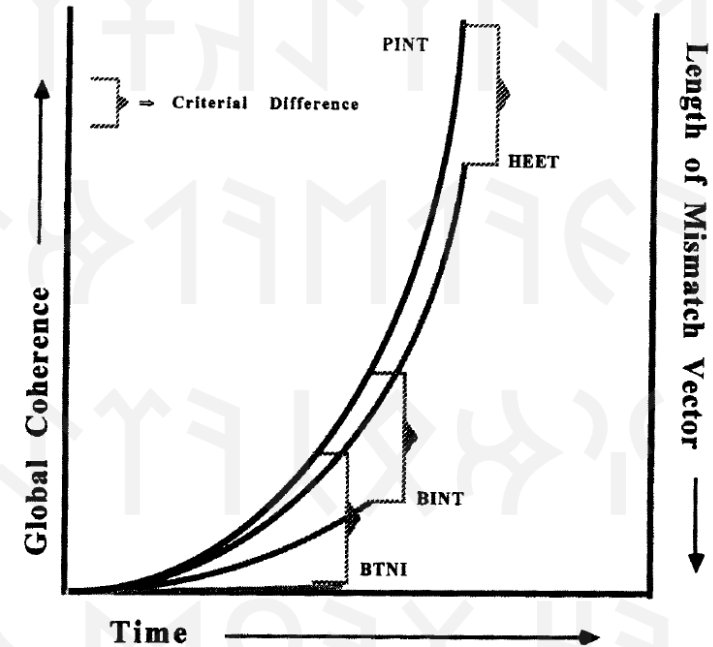
If vowel harmony contributes to the formation of coherent phonological codes in Turkish, **harmonious words** would reach a **stable orthographic-phonological state** in a lexical decision task **faster than disharmonious words**. Conversely, the **opposite** pattern might be expected for **pseudowords**.

Vowel Harmony and lexical processing

In Finnish, disharmonious words are too few—it is not possible to compare a well-controlled set of harmonious vs disharmonious words.

However, it is possible to do that manipulation with pseudowords. Perea, Hyönä, and Marcet's (2022) Experiment 3 compared two sets of pseudowords:

Höpeä - Harmonious (pseudoword)
Vöurio - Disharmonious (pseudoword)

They found that response times in a lexical decision task (word/nonword) were faster for (the less wordlike) disharmonious pseudowords, which is consistent with the global coherence hypothesis.

Can we **directly** examine the effect of vowel harmony on words?

Yes, Turkish has 25% of disharmonious words.

We can compare two sets of words, harmonious vs disharmonious while controlling for other relevant effects (word frequency, length, orthographic neighborhood, …)

|	Word	Pseudoword
Harmonious	sanat [art]	tesil
Disharmonious	zafer [victory]	canit

Experiment 1
Vowel harmony for words

- 142 monomorphemic Turkish nouns of 4 to 6 letters from WordLex (Gimenes & New, 2015): 71 harmonious, 71 disharmonious

- 142 pseudowords generated with Wuggy (Keuleers & Brysbaert, 2010): 71 harmonious, 71 disharmonious

- Thirty-six native speakers of Turkish participants took part in the experiment (M = 26.9 years)—this yielded 2,556 observations per condition.

- The experiment was pre-registered in OSF.

Experiment 1
Vowel harmony for words

500ms

+

zafer

2000ms

Press "z": nonword   Press "m": word
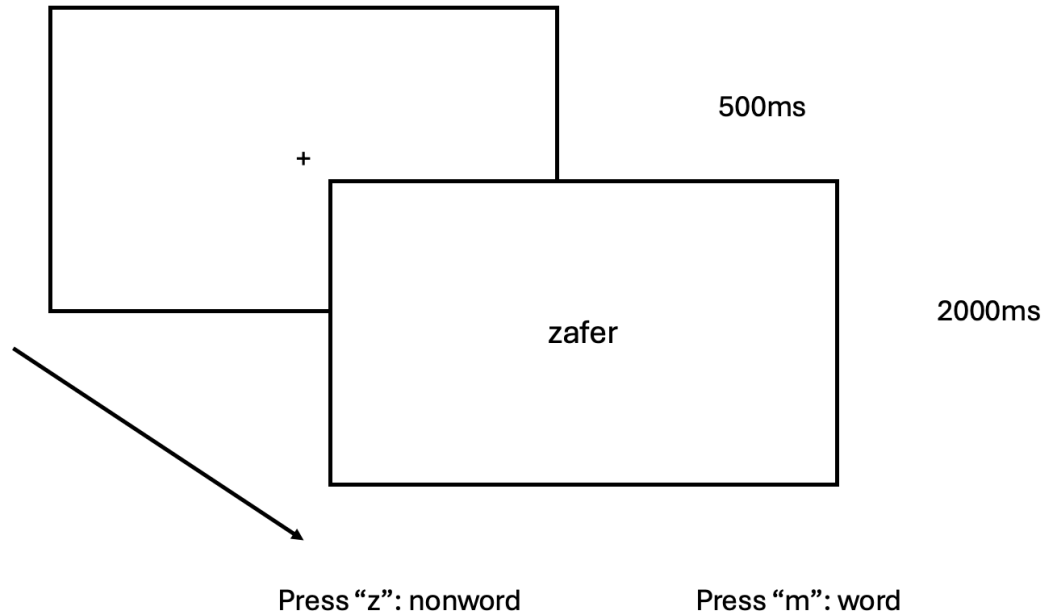
- Lexical decision task.
- Implemented in PsychoPy (Peirce et al., 2019), and conducted online using the Pavlovia server.
- The analyses were conducted using Bayesian linear mixed-effects models.

