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DISTANCE-BASED SIBILANT HARMONY IN MOROCCAN ARABIC

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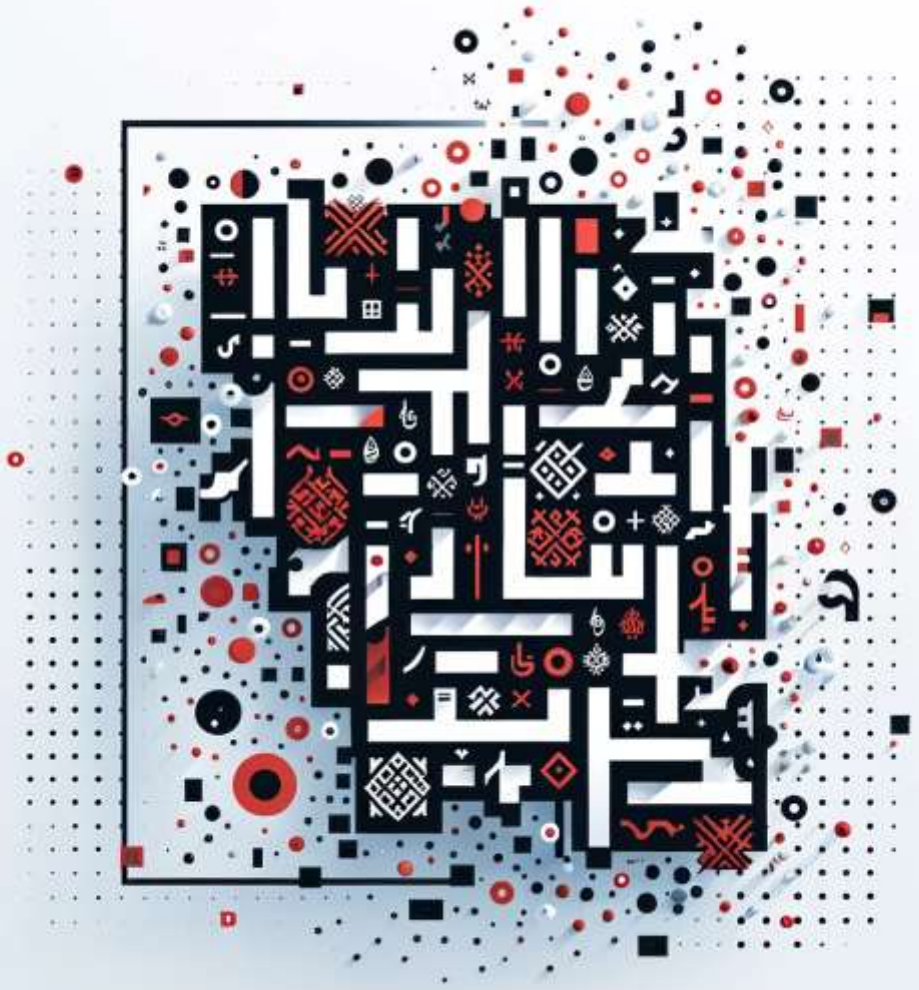


Optional Sibilant Harmony in Moroccan Arabic

- Moroccan Arabic has optional sibilant harmony, triggered by [ʒ] and targeting [z] and [s] (Harrell, 1962; Heath, 1987, 2002, Zellou, 2010, 2013).

(1)	**Non-harmonized**		**Harmonized**	**Gloss**
a.	zaʒ	~	ʒaʒ	‘glass’
	zəliʒ	~	ʒəliʒ	‘tiles’
	zənʒlan	~	ʒənʒlan	‘Sesame seeds’
b.	sərʒəm	~	ʃərʒəm	‘window’
	sfənʒ	~	ʃfənʒ	‘doughnut’
	sətranʒ	~	ʃətranʒ	‘chess’

- Both the harmonized and non-harmonized variants of words are used interchangeably by MA speakers (Weissman, 2007).
- **Research question:** what are the factors that affect which variant is used? How to account for the variation?

Conclusions

- Experimental results show that:
  - The distance between harmonizing segments affects the speaker's choice of using the harmonized vs non-harmonized form.
  - Words derived from a harmonized MSA form must be treated as exceptions
- An analysis using a probabilistic model is needed to predict the variation seen in harmonization patterns of MA.

