OCP10

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ARISTOTLE UNIVERSITY OF THESSALONIKI

In search of the default stress in Greek: Evidence from perception

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1. Introduction

1.1. Aims

#1| To explore the distribution of stress *across* and *within* morphological classes in a language with a three-way stress contrast (i.e. APU, PU & U stress) at the word level.

#2| To examine whether speakers have stress biases, and if they do, where do these derive from. E.g., is one pattern, namely the *(Phonological) Default*, more prevalent compared to all other patterns or not?

Q: HOW?

A: Based on experimental evidence

Greek speakers are expected to successfully identify stress placement on the basis of acoustic cues such as duration, amplitude (and pitch) (Arvaniti 2000).

Stress Deafness Hypothesis of Acquisition (Peperkamp & Dupoux 2002; Dupoux & Peperkamp 2002; Peperkamp 2004; Dupoux et al. 2008)

> Adult speakers of languages with stress contrasts are better trained in perceiving stress contrasts compared to speakers of purely phonological stress systems.

Q1: What will happen when these cues are equated and hence are not available?

Hypothesis #1: Speakers are expected to have a difficulty in identifying stress prominence when acoustic cues are equated.

If this scenario holds true, it might provide an ideal ground for unearthing whether speakers in such situations apply their stress biases or not.

Q2: How are these biases shaped?

Starting point 1: Irregular stress requires lexical specification (Kiparsky 1982; Inkelas 1999[/1994]; Halle 1997; Alderete 1999; Revithiadou 1999; Idsardi 1992; Halle & Idsardi 1995; van der Hulst 1999, in press, a.o.)

Speakers of such systems develop a mechanism for storing lexical stress during language acquisition. Stress contrasts of the input language are engraved in the metrical representations of words in their Mental Lexicon.

Hypothesis #2: Metrical representations are readily available and speakers rely mainly on their inherent stress encoding mechanism when making stress decisions.

- **Expectation:** Bias for 'Non-Default' stress.

Starting point 2: Lexical frequencies are engraved in phonological grammars (Zuraw 2000; Hayes & Londe 2006)

Grammars encode information on lexical frequencies yielding outputs at frequencies that match the lexical ones.

Hypothesis #3: Lexical frequencies kick in affecting speakers' stress making decisions.

- **Expectation:** Bias for whatever pattern is dictated by lexical frequency.

1.2. Setting the stage

Greek is a *lexical accent system* with three stress patterns:

(1)	a.	APU	*p**í**θikos*	'monkey-NOM.SG'	*masc*
	b.	PU	*tsob**á**nos*	'shepherd-NOM.SG'	
	c.	U	*marag**ó**s*	'carpenter-NOM.SG'	

- When looking into the grammar, most m-classes exhibit all three stress possibilities:

(2) Stress patterns * Major morphological classes

stress	**m-classes**					
APU	CVCVC-os	CVCVC-o	CVCVC-as	CVCVC-a	CVCVC-i_{fem}	CVCVC-is
PU	CVCVC-os	CVCVC-o	CVCVC-as	CVCVC-a	CVCVC-i_{fem}	
U	CVCVC-os	CVCVC-o	CVCVC-as	CVCVC-a	CVCVC-i_{fem}	

Certain patterns are assumed to be lexically-inflicted (3b-c) (Revithiadou 1999), whereas one pattern represents the *phonological default* (PDf) (3a):

(3) a. /γiton-as/ *accentless root*
b. /e**ó**n-as/ *accented root*
c. /vasilj**^**-as/ *post-accenting root* ('^' = non-local accent)

- PDf: APU (όσ)<σ> (Malikouti-Drachman & Drachman 1989; Ralli & Touratzidis 1992; Revithiadou 1999, 2007, Burzio & Tantalou 2007 a.o.)

▷ Important note: PDf is an analysis-specific construct

Russian: Default is initial (Halle 1973, 1997; Kiparsky & Halle 1977; Melvold 1990); Default is post-stem (Alderete 1999, 2001a,b)

- Cross-linguistic experimental research on the Default in lexical stress systems (see Nikolaeva 1971; Crosswhite et al. 2003; Fainleib 2008; Lavitskaya & Kabak 2011a,b, in press for Russian and Fainleib 2008 for Hebrew) yielded diverse results regarding the relation between phonological and psycholinguistic default.

2. Methodology

- Two judgment task (perception) experiments with pseudowords from the five most productive noun classes: *-os, -o, -a, -as, -i*

  ⇒ Pseudoword construction (Revithiadou, Ioannou, Chatzinikolaou & Aivazoglou 2012)

  ⇒ Pseudoword recording and manipulation

  ⇒ Experiment 1 and Experiment 2 methodology (participants, items & procedure)

2.1. Constructing the experimental items

- Perceptual stimuli: **260** pseudowords (PseudoW)
- Recorded by a male speaker of Standard Greek (in his early 30s) in a carrier sentence in post-focus position:

(4) sti **meɣáli** léna _____ miláj

lit. 'To **elderly** Lena *pseudoword* speaks.' '_____ speaks to the **elderly** Lena.'

Sww		
wSw	Sw	*all three patterns were*
wwS	wS	*represented*

→ the PsW was deaccented due to the post-focus flat contour (Baltazani & Jun 1999)

- **65** served as fillers (i.e., they retained their original stress)
- **195** were manipulated so that: (1) all syllables were stressed (Experiment 1) and (b) all syllables were unstressed (Experiment 2)

- Experiment 1
  - ⇒ The speaker uttered 2 (or 3 in the case of 3σ PseudoW) versions of each PseudoW, one with the stress on the 1st syllable and one on the 2nd syllable (stress on the 3rd syllable in the case of 3σ PseudoWs). All possible stress patterns were thus represented.

  - ⇒ The unstressed syllable of the first version was then replaced with the stressed syllable of the second version (this replacement was done twice in the case of the 3σ PseudoWs).

  - ⇒ The new PseudoWs thus contained syllables with only full (i.e., non-reduced) stressed vowels.

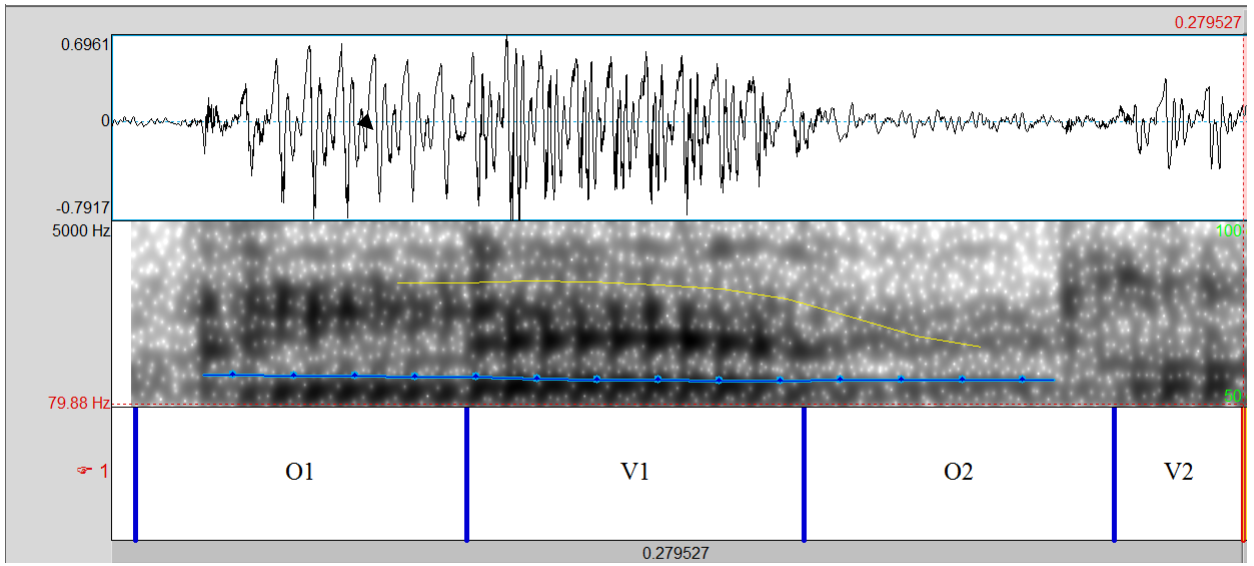
⇒ Syllables were normalized to have the same duration and intensity contour by averaging the duration and intensity of the two/three vowels and applying the average duration and intensity values to both/three vowels using *Praat* scripts (Boersma & Weenink 2011).

