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Greece 2.0
NATIONAL RECOVERY AND RESILIENCE PLAN

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Beyond unpredictability: A GHG analysis of Greek noun stress

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This presentation is part of ongoing research within the project

***GRADIENCE**: Modeling the limits of grammar: Integrating lexical frequency in a Gradient Harmonic model of lexical stress; Evidence from young and adult Greek speakers' grammars*

The research project with the title "Gradience" is being implemented within the framework H.F.R.I call "Basic research Financing (Horizontal support of all Sciences)" under the National Recovery and Resilience Plan "Greece 2.0" funded by the European Union – NextGenerationEU (Implementation body: H.F.R.I. || H.F.R.I. Number: 15053; A.U.Th. Special Account for Research Funds Project Number: 76809)

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Introduction

- Standard view: Greek stress assignment is **not predictable**
- The only restriction: **trisyllabic window**

(1)

a.	**U**:	a.na.ˈ**nas**	‘pineapple’
b.	**PU**:	ka.ˈ**no**.nas	‘rule’
c.	**APU**:	ˈ**pi**.na.kas	‘writing board’

(see, among others, Malikouti-Drachman & Drachman 1989; Ralli & Touratzidis 1991; Drachman & Malikouti-Drachman 1999; Revithiadou 1999, 2007; Apoussidou 2003; Burzio & Tantalou 2007; van Oostendorp 2012)

Introduction

- However:
  - stress assignment in **verbs** is rather systematic (Spyropoulos & Revithiadou 2009; van Oostendorp 2012; Spyropoulos et al. 2015), e.g.:

(2)

a.	NON-PASS, NON-PAST:	PU/U	e.g.	a.ˈ**la**.zo ‘I change’
b.	PASS, IPFV, NON-PAST:	APU/PU		a.ˈ**la**.zo.me
c.	PASS, PFV, NON-PAST:	U		a.la.ˈ**xθo**
d.	PFV, PAST:	APU		ˈ**a**.la.ksa

  - derivational affixes have **dominant stress properties** (Revithiadou 1999), e.g. **-ˈdzis** (NMZ ‘profession’), **-ˈaki** (NMZ ‘DIMINUTIVE’), **-ˈi** (ADJV ‘color’)

Introduction

- **Main question**: What about the distribution of stress patterns in non-derived nouns?
- **Experimental evidence** (Apostolouda 2012, 2018; Revithiadou & Lengeris 2016): Correlation between specific stress patterns and specific inflectional suffixes
- **Aim of the paper**: To offer a theoretical account of the experimental findings
- **Theoretical framework**: *Gradient Symbolic Representations / Gradient Harmonic Grammar* (Smolensky & Goldrick 2016)

Roadmap

1. Greek nominal system
2. Experimental evidence
3. Analysis
4. Project GRADIENCE: Future steps
5. Conclusions

1. Greek nominal system

- Mostly **fusional**
- Grammatical features:
  - **gender** (masculine/feminine/neuter)
  - **number** (singular/plural)
  - **case** (nominative/accusative/genitive/vocative)
- Various inflectional paradigms – **inflection classes** (Ralli 2000; Alexiadou & Müller 2008; Anastassiadis-Symeonidis 2012; cf. Markopoulos 2018)
- In most cases, inflection class is indicated by a **theme vowel/element** (see Thomadaki 1994; Revithiadou & Spyropoulos 2016; Markopoulos 2018)

1. Greek nominal system

- Feminine – neuter nouns

(3) a. kaˈrekl-**a**-Ø
chair-**TH**-SG.NOM/ACC
‘chair (FEM)’

b. ˈprosop-**o**-Ø
face-**TH**-SG.NOM/ACC
‘face (NEUT)’

- Masculine nouns

(4) a. ˈanθrop-**o**-s
human-**TH**-SG.NOM
‘human (MASC)’

1. Greek nominal system

- Revithiadou & Spyropoulos (2016):
  - Root exponents are accentless

    evidence: compounds, e.g. *trapez-o-m**á**ndil-o* 'table cloth'; cf. the relevant categorized nouns *trap**é**z-i* 'table' and *mand**í**l-i* 'cloth'
  - Exponents of F-morphemes (ThV/Es, DerSs, InflSs) are accent-bearing

⇒ all root exponents are assigned metrical representations once combined with exponents of grammatical morphemes

1. Greek nominal system

- GRADIENCE: Focus on the distribution of stress patterns within/across 7 inflection classes
  - *-os* (MASC) e.g. ˈanθropos ‘human’
  - *-is* (MASC) plaˈnitis ‘planet’
  - *-a* (FEM) kaˈrekla ‘chair’
  - *-i (-η)* (FEM) ˈzaxari ‘sugar’
  - *-o* (NEUT) ˈprosopo ‘face’
  - *-i (-ι)* (NEUT) traˈpezi ‘table’
  - *-ma* (NEUT) ˈmaθima ‘lesson’