Predicted factors for harmonization: Distance

- **The hypothesis:** More intervening elements typically reduce the likelihood of harmonization (Odden, 1994; Piggott, 1996; Suzuki, 1998; Walker, 2000c; Rose & Walker, 2004; Hansson, 2010).

More Intervening Segment	→	less harmonization:	e.g. 'zaʒ' → 'ʒaʒ' (glass)
Less Intervening Segment	→	more harmonization:	e.g. 'zəlliʒ' → 'ʒəlliʒ' (tiles)

Predicted factors for harmonization: Voicing

- **Hypothesis 1:** words with [s] are more prone to harmonization compared to those with [z].

Target is [s]	→	more harmonization:	e.g. ‘sərʒəm' → 'ʃərʒəm’ (window)
Target is [z]	→	less harmonization:	e.g. 'zaʒ' → 'ʒaʒ' (glass)

- **Hypothesis 2:** words with [z] are more prone to harmonization compared to those with [s].

Target is [z]	→	more harmonization:	e.g. 'zaʒ' → 'ʒaʒ' (glass)
Target is [s]	→	less harmonization:	e.g. ‘sərʒəm' → 'ʃərʒəm’ (window)

Predicted factors for harmonization: Morphological Complexity

- **The hypothesis:** Complex forms (those with multiple affixes) might resist harmonization compared to simpler forms.

- **Cyclical Application of Harmonization:**
  - Harmonization in complex forms might need to occur at each morphological level (root, root+affix1, root+affix1+affix2, etc.) (Bakovic, 2000).
  - ➢ Harmonization more challenging in complex words.

Simple Forms	→	More harmonization:	e.g. 'zwaʒ' → 'ʒwaʒ' (marriage)
Complex Forms	→	less harmonization:	e.g. 'z-zwaʒ' → 'ʒ-ʒwaʒ' (the marriage)

Experiment: an online survey

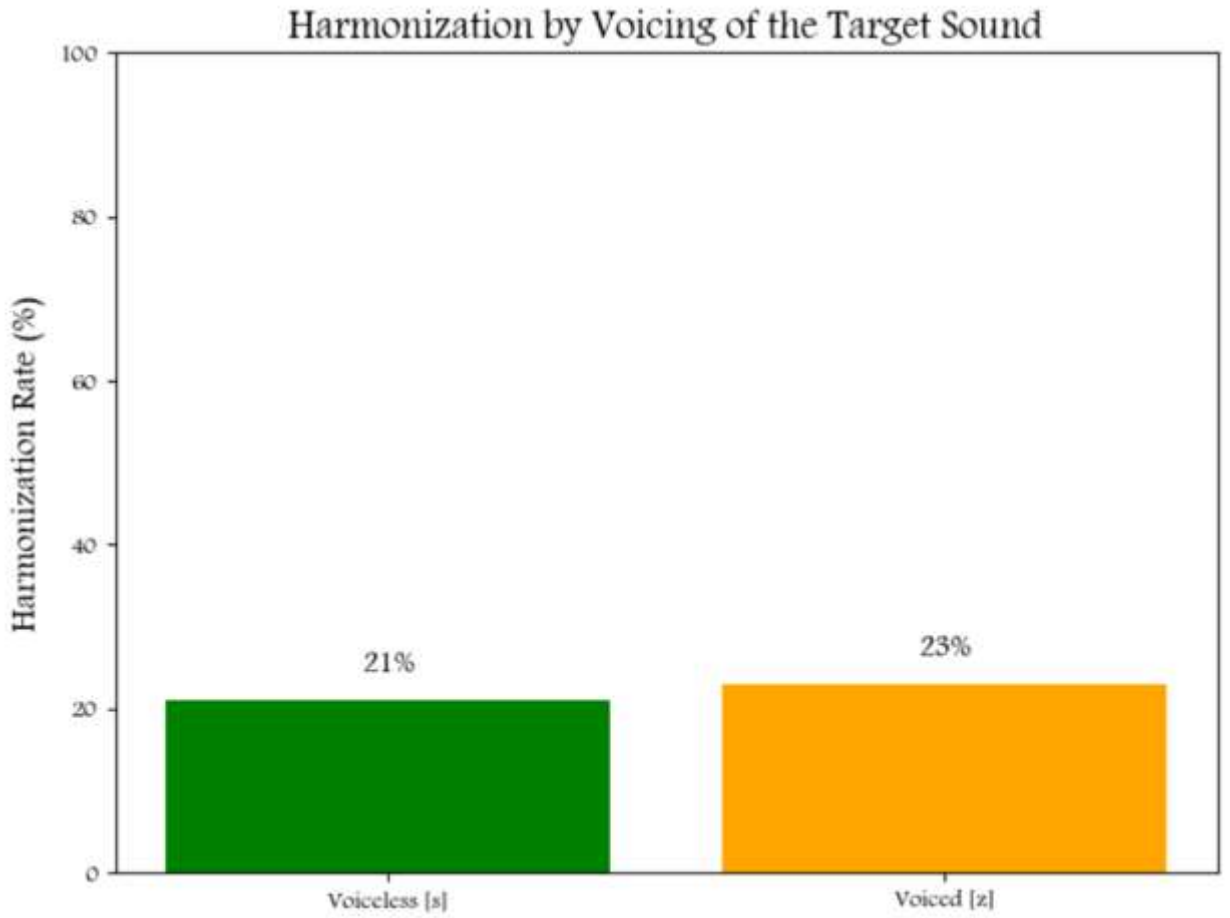
- **Participants:**
  - Total of 48 adult participants, aged between 18 and 60 years.
  - ***Criteria:*** Native MA speakers with proficiency in French and/or English.
- **Stimuli:** total of 16 words selected, divided equally between those with [z] and [s], simple and complex forms, and with varying numbers of intervening segments.
  - Voiced [z]: 'zaʒa' (one glass), 'zwaʒ' (marriage), 'mzəwwʒin' (married)….
  - Voiceless [s]: 'sfənʒa' (one doughnut), 'sərʒəm' (window), 'sfərʒla' (one quince)…..
- Participants provided with 40 sentences in both English and French: 16 with target words and 24 fillers.
- Participants asked to write their MA translations for each sentence.
  - **English:** "I like doughnuts." **French:** "J'aime les beignets."
  - **English:** "This house has only one window." **French:** "Cette maison n'a qu'une seule fenêtre."