⇒ All syllables of the resulting PseudoWs had therefore the same:
(1) type of vowel (stressed/full in terms of quality)
(2) duration
(3) amplitude
(4) pitch

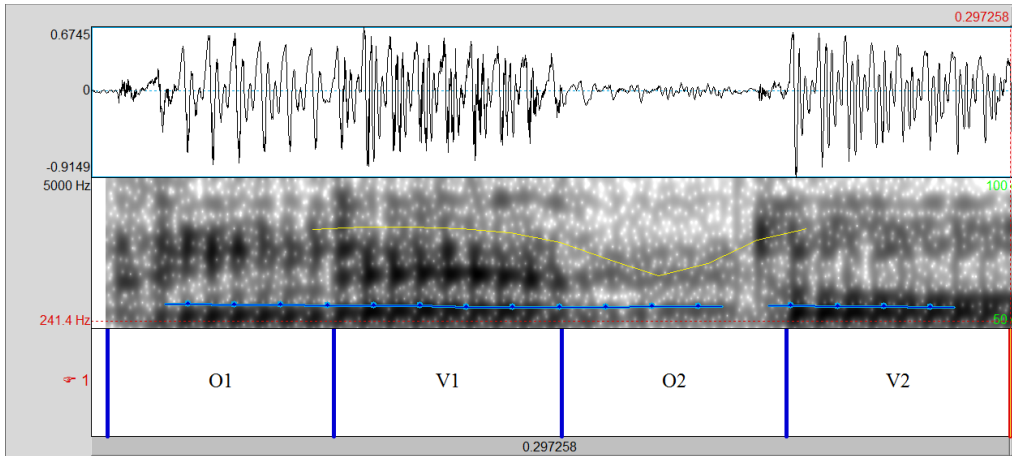
Experiment 2

⇒ The same manipulation procedure was followed but this time the new PseudoWs contained syllables with only unstressed (reduced) vowels.

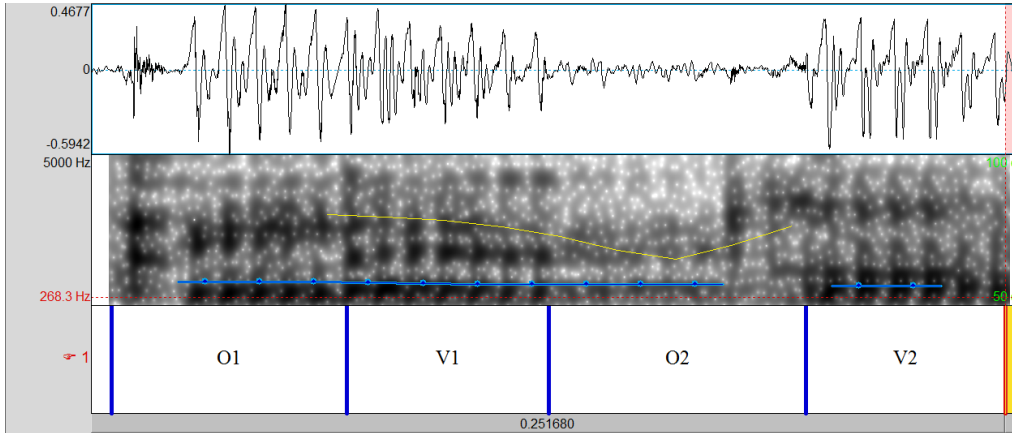
An example (PseudoW = /kleto/)



Original PsW with stress on 1st syllable



/kleto/ both syllables stressed



/kleto/ both syllables unstressed

2.2. Experiment 1 & 2: Methodology

- **Participants:** 26 participants (8 male, 18 female; Mean age: 21 years old)

- **Items:** 195 manipulated PseudoWs (65 PseudoWs as fillers)

- **Factors the items were controlled for:**
  - ⇒ Type of inflection/morphological classhood; Nouns in *-os*, *-o*, *-as*, *-a, -i*
  - ⇒ Word size (2σ, 3σ words) -- 20 items of 2σ and 19 items of 3σ, 39 items of each class → 195 PseudoWs;
  - ⇒ Syllable structure: CV.CV(C), CV.CV.CV(C), CCV.CV(C), CCV.CV.CV(C)

- **Fillers:** 2σ & 3σ PseudoWs with (APU/)PU/U stress; 13 from each m-class

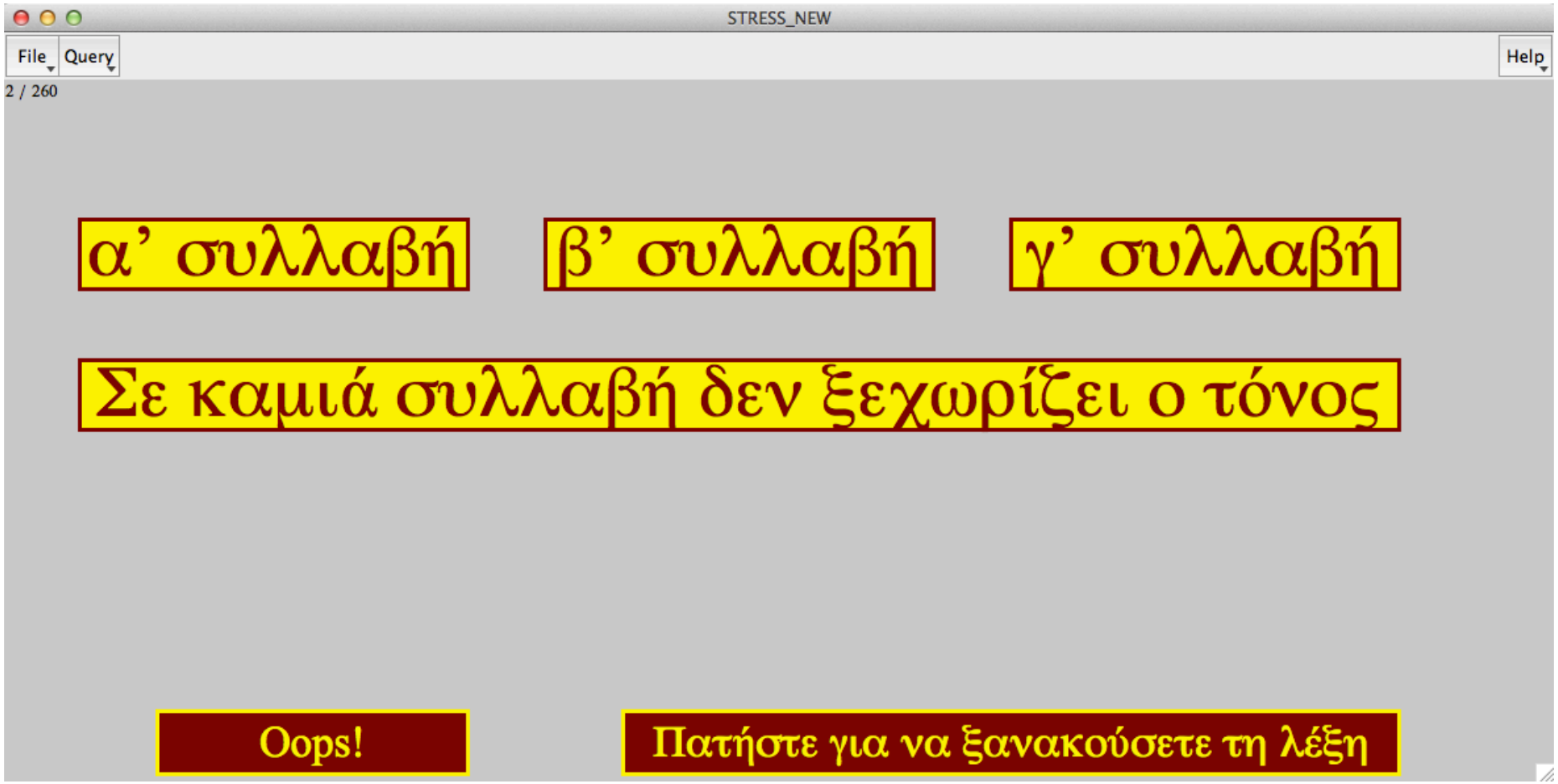
Procedure:

⇒ Participants were tested individually in a quiet room using a laptop computer and high-quality headphones (AKG K81DJ).

⇒ Participants heard a PseudoW in random order and chose, by clicking on a label on the screen, between three (or four in 3σ PseudoWs) options, namely "Stress on the first (syllable)", "Stress on the second (syllable)", "Stress on the third (syllable)", and "There is no (stress) prominence in any syllable", lit. In no syllable stress prominence is discernible (henceforth *NA*).

⇒ Participants could hear each stimulus twice if they wanted by clicking on a repeat button.

⇒ A practice task with 20 stimuli preceded the experiment.