1. Greek nominal system

- Today's talk: Focus on 4 inflection classes
  - -*os* (MASC) e.g. ˈanθropos 'human'
  - -*is* (MASC) plaˈnitis 'planet'
  - -*a* (FEM) kaˈrekla 'chair'
  - -*i* (-*η*) (FEM) ˈzaxari 'sugar'
  - -*o* (NEUT) ˈprosopo 'face'
  - -*i* (-*ι*) (NEUT) traˈpezi 'table'
  - -*ma* (NEUT) ˈmaθima 'lesson'

2. Experimental evidence

- Apostolouda (2018)
  - 2 tasks: **production/perception**
  - 2 age groups: **children** (7-8 y.o.) / **adults** (18-23 y.o.)
  - **pseudo-nouns** (pseudo-stems + actual suffixes), e.g.:

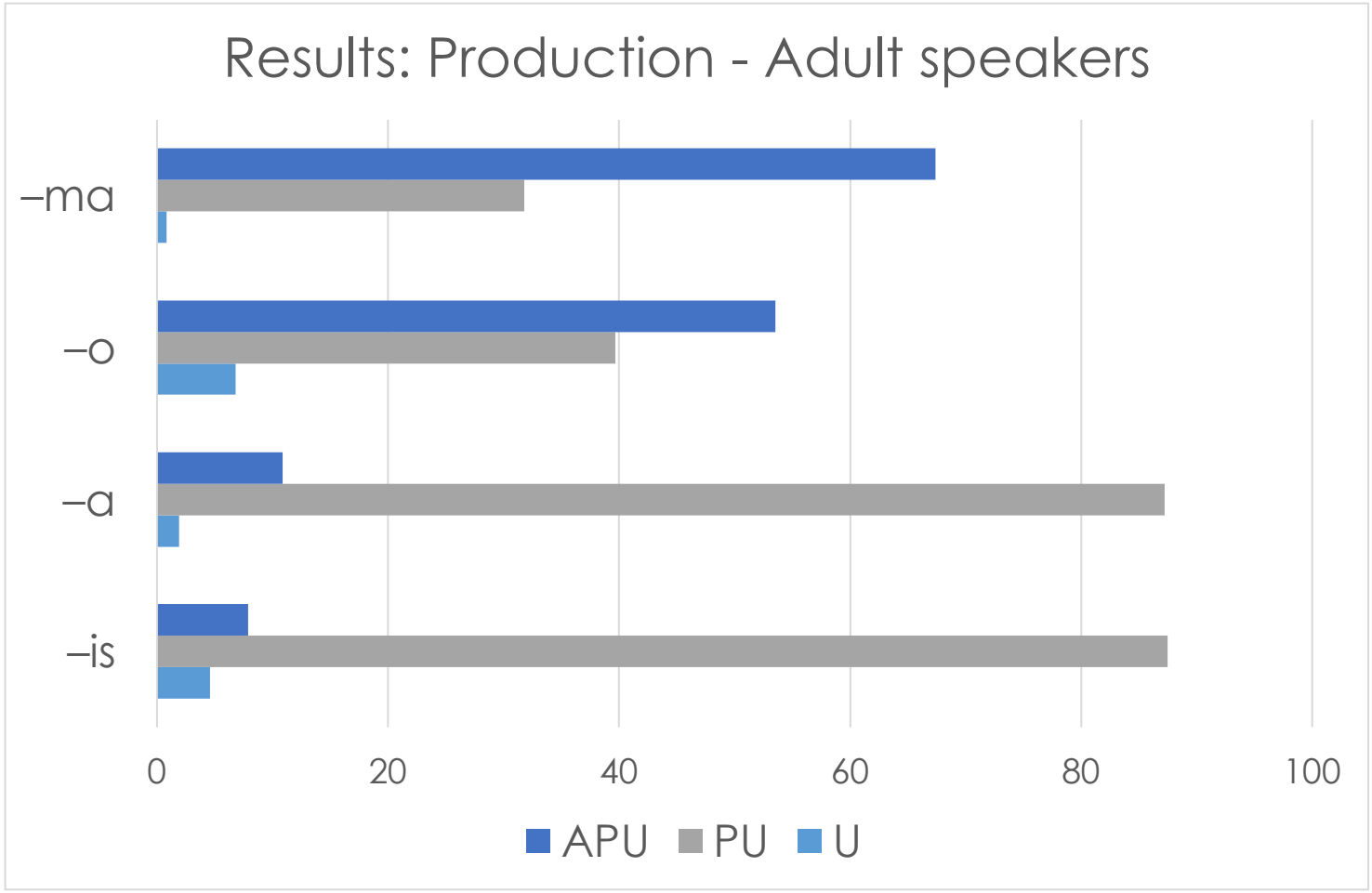
(5) *Production task*

ΛΕΡΙΧΟ (/lerixo/)