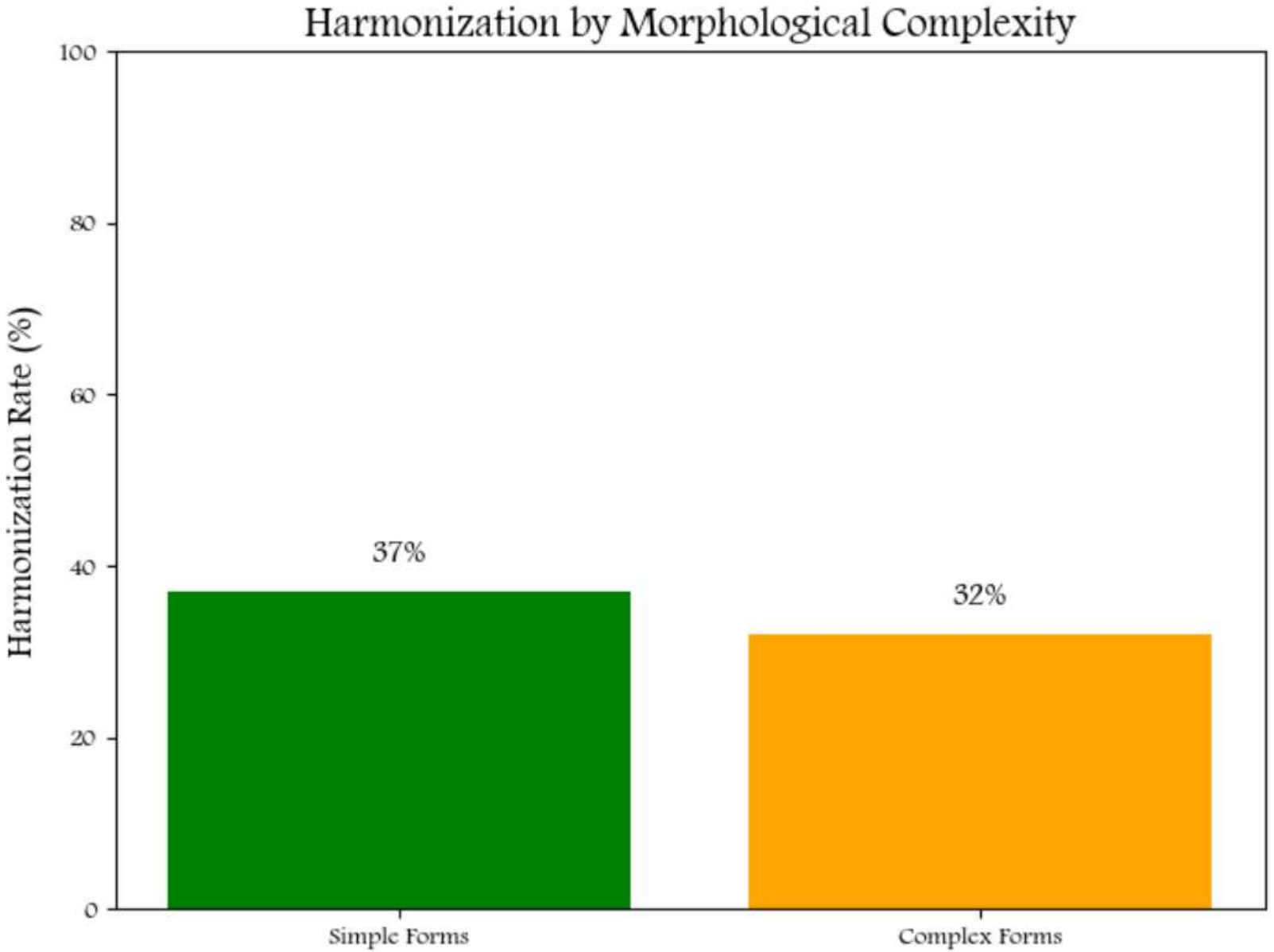
Results

- Most words follow a consistent trend with respect to the three factors
- Two [s] words had a very high harmonization rate: those that are derived from a harmonized MSA form