- Expl: All syllables were stressed – 5070 data
- Exp2: All syllables were unstressed – 5070 data
  + fillers =13780 data

3. Results: Experiments 1 & 2

3.1. The perception of (non-)prominence

Experiment 1: NA vs. Stress decisions in 2σ & 3σ PseudoWs

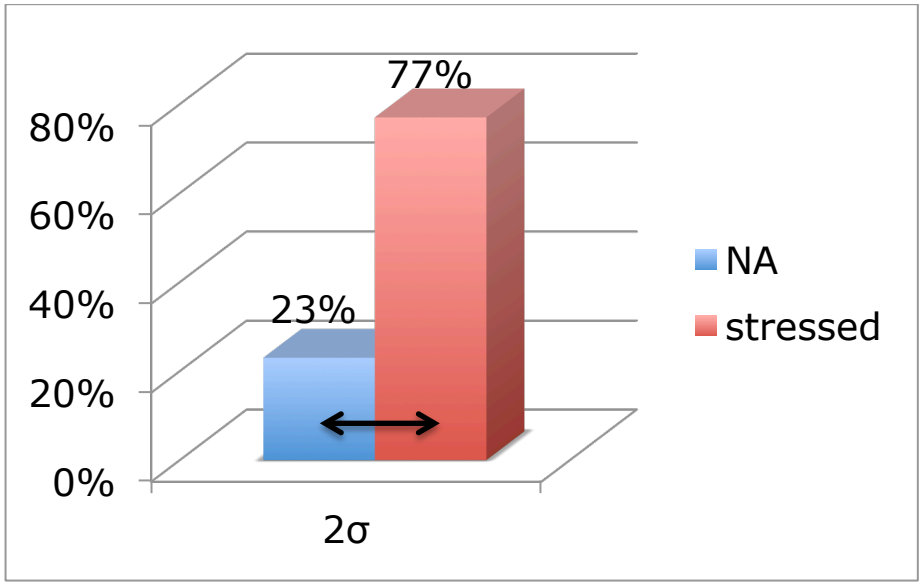


Fig. 1

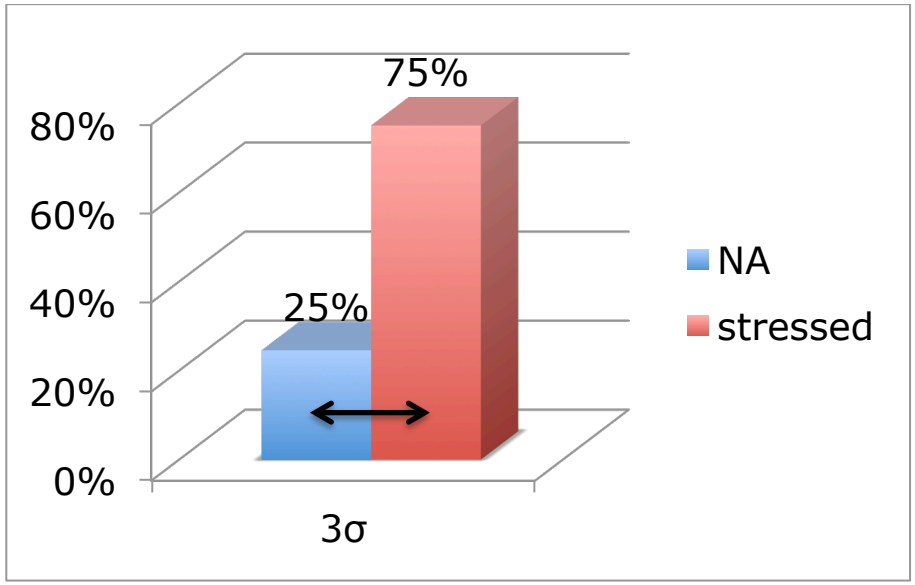


Fig. 2

2σ: $\chi^2(1)$: 723.485, p=.000

3σ: $\chi^2(1)$: 616.783, p=.000

Experiment 2: NA vs. Stress decisions in 2σ & 3σ PseudoWs

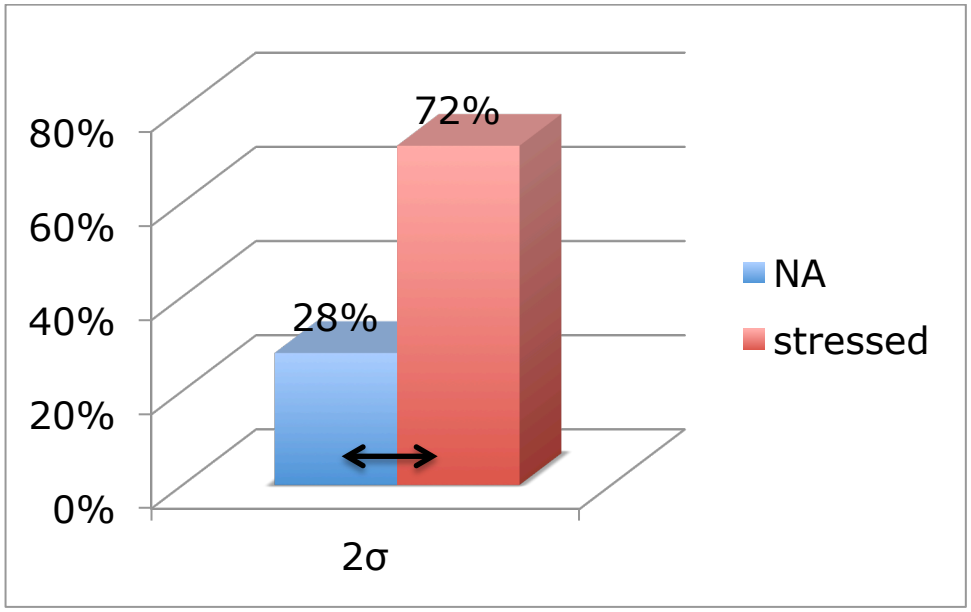


Fig. 3

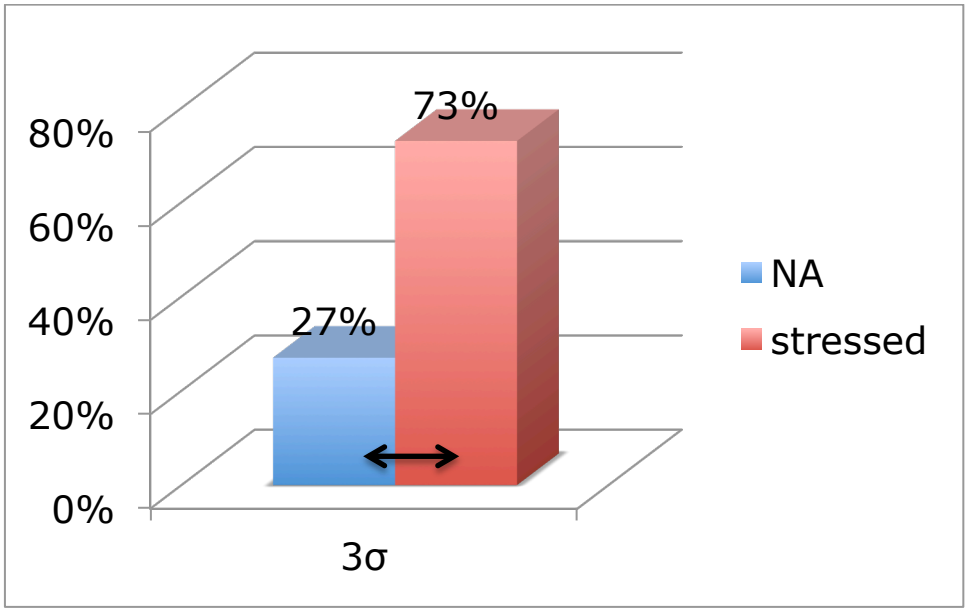


Fig. 4

2σ: $\chi^2(1)$: 491.853, p=.000

3σ: $\chi^2(1)$: 529.300, p=.000

➔ In both experiments there is a statistically significant difference between the 'NA' and the 'There is a stress on syllable x' answers.

Hypothesis #1 is confirmed

Greek speakers perceived stress oppositions that were NOT present in the input in environments in which all syllables are (a) stressed (Exp 1), and (b) unstressed (Exp 2).

Next step: To see whether they are biased for specific stress patterns!