Possible realizations

i. 'lerixo
ii. le'rixo
iii. leri'xo

2. Experimental evidence



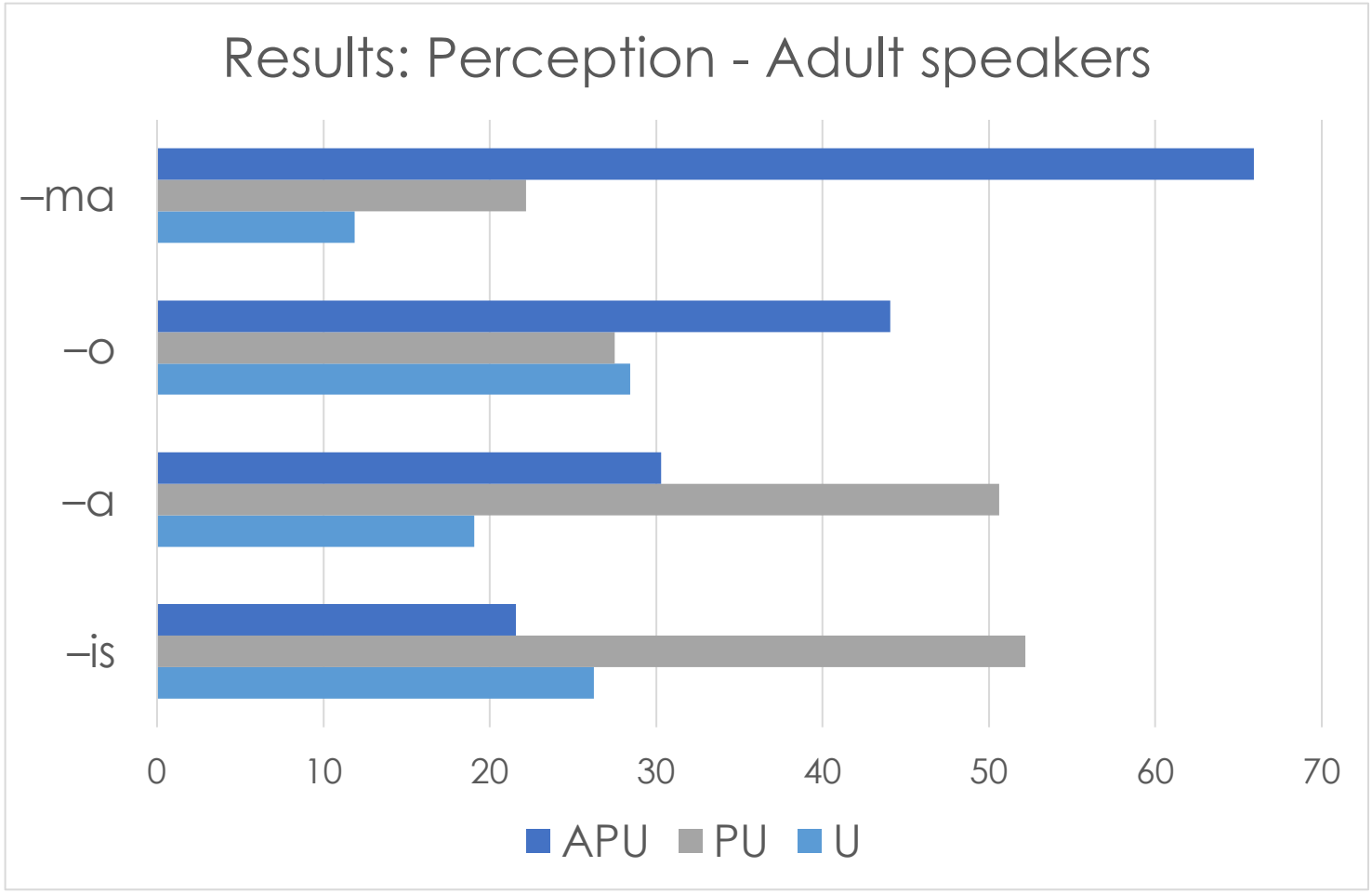
APU > PU > U

APU > PU > U

PU > APU > U

PU > APU, U

2. Experimental evidence



APU > PU > U

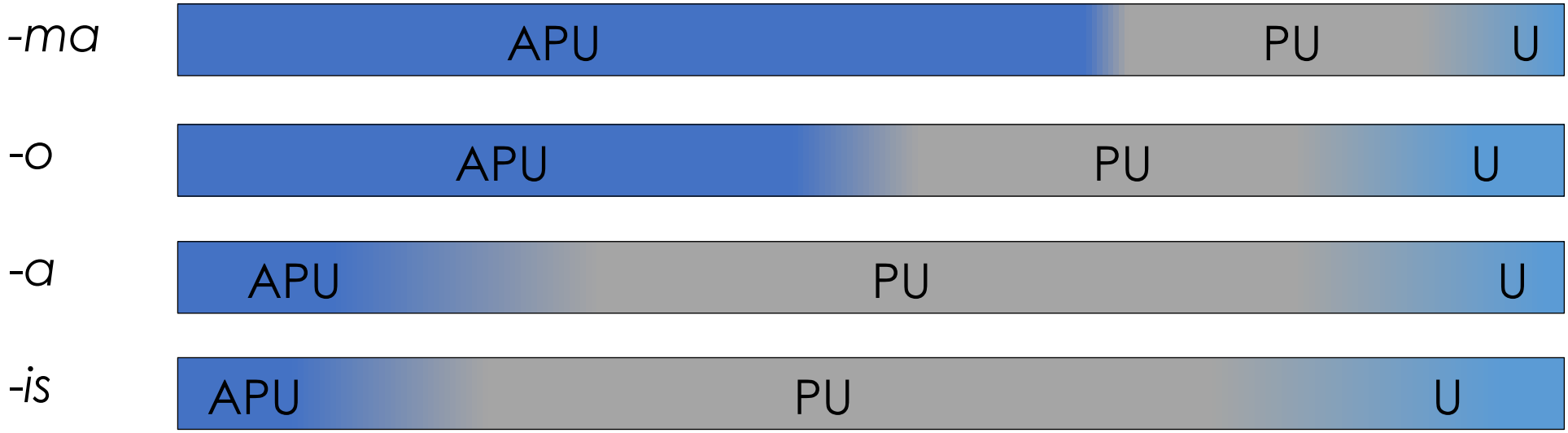
APU > U, PU

PU > APU > U

PU > U, APU

2. Experimental evidence