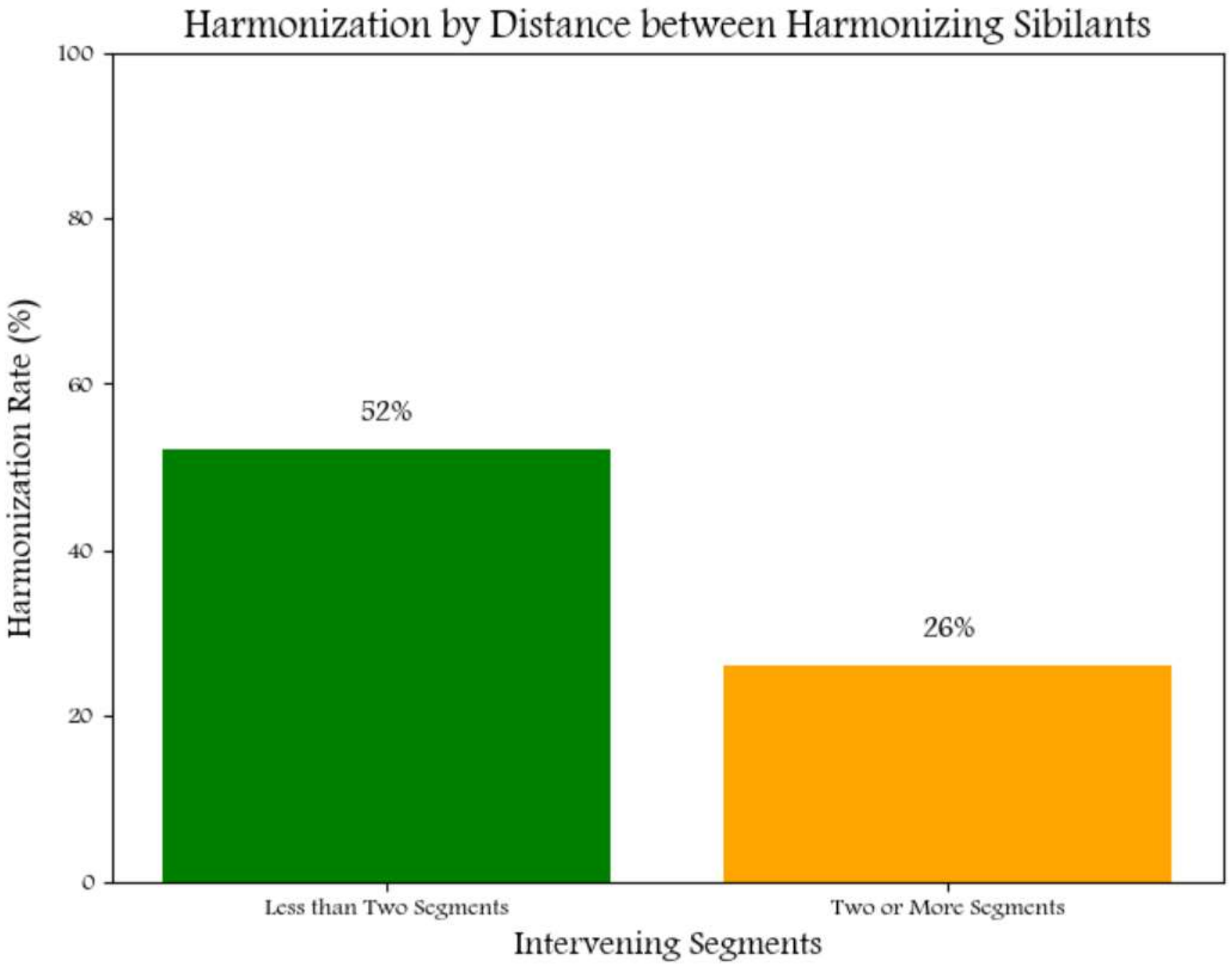
MA form	MSA form	harmonization rate
zwaʒ	zawaaʒ	14.75%
zəlliʒa	zaliʒa	16.27%
sfənʒa	ʔisfanʒ	17.82%
sfərʒla	safarʒal	15.12%
sətranʒ	ʃataranʒ	81.82%