3.2. Stress patterns across m-classes

Exp1: Stress in 2σ PseudoWs

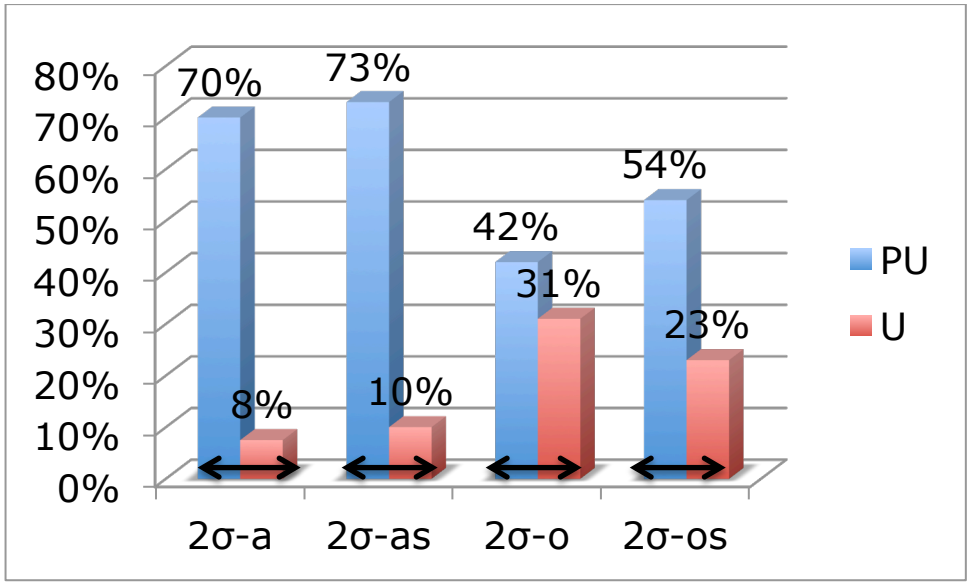


Fig. 5

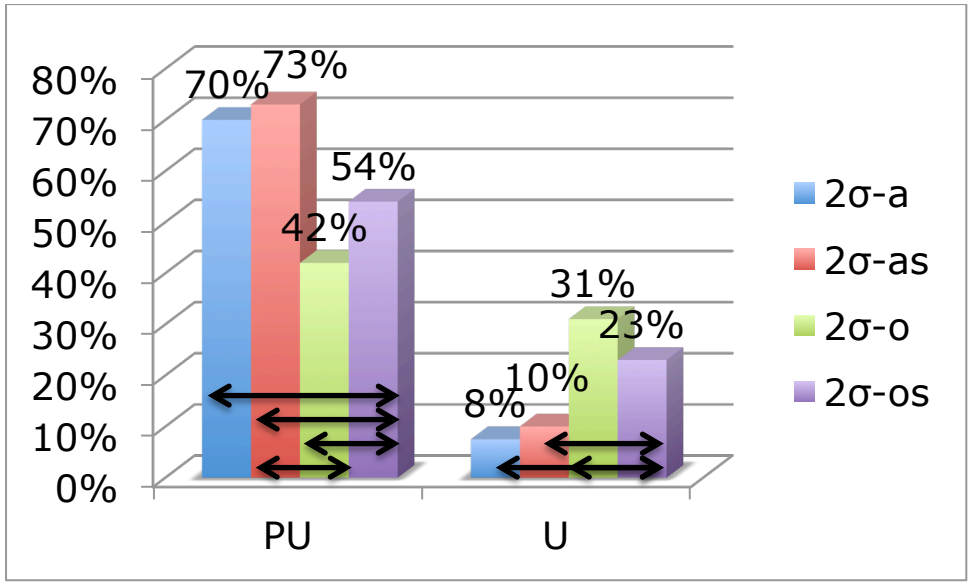


Fig. 6

-a: $\chi^2(1)=261.134$, p=.000
-as: $\chi^2(1)=243.551$, p=.000

-o: $\chi^2(1)=9.818$, p=.002
-os: $\chi^2(1)=58.247$, p=.000

Hierarchy for U stress: -o > -os > -as, -a

*(N=26, Friedman X^2=53.062, p<0.001)

- *-o* more likely than *-as* (z=-4.188, p<0.001), *-a* (z=-4.199, p<0.001) and *-os* (z=-3.299, p=0.001) to lead to U stress

- *-os* more likely than *-as* (z=-3.722, p<0.001) and *-a* (z=-3.745, p<0.001) to lead to U stress

Hierarchy for PU stress: -a, -as > -os > -o

(N=26, Friedman X^2=38.976, p<0.001)

- *-as* more likely than *-os* (z=-3.967, p<0.001) and *-o* to be associated with PU stress (z=-4.198, p<0.001)
- *-a* more likely than *-os* (z=-3.589, p<0.001) and *-o* (z=-4.183, p<0.001) to be associated with PU stress

*Statistically significant conclusions after Bonferroni adjustment, α=0.0083

Exp1: Stress in 3σ PseudoWs

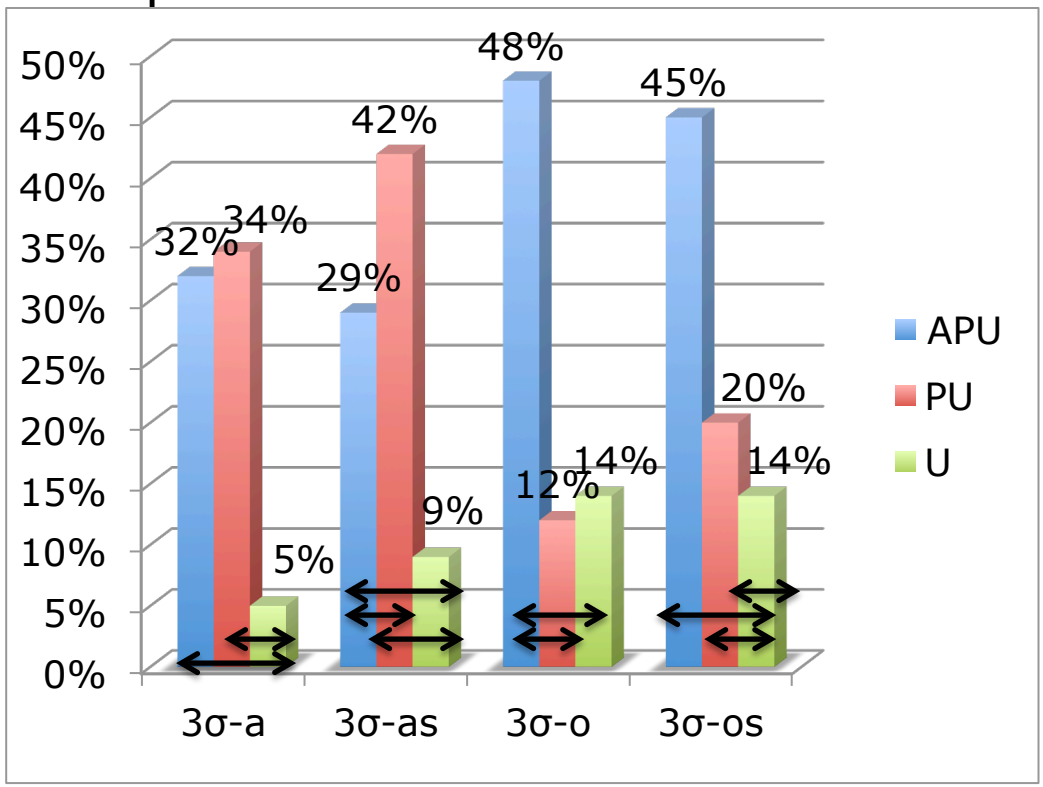


Fig. 7

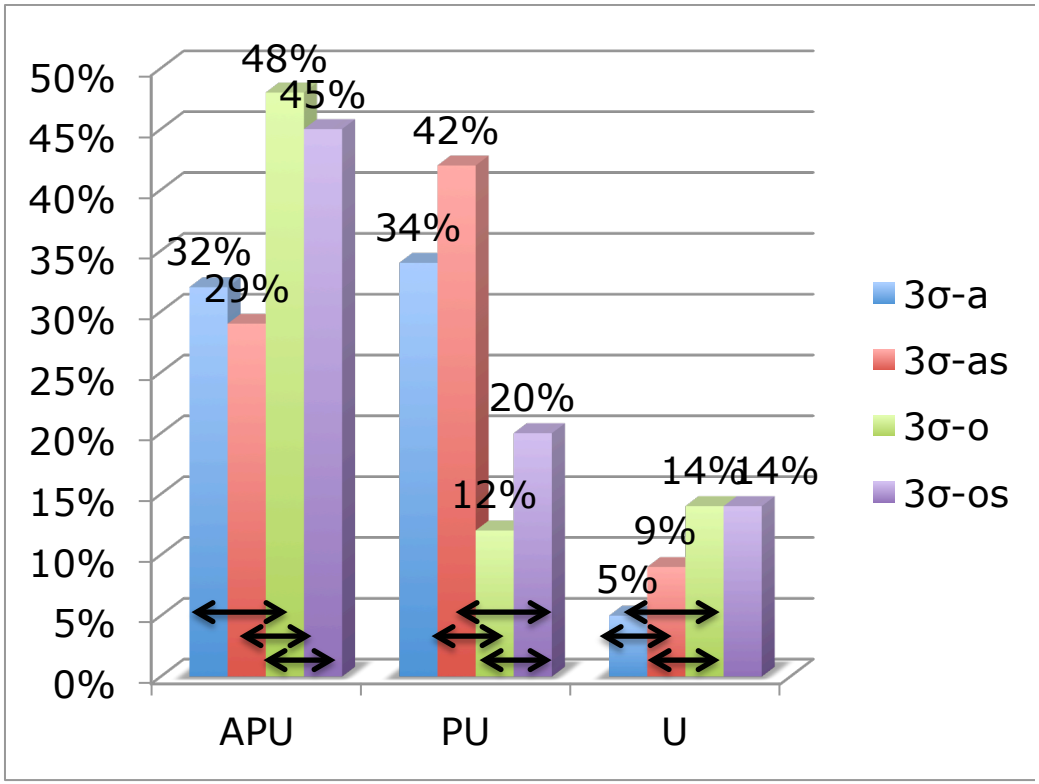


Fig. 8

Hierarchy for U stress: -o > -os > -as, -a

(N=26, Friedman X^2=53.062, p<0.001)