- Adult speakers: Overall results



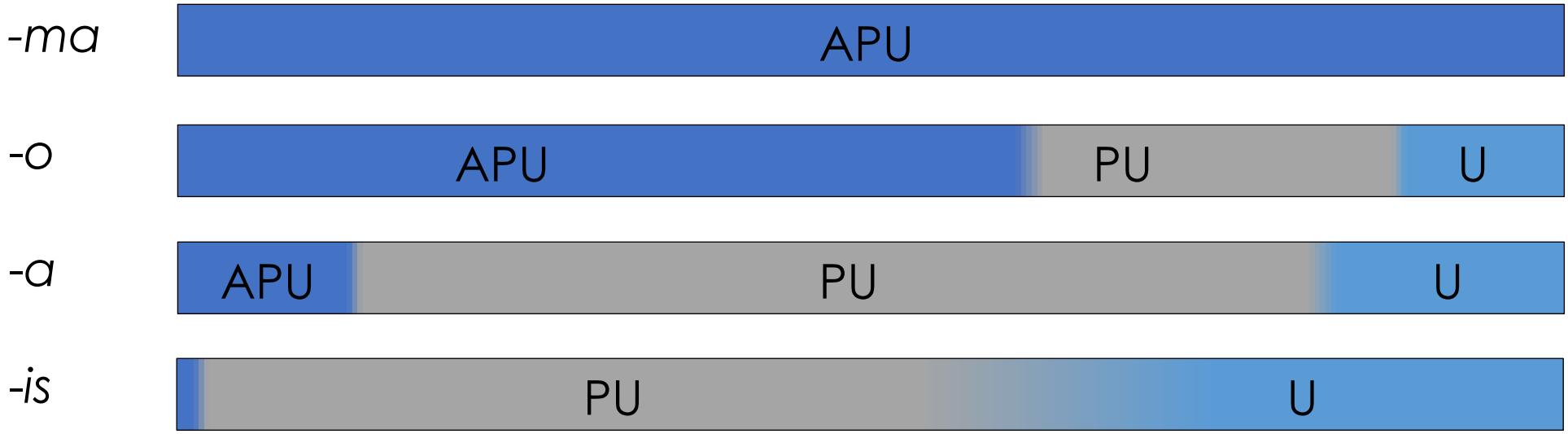
2. Experimental evidence

- Adult speakers: Overall results
  - preference for **APU** or **PU** stress is determined by the particular suffix at hand (***-ma***, ***-o*** → **APU**; ***-a***, ***-is*** → **PU**)
  - **U** stress seems to be the **most marked option**