- When excluding such forms, we find that there is no difference in harmonization rates based on voicing





NOT Statistically Significant (p=0.0719)



Schwa is not counted

Analysis: Agreement-by-Correspondence (Rose & Walker 2000, 2004)

- Central to enforcing long-distance consonant assimilation.
- Divides the task into establishing a correspondence and ensuring feature agreement.

  - Set up a correspondence between similar output segments.
    - **CORR-[place]CC:**

      Given an output string S, and consonants C_i, Cj in S, where C_i precedes C_j and they differ at most in the feature [place], then a correspondence relation must be present between Ci and Cj.

  - Require feature agreement (IDENT[F]-CC) among correspondents.
    - **IDENT[place]-CC:**

      Let C_i be a consonant in the output and C_j be any correspondent of C_i in the output.
      If C_i is [αplace], then C_j is [αplace].

Analysis: Distance in ABC

- **Distance effects (Hansson 2010):**
  - Consonant pairs closer in the string demand stronger correspondence.
  - I use this hierarchy:
    - **CORR-[place]$_{C\text{-}x\text{-}C}$ >> CORR-[place]$_{C\text{-}\infty\text{-}C}$**

    - **CORR-[place]$_{C\text{-}x\text{-}C}$:**

      Given an output string S, and consonants C_i and C_j in S, where C_i precedes C_j by only one segment and they differ at most in the feature [place], then a correspondence relation must be present between C_i and C_j.
    - **CORR-[place]$_{C\text{-}\infty\text{-}C}$:**

      Given an output string S, and consonants C_i and C_j in S, where C_i precedes C_j by any number of segment and they differ at most in the feature [place], then a correspondence relation must be present between C_i and C_j.

Analysis: Sibilant Harmony and Distance

/zaʒa/	CORR-[place]$_{C\text{-}X\text{-}C}$	IDENT[place]-CC	IDENTIO(place)	CORR-[place]$_{C\text{-}\infty\text{-}C}$
$z_i a ʒ_i a$		*!		
$z_i a ʒ_j a$	*!			*
☞ $ʒ_i a ʒ_i a$			*	

/zwaʒ/	CORR-[place]$_{C\text{-}X\text{-}C}$	IDENT[place]-CC	IDENTIO(place)	CORR-[place]$_{C\text{-}\infty\text{-}C}$
$z_i w a ʒ_i$		*!		
☞ $z_i w a ʒ_j$				*
$ʒ_i w a ʒ_i$			*!	