- -*os* more likely than -*as* (z=-3.722, p<0.001) and -*a* (z=-3.745, p<0.001) to lead to U stress
- -*o* more likely than -*as* (z=-4.188, p<0.001), -*a* (z=-4.199, p<0.001) and -*os* (z=-3.299, p=0.001) to lead to U stress

Hierarchy for PU stress: -as >* -a > -os > -o

(F=36.882, p<0.001, partial η^2=0.596)

- -*as* more likely than -*os* (t=6.401, df=25, p<0.001) and -*o* (t=7.713, df=25, p<0.001) to lead to PU stress
- -*a* more likely than -*os* (t=4.342, df=25, p<0.001) and -*o* (t=6.401, df=25, p<0.001) to lead to PU stress
- -*as* more likely than -*a* (t=2.704, df=25, p=0.012) to lead to PU stress
- -*os* more likely than -*o* (t=4.673, df=25, p<0.001) to lead to PU stress

*Holm-Bonferroni adjusted α level=0.025

Hierarchy for APU stress: -os, -o > -as, -a

($F=25.909$, $p<0.001$, partial $\eta^2=0.509$)

- *-os* more likely than *-as* (t=-6.874, df=25, p<0.001) and *-a* (t=-3.98, df=25, p=0.001) to lead to APU stress
- *-o* more likely than *-as* (t=-7.37, df=25, p<0.001) and *-a* to lead to APU stress (t=-5.666, df=25, p<0.001)

Exp2: Stress in 2σ PseudoWs

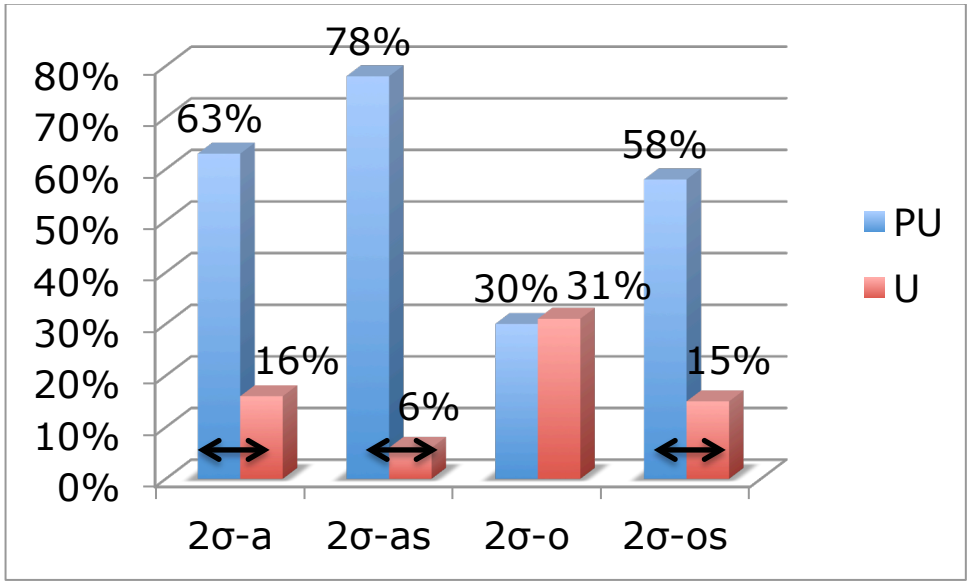


Fig. 9

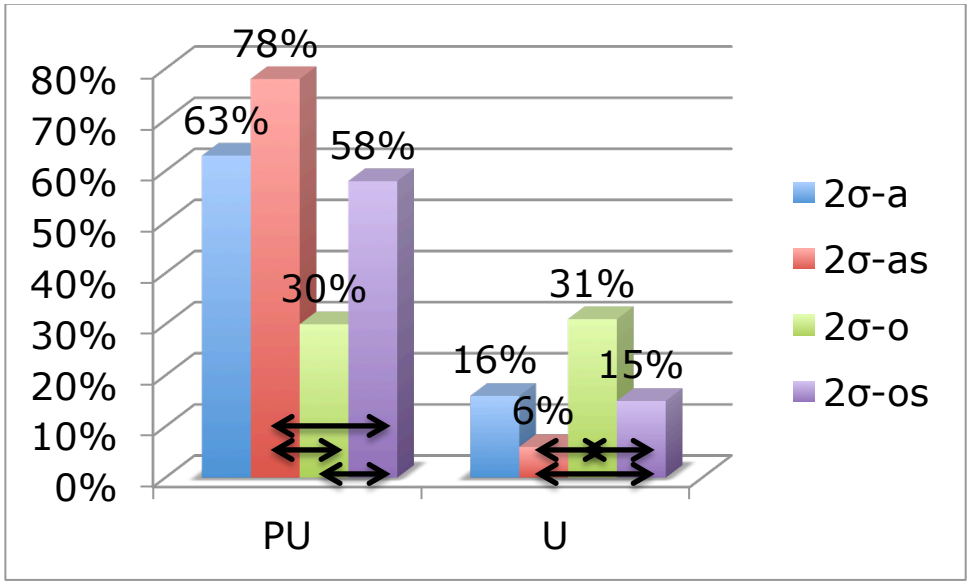


Fig. 10

-a: $\chi^2(1)=147.482$, p=.000
-as: $\chi^2(1)=288.000$, p=.000

-o: $\chi^2(1)=.050$, p=.823
-os: $\chi^2(1)=121.560$, p=.000

Hierarchy for U stress: -o > -os, -a > -as

- *-o* more likely than *-a* (z=3.508, p<0.001), *-as* (z=4.116, N=26, p<0.001), and -os (z=4.073, p=0.001) for U stress
- *-os* and *-a* more likely than *-as* for U stress with statistics (z=3.553, p<0.001) and (z=3.453, N=26, p=0.001), respectively

Hierarchy for PU stress: -as > -a > -os > -o

- *-as* more likely than *-a* *(z=2.08, p=0.038), *-os* (z=4.124,p<0.001) and *-o* for PU stress (z=4.352, p<0.001)
- *-a* more likely than *-os* *(z=2.458, p=0.014) and *-o* (z=4.377, p<0.001) for PU stress
- *-os* more likely than *-o* (z=4.142, p<0.001) for PU stress

* Significant at Holm-Bonferroni adjusted 0.05 and 0.025 significance thresholds, respectively.