- Further evidence: Revithiadou & Lengeris (2016) – perception task
  - preference for **APU** stress is stronger in pseudo-nouns with ***-o*** compared to pseudo-nouns with ***-a***
  - **U** has been found again to be the **most marked option**

2. Experimental evidence

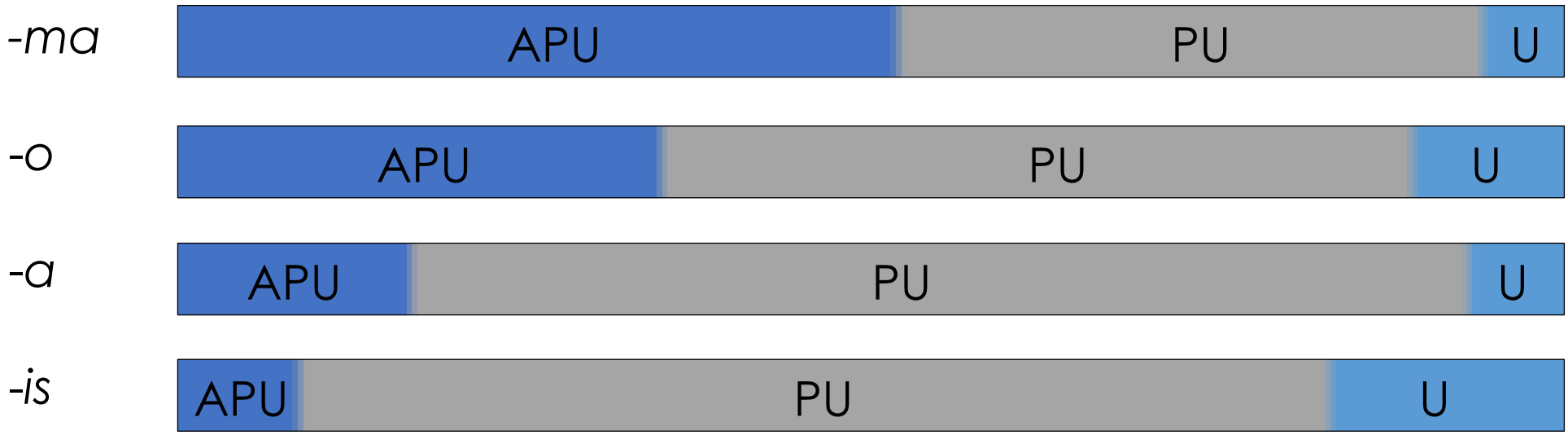
- Interestingly, the experimental findings seem to mirror the distribution of stress patterns in **written corpora***:



**A-Clean*, based on Protopapas et al. (2012), and the *Reverse Dictionary* (Anastassiadis–Symeonidis 2002); see Apostolouda 2018

2. Experimental evidence

- On the other hand, **children** show a general preference for **PU** stress (Apostolouda 2018):



2. Experimental evidence

- Main conclusions
  - **PU** → **default** stress position for the phonological grammar (as reflected in children's responses)
  - **APU** → the overrepresentation of APU stress in **certain inflection classes** affects adult speakers' grammars
  - **U** → **least preferred** stress position overall (except for ***-is***)
  - **Desideratum** → a formal analysis that models the **probability** for each stress position to emerge

3. Analysis

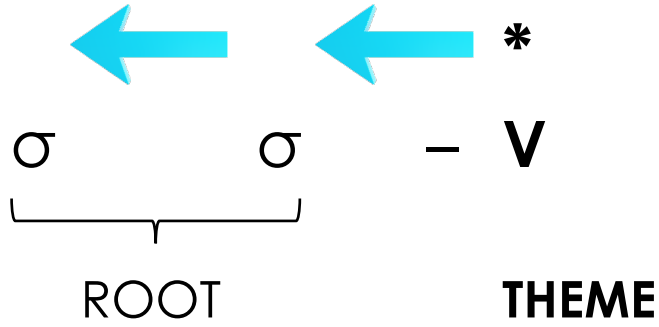
- In a nutshell:
  - Greek theme elements (ThE) are **inherently specified** to require **APU stress**
  - This inherent stress property is **stronger** in some ThEs and **weaker** in others
  - High strength → it can **dominate** over default PU stress
  - Medium strength → APU stress comes **second**
  - Low strength → APU is the **least preferred** option

3. Analysis

3.1. The stress property of ThEs

- ←←*V_{Th}

(6)