Experimental results show variation

Input	Variants	% of Harmonization
/zaʒa/	zaʒa	63%
	ʒaʒa	37%
/zwaʒ/	zwaʒ	86%
	ʒwaʒ	14%

Analysis: Accounting for Variation

- **Classical OT with Strict Rankings:**
  - Predicts absolute outcomes; no partial assimilation.
  - Fails to account for the variation in harmonization within the same form.

- **Maximum Entropy Grammar (Goldwater & Johnson, 2003):**
  - Underlying representations map to a probability distribution over possible surface representations.
  - Uses Harmonic Grammar with weights instead of strict rankings
  - Subtle differences in constraint weights enable variable outcomes.

Analysis: Accounting for Variation

- Maximum Entropy grammars allow phonologists to analyze variable processes.

***Categorical** Deletion Process*

/bat/ Weights >	NoCoda 50	Max 1	H	p(SR|UR)
bat	-1		-50	~0
☞ ba		-1	-1	~1

***Variable** Deletion Process*

/bat/ Weights >	NoCoda 3	Max 2	H	p(SR|UR)
☞ bat	-1		-3	.27
☞ ba		-1	-2	.73

- ***H**: the sum of the products of constraint weights and their satisfaction
- **p(SR|UR)**: the exponential of harmony, normalized across all possible outputs

Analysis: Accounting for Variation

Harmonic Grammar in R (Staubs, 2011) was used the algorithm used to find the weights

/zwaʒ/	**p(exp)**	**CORR-[place]$_{C\text{-}X\text{-}C}$** **1**	**IDENT[place]-CC** **13.5**	**IDENTIO[place]** **1.7**	**CORR-[place]$_{C\text{-}\infty\text{-}C}$** **0.1**	**H**	**p(SR|UR)**
$z_i wa ʒ_i$	0		-1			-13.5	0
☞ $z_i wa ʒ_j$	.83				-1	-0.1	~.83
☞ $ʒ_i wa ʒ_i$	.17			-1		-1.7	~.17

p(exp): the probability observed in the experimental results.

Analysis: Accounting for Variation

- This fails to account for the cases exceptional cases

/stranʒ/	p(exp)	CORR-[place]$_{C\text{-}x\text{-}C}$ 1	IDENT[place]-CC 13.5	IDENTIO[place] 1.7	CORR-[place]$_{C\text{-}\infty\text{-}C}$ 0.1	H	p(SR|UR)
s_iətran$ʒ_i$	0		-1			-13.5	0
☹ s_iətran$ʒ_j$	.19				-1	-0.1	~.83
☹ $ʃ_i$ətran$ʒ_i$	.81			-1		-1.7	~.17

Analysis: Accounting for Exceptionality

- **Lexically indexed constraints (Pater, 2000, 2009):**
  - Explain phonological exceptionality, where certain lexical items behave differently from the general phonological rules of a language.