Experiment 1

Means

	RT	Accuracy
Word		
Harmonious	604	0.974
Disharmonious	623	0.973
Pseudoword		
Harmonious	685	0.946
Disharmonious	686	0.943

Delta plots
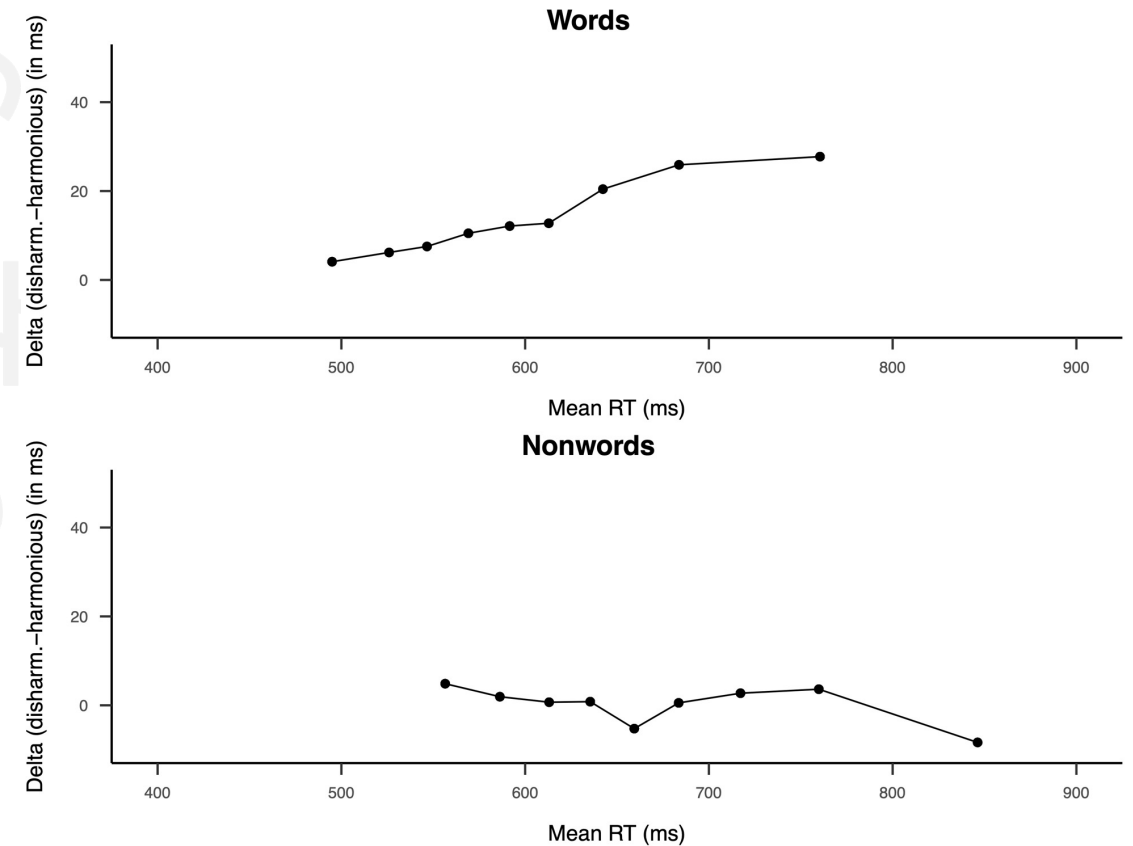
As expected, harmonious words produced faster responses than disharmonious words. However, there was no effect of VH for pseudowords.

Experiment 2
Solving the apparent discrepancy for pseudowords

- Option 1: In the Finnish experiment of Perea et al. (2022), words were *always* harmonious. Thus, any item that was not harmonious was a nonword, which could have induced faster RTs for disharmonious pseudowords.