Exp2: Stress in 3σ PseudoWs

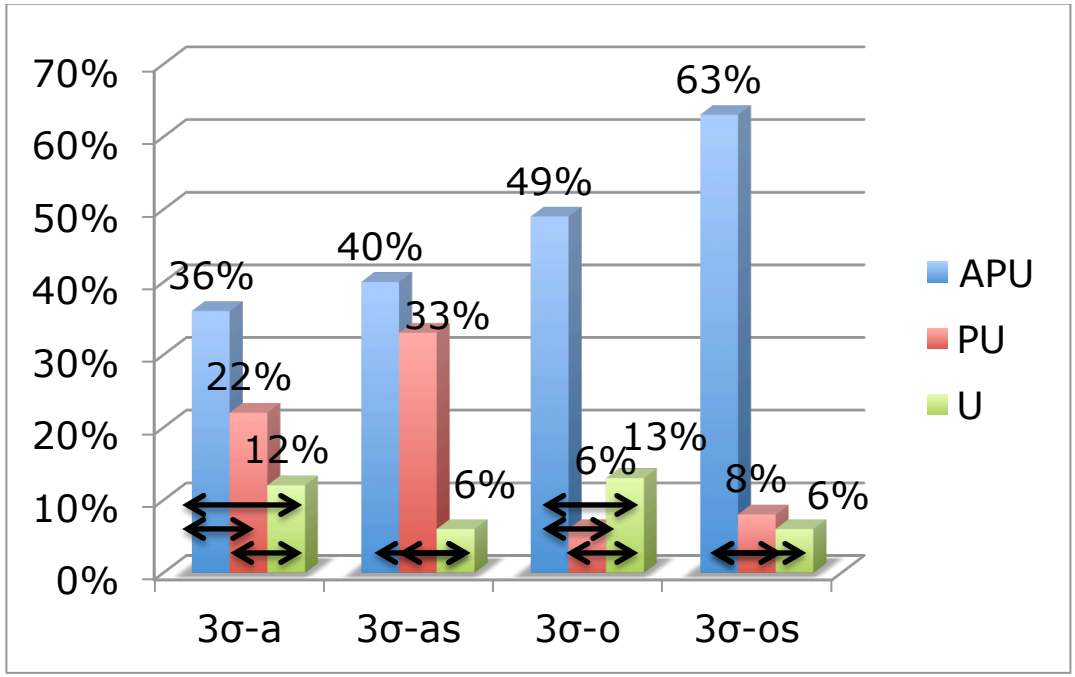


Fig. 11

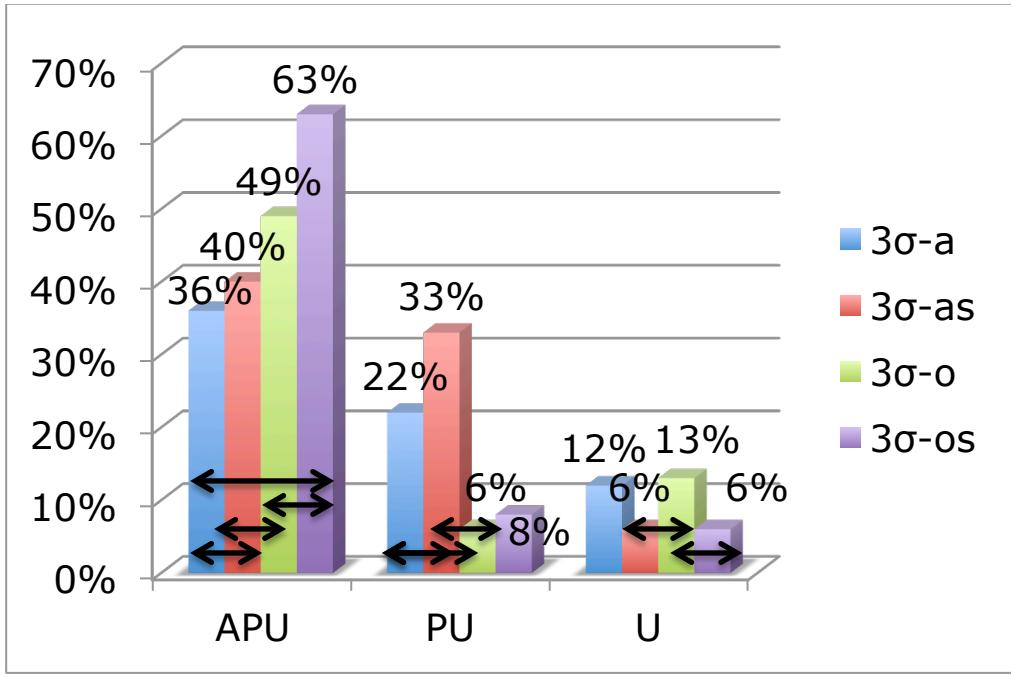


Fig. 12

Hierarchy for U stress: -o > -os > -as, -a

(Friedman $X^2(3)=27.642$, $p<0.001$)

- *-o* more likely than *-as* (z=4.116, p<0.001), *-a* (z=3.508, p<0.001) and *-os* (z=4.073, p=0.001) for U stress
- *-os* more likely than *-as* (z=3.722, p<0.001) and *-a* (z=3.745, p<0.001) for U stress

Hierarchy for PU stress: -as > -a > -os, -o

(Friedman $X^2(3)=51.781$, $p<0.001$)

- *-as* more likely than *-a* (z=3.045, p=0.002), *-os* (z=4.388, N=26, p<0.001) and *-o* (z=4.379,p<0.001) for PU stress
- *-a* more likely than *-os* (z=3.511, p<0.001) and *-o* (z=4.039, p<0.001) for PU stress

Hierarchy APU stress: -os > -o > -as, -a

($F(3,75)=37.439$, $p<0.001$, partial $\eta^2=0.6$)

- *-os* more likely than *-o* ($t(25)=4.533$, $p<0.001$), *-as* ($t(25)=7.952$, $N=26$, $p<0.001$) and *-a* ($t(25)=9.867$, $p<0.001$) for APU stress
- *-o* more likely than *-as* ($t(25)=3.310$, $p=0.003$) and *-a* ($t(25)=4.859$, $p<0.001$) for APU stress

Conclusions Exp1 & Exp2:

⇒ *-o, -os* are more likely to surface with **APU** stress
⇒ *-a, -as* are more likely to surface with **PU** stress; **APU** is also significant
⇒ **U** stress is mainly linked with *-o* > *-os*

4. Discussion: Experiments 1 & 2

4.1. PDf vs. lexical stress patterns

#1| PDf is alive and kicking! Best stress choice for -o/-os. Equal or second best stress choice for -a/-as.

Hypothesis #2 is not confirmed: Speakers do use APU stress. PDf is not a mere phonological construct; it is active in speakers' grammar

#2| PU stress is also a popular stress choice ➔ Speakers do rely on underlying metrical representations but categorize U stress as marginal compared to PU stress.

#3| THV is a cue for stress. It carries information on a stress preference hierarchy:

(5)

-**o**/-**o**s	APU > PU ≥ U	-**a**/-**a**s	PU ≥ APU > U

4.2. Further evidence from 'fillers'

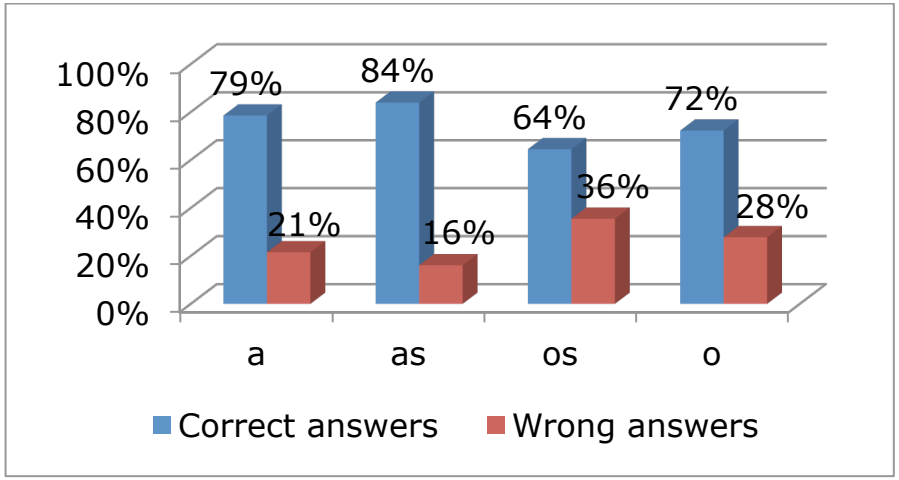


Fig. 13

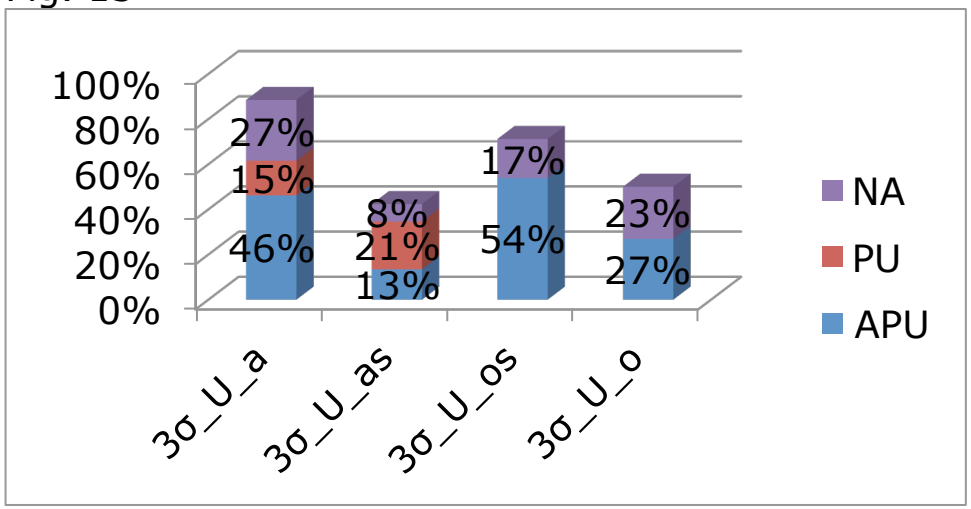


Fig. 14

Expl

- Curiously, a high percentage of wrong answers is also attested in fillers (=stressed words)