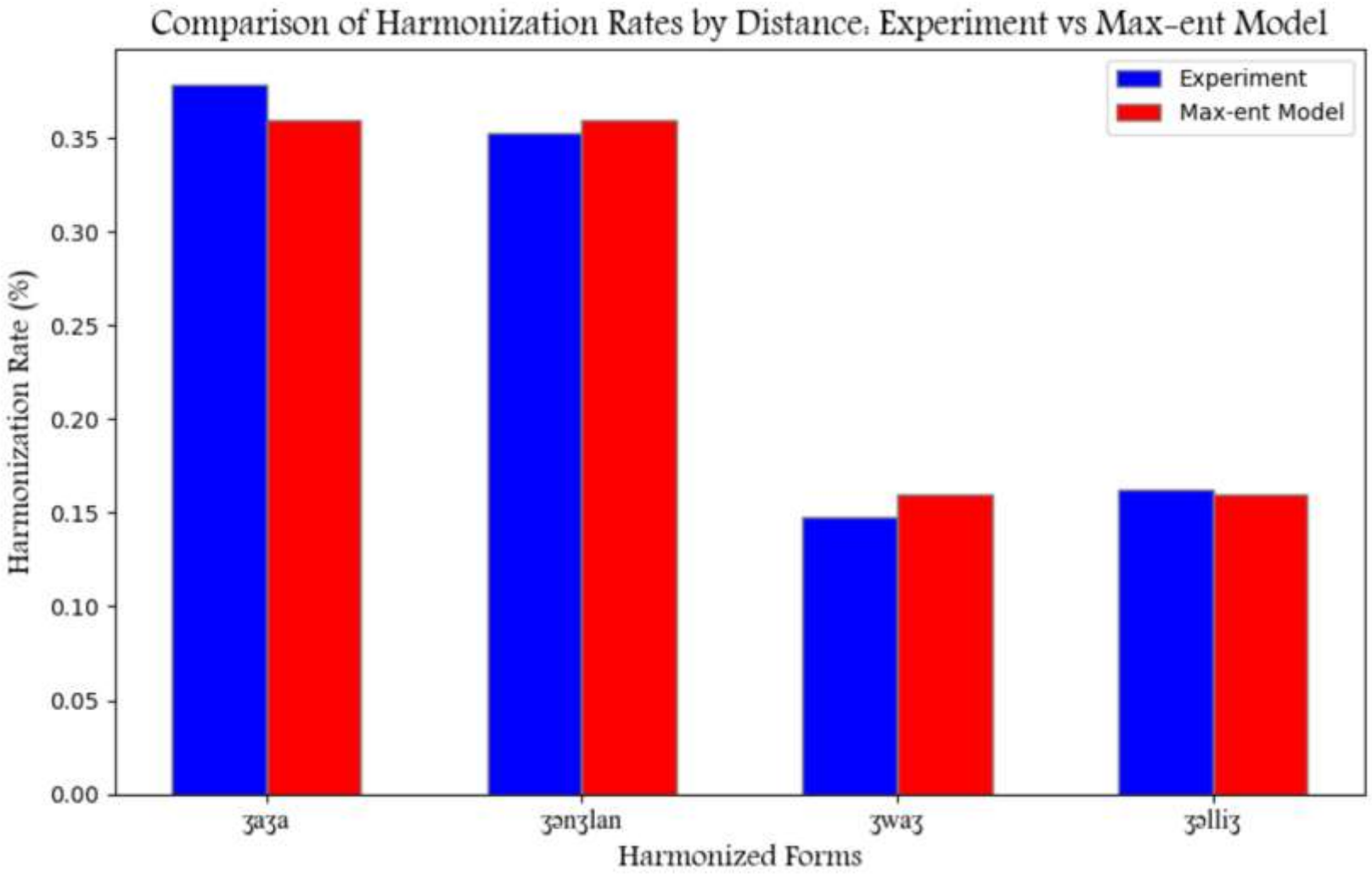
    - *Default behavior:* general constraints
    - *Exceptionality behavior:* lexically-indexed constraints

Analysis: Accounting for Exceptionality

- **CORR-[place]$_{C\text{-}\infty\text{-}C\text{-}stranʒ}$:** Given and output string S derived from the input *stranʒ*, and consonants C_i and C_j in S, where C_i precedes C_j by any number of segment and they differ at most in the feature [place], then a correspondence relation must be present between C_i and C_j.

/stranʒ/	**p(exp)**	**CORR-[place]$_{C\text{-}x\text{-}C}$** **1**	**IDENT[place]-CC** **13.5**	**IDENTIO[place]** **1.7**	**CORR-[place]$_{C\text{-}\infty\text{-}C}$** **0.1**	**CORR-[place]$_{C\text{-}\infty\text{-}C\text{-}stranʒ}$** **3**	**H**	**p(SR|UR)**
s_iətran$ʒ_i$	0		-1				-13.5	0
☞ s_iətran$ʒ_j$	.19				-1	-1	-3.1	~.19
☞ $ʃ_i$ətran$ʒ_i$	.81			-1			-1.7	~.81

Comparison: Model vs Experiment



Main Findings

- The **distance** between the two harmonizing sounds is the main factor determining the probability of harmonization taking place.

- The high rates of harmonization for items is only seen in a couple of items that are **derived from harmonized MSA forms** and therefore should be treated as exceptional.

- **A probabilistic model** is needed to account for the harmony patterns of MA.

Reflections and Future Directions:

- **Limited Word Selection:**
  - The experiment's limited word set may affect the generalizability of results.
- **Preceding Word Effect:**
  - Potential avoidance of dispreferred consonantal sequences (e.g., ʒ..z..ʒ).
- **Social Factor:**
  - Regional variation, age, education level, etc.

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QUESTIONS & ANSWERS

University of Massachusetts Amherst