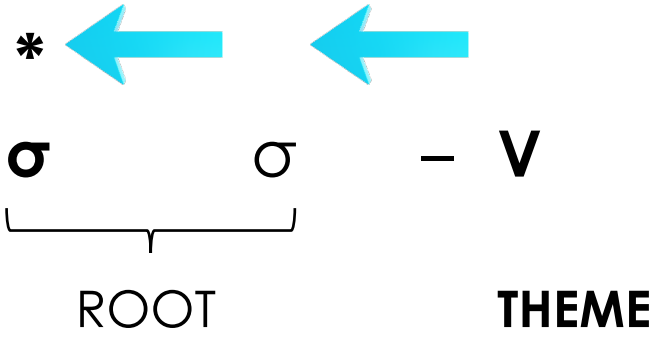


3. Analysis

3.1. The stress property of ThEs

- ←←*V_{Th}

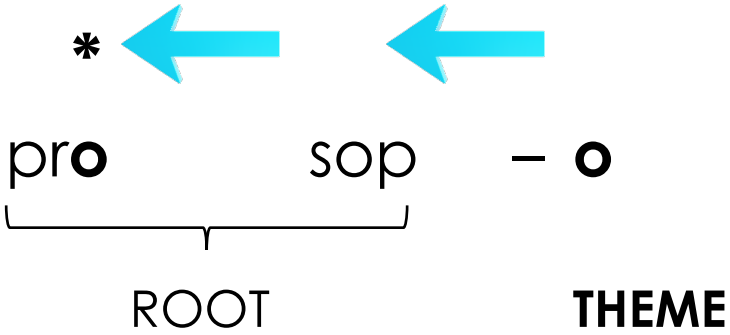
(6)



3. Analysis

- Example: *'prosop-o* 'face'

(7)



3. Analysis

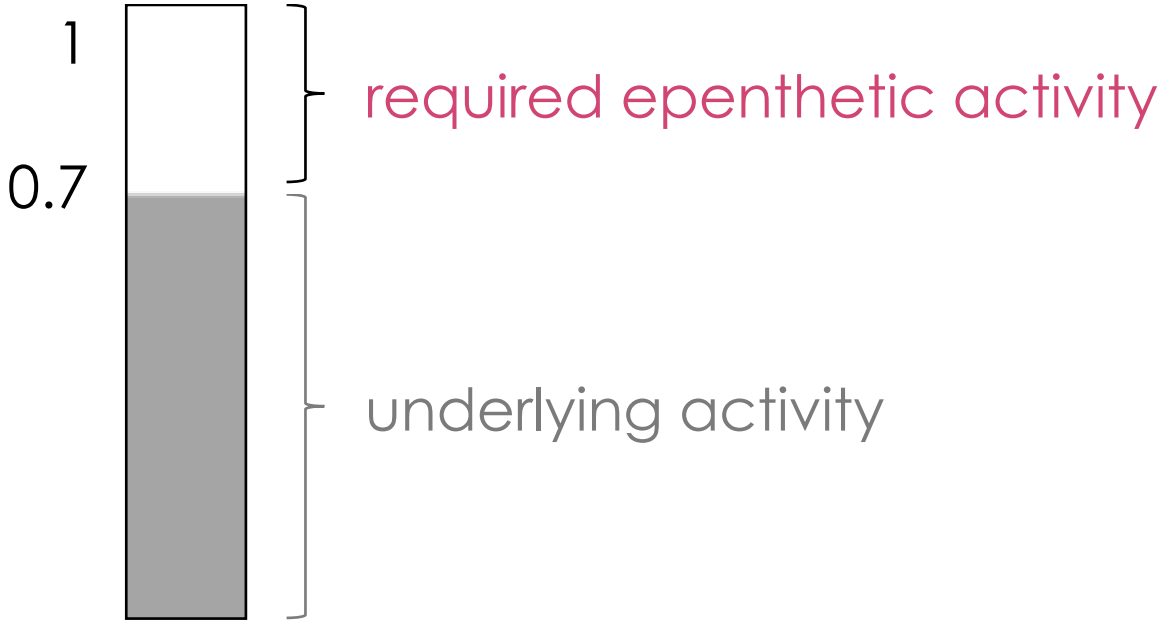
3.2. Gradient Symbolic Representations

- The APU stress property is **not equally strong** in all ThEs
- Formalization of strength differences → ***Gradient Symbolic Representations*** (Smolensky & Goldrick 2016; see also Rosen 2016; Faust & Smolensky 2017; Revithiadou et al. 2019; Zimmermann 2018, 2021, among others)
  - phonological elements bear an inherent ***Activity Level* (AL)**
  - **$0 \leq AL \leq 1$**
  - Required AL value for realization: **1**

3. Analysis

- Weak (low-AL) elements require **epenthetic activity**
- E.g. /*$^{0.7}$/

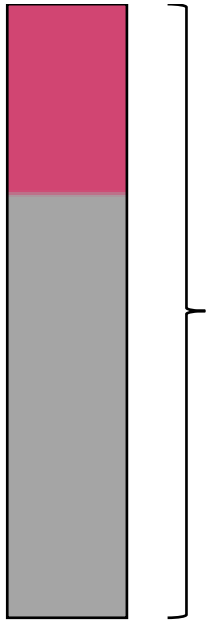
(8)