- Focus on wrong answers, taking 3σ_U words (e.g. *klapikás*, *zikará*, etc.) as an example:

-a: APU > PU
-as: PU > APU
-os: APU
-o: APU

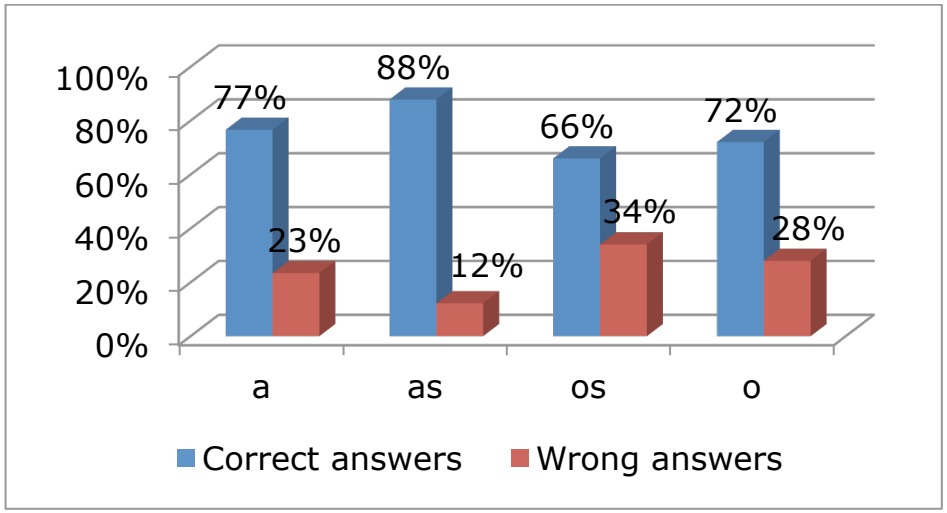


Fig. 15

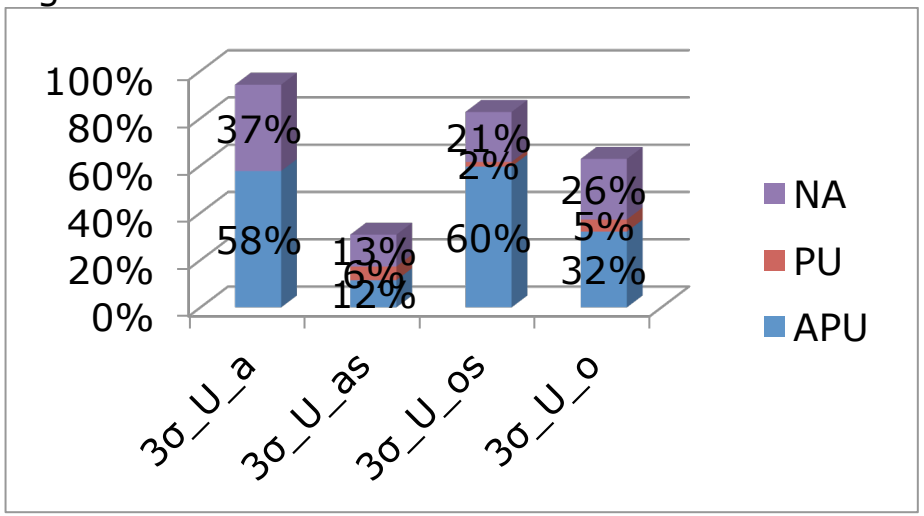


Fig. 16

Exp2

- A high percentage of wrong answers is also attested in fillers (=stressed words) in Exp2

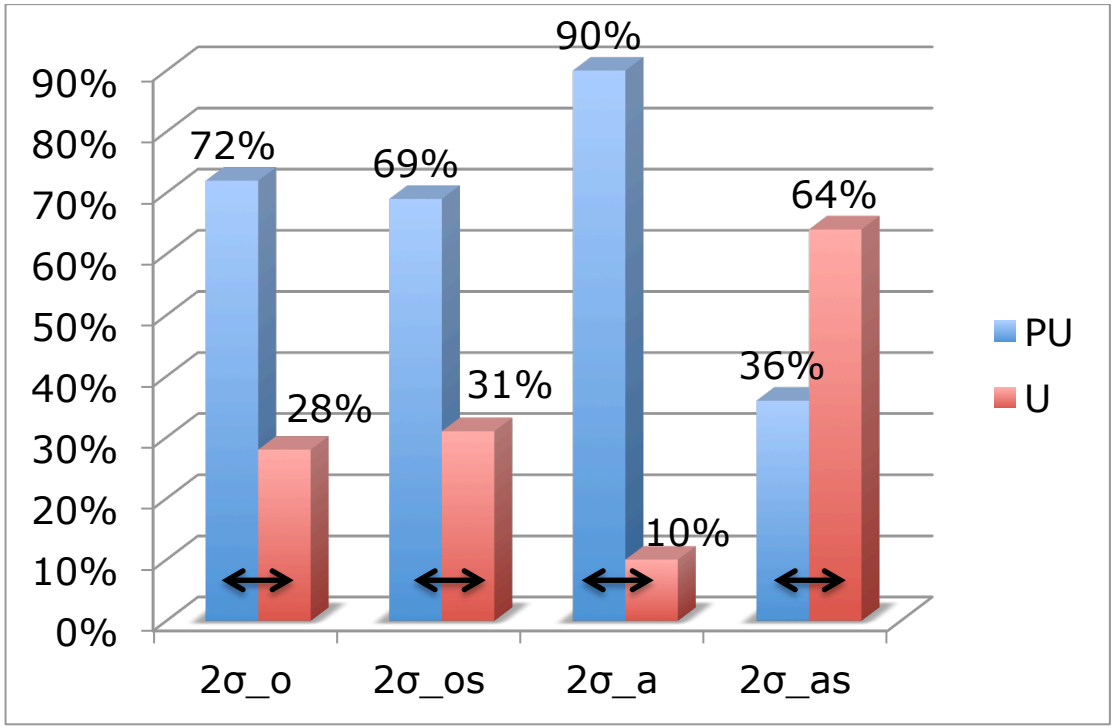
- Focusing on 3σ_U:

-a: APU
-as: APU > PU
-os: APU
-o: APU > PU

5. Stress and the Lexicon

- The distribution of stress patterns revealed by both experiments may reflect lexical frequency effects.

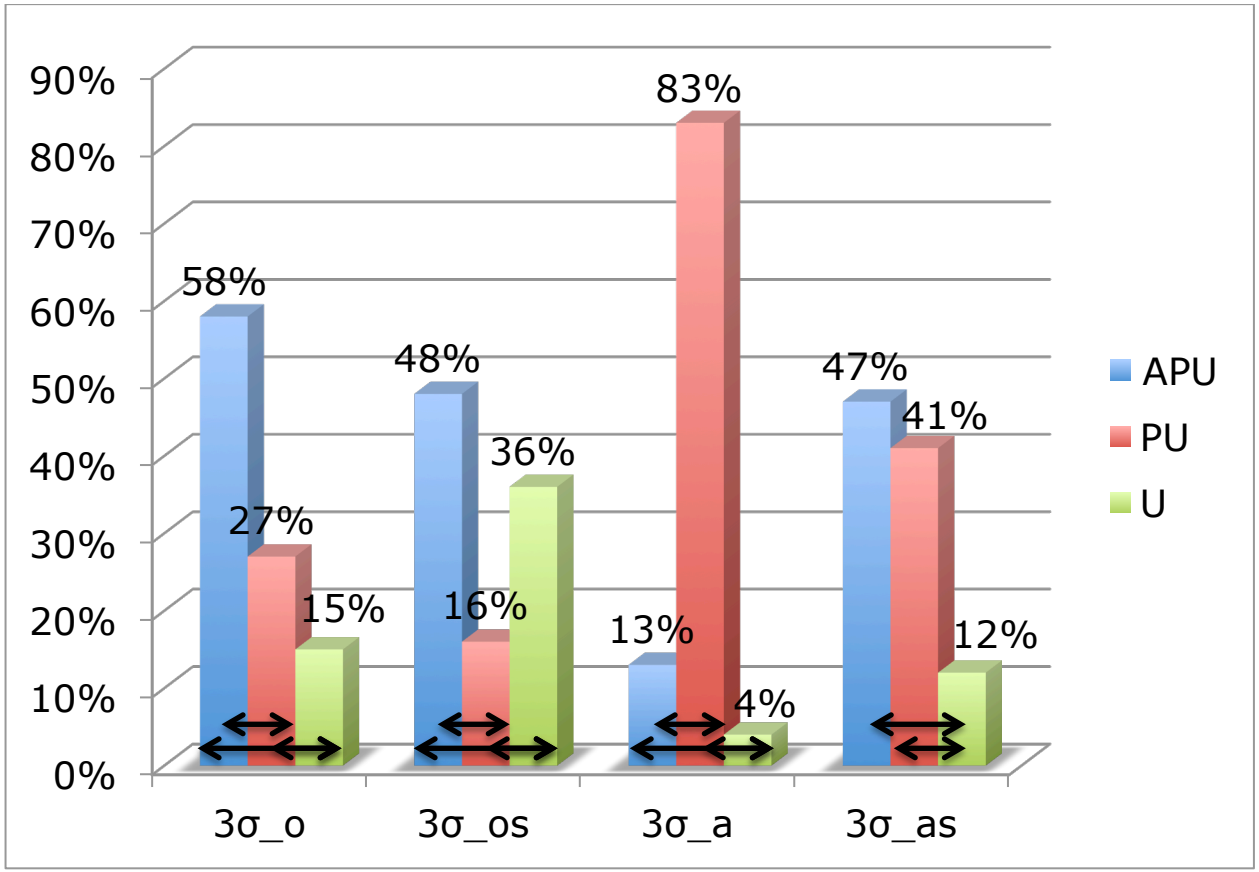
- **Source**: 4.260 nouns culled up from the Anastassiadis-Symeonidis' On-line Reverse Dictionary (Apostolouda 2012). [http://www.komvos.edu.gr/dictionaries/dictOnLine/DictOnLineRev.htm]