- Option 2: Vowel harmony is less crucial for Turkish (around 25% of words are disharmonious) than Finnish readers, so it is a less salient marker for "nonword" responses.

To tell apart these two explanations, we designed Experiment 2

Experiment 2
Vowel harmony for pseudowords

- We replaced the 71 disharmonious nouns with similar-frequency harmonious nouns from the same corpus. This way, **all words were harmonious**.

- The pseudowords were the same as in Experiment 1.

- A new sample of thirty-six Turkish participants participated (M = 26.94 y.o.).

- All procedures and data analyses are the same as in Experiment 1.
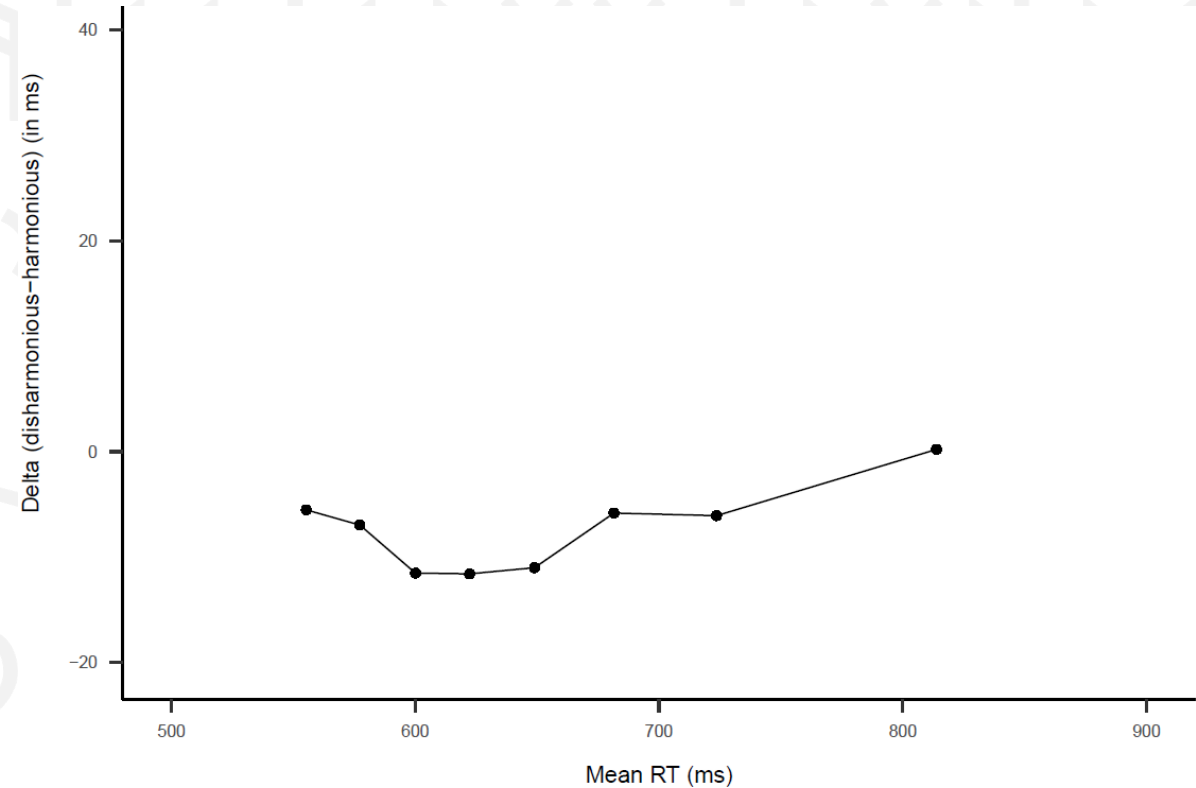
- The experiment was pre-registered in OSF.

Experiment 2

Delta plot

Means

	RT	Accuracy
Pseudoword		
Harmonious	658	0.955
Disharmonious	652	0.957

Words: 581 ms, 0.955

We found evidence for a small but reliable effect of vowel harmony ($b = 5.72$, 95%CrI [0.25, 14.14]): RTs were faster for disharmonious than harmonious pseudowords—the same direction as in the cited experiment in Finnish.

Conclusions

1) This is the first demonstration of a facilitative effect of vowel harmony on the identification of visually presented words.

2) This finding is consistent with the idea that vowel harmony helps to create a stable phonological code (*global coherence hypothesis*) during lexical access.

3) Unlike Finnish, vowel harmony only plays a very small role in "no" responses in lexical decision in Turkish, most likely because vowel disharmony is not a reliable marker of *nonword-likeness*.

Next step: Examining the effects of vowel harmony in a more "ecological" situation, during silent reading.