3. Analysis

- /*0.7/ → [*0.7**+0.3**]

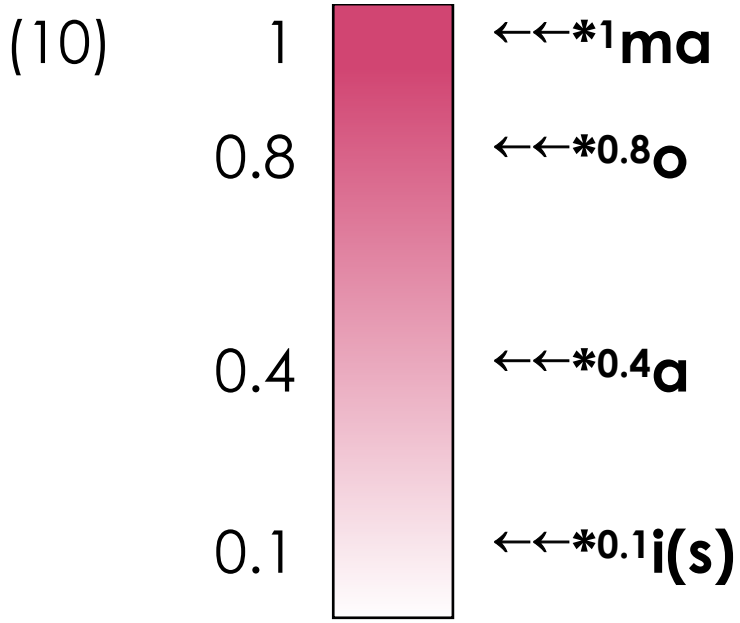
(9)



underlying + epenthetic activity

3. Analysis

- APU stress properties of ThEs:



3. Analysis

3.3. Gradient Harmonic Grammar

- Activity epenthesis → violation of DEP
- Non-realization of underlying activity → violation of MAX

(11)	/*0.8/	DEP *weight: 2*	MAX *weight: 3*	Harmony
	[*1]	– (0.2 × 2) = **–0.4**		**–0.4**
	[*0]		– (0.8 × 3) = **–2.4**	**–2.4**

3. Analysis

- ←←*¹**ma**
  - no requirement for epenthetic activity
  - **APU stress** is **by far** the **most probable** choice

(12)	/leri-←←*¹**ma**/	DEP *2*	MAX *3*	TROCHEE *2*	ALIGN-R *3*	H
1	ˈ**le**rima ☺				–3	**–3**
2	leˈ**ri**ma 😕	–2	–3			**–5**
3	leriˈ**ma** ☹	–2	–3	–2		**–7**

3. Analysis

- ←←*0.8**o**
  - little amount of epenthetic activity
  - **APU stress** is still **first**, but with a **smaller** difference

(13)	/lerif-←←*0.8**o**/	DEP 2	MAX 3	TROCHEE 2	ALIGN-R 3	H
1	ˈ**le**rifo ☺	–0.4			–3	**–3.4**
2	leˈ**ri**fo 😕	–2	–2.4			**–4.4**
3	leriˈ**fo** ☹	–2	–2.4	–2		**–6.4**

3. Analysis

- ←←*0.4**a**
  - large amount of epenthetic activity
  - default **PU stress** is the **most probable** outcome (**APU** follows)

(14)	/lerif-←←*0.4**a**/	DEP *2*	MAX *3*	TROCHEE *2*	ALIGN-R *3*	H
2	ˈlerifa ☹	–1.2			–3	**–4.2**
1	leˈrifa ☺	–2	–1.2			**–3.2**
3	leriˈfa ☹	–2	–1.2	–2		**–5.2**

3. Analysis

- ←←*0.1**i(s)**
  - **APU stress** is too "costly" and becomes the **least probable** choice

(15)	/lerif-←←*0.1**is**/	DEP 2	MAX 3	TROCHEE 2	ALIGN-R 3	H
3	'lerifis ☹	–1.8			–3	**–4.8**
1	le'rifis ☺	–2	–0.3			**–2.3**
2	leri'fis 😟	–2	–0.3	–2		**–4.3**

4. Project *GRADIENCE* – Future steps

4.1. Experimental investigation

- Production task
- Three groups
  - 2nd–3rd Grade students (primary education)
  - 4th–6th Grade students (primary education)
  - Adults (18–40 years old)
- Replication of previous findings?

4. Project *GRADIENCE* – Future steps

- Example

Possible realizations

i. 'fusemo
ii. fu'semo
iii. fuse'mo

4. Project *GRADIENCE* – Future steps

4.2. Computational processing

- **Fine-tuning** of the **AL and weight values** based on the experimental findings
- Construction of a comprehensive **probabilistic model** for the stress of Greek nouns

5. Conclusions

- Stress assignment in Greek nouns is **not that unpredictable** after all!
- Early grammars (children) → **default PU stress**
- Adult speakers' grammars → **influenced by the lexicon**
- **APU distribution** per inflection class → encoded in the underlying representation of ThEs as a stress property with varying **AL values**
  - High AL → **APU** > **PU** > **U**
  - Medium AL → **PU** > **APU** > **U**
  - Low AL → **PU** > **U** > **APU**

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Thank you for your attention!

(ongoing project → feedback is welcome ☺)

Appendix A

Results (Children – Production task)

Suffix	APU	PU	U	Total
-ma	191 51,34%	158 42,47%	23 6,18%	372
-o	127 34,32%	199 53,78%	44 11,89%	370
-a	62 16,71%	282 76,01%	27 7,27%	371
-is	32 8,57%	277 74,26%	64 17,15%	373

(Apostolouda 2018: 103)

Results (Adults – Production task)

Suffix	APU	PU	U	Total
-ma	248 67,39%	117 31,79%	3 0,81%	368
-o	197 53,53%	146 39,67%	25 6,79%	368
-a	40 10,86%	321 87,22%	7 1,90%	368
-is	29 7,88%	322 87,50%	17 4,61%	368

(Apostolouda 2018: 127)

Results (Adults – Perception task)

Suffix	APU	PU	U	Total
-ma	211 65,93%	71 22,18%	38 11,87%	320
-o	141 44,06%	88 27,50%	91 28,43%	320
-a	97 30,31%	162 50,62%	61 19,06%	320
-is	69 21,56%	167 52,18%	84 26,25%	320

(Apostolouda 2018: 144–145)

Results (Written corpora)

Suffix	Corpus	APU	PU	U	Total
-ma	RD	247 (100%)	0	0	247
	AC	170 (100%)	0	0	183
-o	RD	240 (60,15%)	104 (26,05%)	55 (13,78%)	399
	AC	133 (60,18)	59 (26,69%)	29 (13,12%)	221
-a	RD	71 (12,76%)	461 (82,91%)	24 (4,31%)	556
	AC	56 (12,30%)	315 (69,23%)	84 (18,46%)	455
-is	RD	4 (1,60%)	180 (72,28%)	65 (26,10%)	253
	AC	1 (0,69%)	74 (51,38%)	69 (47,91%)	144

(Apostolouda 2018: 173, 175, 177)

Appendix B

Inherent stress on the APU – Possible representations:

- Underlying foot-tail (Revithiadou 1999):

  .)
  prosop-o

- Right-boundary projection (Idsardi 1992; Halle & Idsardi 1995):

)
  prosop-o

- Floating *π*-accent (Spahr 2016; Revithiadou 2023) exponent of the ThV with a prefixal linearization specification:

  *

  prosop-o

Appendix C

- Example: predictions of a Random Forest algorithm (trained on *OpenSubtitle Corpus*) on a set of pseudowords:

ΧΟΥΤΙΜΟΣ

APU	PU	U
0.360442	0.339076	0.300481

ΘΟΥΠΑΣΗΣ

APU	PU	U
0.293012	0.370993	0.335995

(Software: Wolfram Mathematica)

- A supervised learning algorithm was trained using the *OpenSubtitle Corpus* (http://www.opensubtitles.org), consisting of 587,728 words.
- To teach the program to recognize word accents, we employed a machine learning algorithm known as *Random Forest*, which consisted of 300 Decision Trees.
- Our dataset was split into two parts for evaluation. The first part served as the **training set** for algorithm development, while the second part, the **test set**, was used to assess the algorithm's performance on previously unseen words. The algorithm achieved a success rate of 71% on the test set (=real words).

Appendix D

	/lerifo/	TROCHEE	IAMB	NONFIN	ALIGN-R	**H**
		4 + 1$_{N4}$	*2 + 0*$_{N3}$	*2 + 4*$_{N1}$	*3 + 2*$_{N1}$	
a.	ˈlerifo	0	–1 × (2 + 0)= **–2**	0	–1 × (3 + 2) =**–5**	**–7**
b.	leˈrifo	0	–1 × (2 + 0)= **–2**	–1 × (2 + 4)= **–6**	0	**–8**
c.	leriˈfo	–1 × (4 + 1)= **–5**	0	–1 × (2 + 4)= **–6**	0	**–11**

($N_1 > N_2, N_3, N_4$)