PU vs. U:
-o: $\chi^2(1)= 35.766$, p=.000
-os: $\chi^2(1)=61.213$, p=.000
-a: $\chi^2(1)=330.880$, p=.000
-as: $\chi^2(1)=5.880$, p=.015

Fig. 17: Stress patterns of 2σ nouns in the Lexicon (Apostolouda 2012)

- **Lexicon:** Preference hierarchy of Stress per Suffix
  -o, -os, -a: PU > U -as: U > PU



APU vs. PU
-o: $\chi^2(1)=42.853$, p=.000
-os:$\chi^2(1)=37.751$, p=.000
-a: $\chi^2(1)=285.902$, p=.000
-as: $\chi^2(1)=.847$, p=.357

PU vs. U
-o: $\chi^2(1)=12.571$, p=.000
-os: $\chi^2(1)=18.256$, p=.000
-a: $\chi^2(1)=393.751$, p=.000
-as: $\chi^2(1)=29.369$, p=.000

APU vs. U
-o: $\chi^2(1)=94.815$, p=.000
-os: $\chi^2(1)=4.000$, p=.046
-a: $\chi^2(1)=23.253$, p=.000
-as: $\chi^2(1)=39.035$, p=.001

Fig. 18: Stress patterns of 3σ nouns in the Lexicon (Apostolouda 2012)

- **Lexicon**: Preference hierarchy of Stress per Suffix
  - -o: APU > PU > U
  - -os: APU > U > PU
  - -a: PU > APU > U
  - -as: APU, PU > U

Comparison between the Lexicon and Exp 1 & 2

- Lexicon Frequency (LexF) is reflected on the top stress choice of each m-class, provided that this choice is not U stress, e.g. 2σ nouns in *-as*.

(See also Apostolouda 2012; Apostolouda, Revithiadou & Papadopoulou 2011 for similar findings from a production experiment.)

Hypothesis #3 is partly confirmed

⇒ LexF is mainly reflected in top stress choices, unless the top stress choice is a marked stress pattern, i.e. U.

⇒ The Greek speaker is not a 'blind frequency matcher' (e.g., Frazier 1995; Fodor 1998; Zuraw 2007; Becker et al. 2011). Phonological factors (e.g. markedness of iambs/degenerate feet) filter lexical statistics.

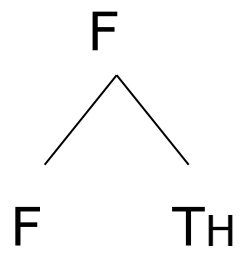
6. Theoretical implications: One default or many?

6.1. Implications for morphological analyses of the Greek nominal system

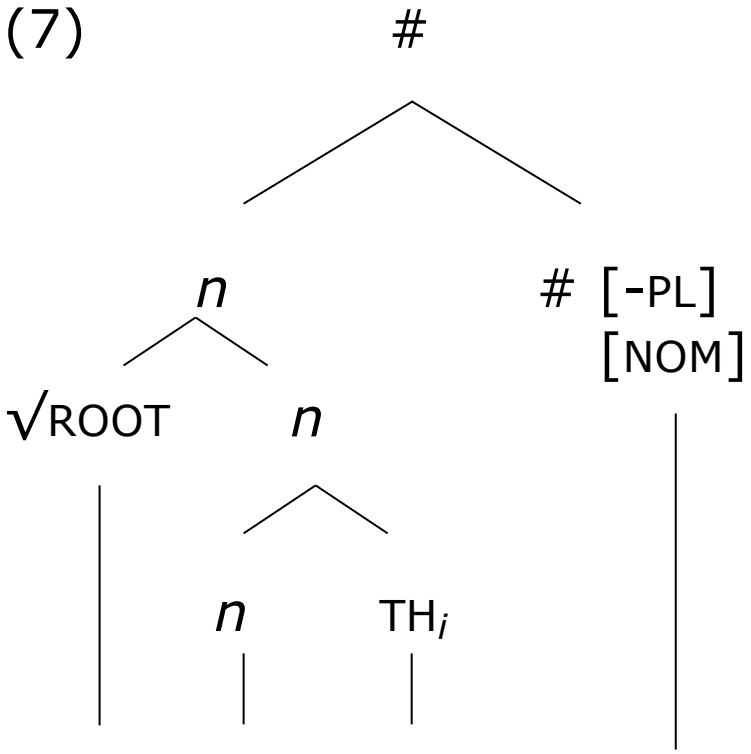
- DM (Halle & Marantz 1993; Embick & Noyer 2007, a.o.)
  - Roots have no category but they merge in the syntax with functional heads that assign them a specific category. ***Heads***: v, n, a for verbal, nominal and adjectival categories, respectively.
  - Greek wellformedness condition: At MS, all category functional heads require a theme position.

(See also Oltra-Massuet & Arregi 2005 for Spanish)

(6) F →



(7)



where *i* is an index for stress

θalas	ø	a	ø	'sea-NOM.SG'
anθrop	ø	o	s	'man-NOM.SG'

- TH does not introduce any m/s features but rather serves as an index for stress preference patterns:

(8) a. ThV-a is more likely to be associated with PU or APU stress as a first stress choice.

b. ThV-o is more likely to be associated with APU stress as a first stress choice.

c. ThV-o is more likely than ThV-a to be associated with U stress.

6.2. Implications for phonological analyses of Greek stress

#1| Representational approaches to stress (morphemes carry inherent metrical representations).

Q: Is there a default?

Yes, APU is not just a phonological construct; it is empirically real. PU is the 'default'=productive pattern of the lexical stress encoding mechanism.

➔ Lexical stress is not totally unpredictable; it mainly targets one specific position: the root-final syllable (juncture of morphemes):

(9) accented roots

*

σσ-

- U stress marginal because it is mainly the byproduct of either (10a) or (10b):

(10) a. σ-□ → $\sigma_R\sigma_{ThV}$ iamb (originally lacking a foot-head)

(. *) (. *)

*

b. σ-□ → $\sigma_R\sigma_{ThV}$ floating accent yielding a degenerate foot

(*)

#2| Non-representational approaches to stress: APU & PU are both dynamically present but with different likelihood (perhaps expressed in terms of different constraint weights, e.g., MaxEnt grammars, Hayes & Wilson 2008; Harmonic Grammars, Coetzee & Pater 2008; or frequency-oriented T-ordered grammars, Anttila 2008) across and within m-classes.

Q: Is there a default (=statistically prevalent) pattern?

Yes, but it may differ across m-classes.

7. Conclusions

- Both experiments show that speakers perceive stress even when the acoustic cues are equated, thus unveiling their stress biases. The similarity of findings between experiments ensures that the listeners' behavior cannot be attributed to our stress manipulation techniques.

- The stress bias effect is also reflected on fillers, which lends further support to the validity of our results.

- Stress in Greek is morphologically-oriented in yet another respect: The ThV carries information on stress.

- Lexical frequency exercises an effect but within the confines imposed by grammar itself.

Future research

- Stress in longer words; verbs; derived words
- Construction of corpora and morphological annotation of existing ones in order to be used for extraction of information on stress patterns
- Implementation of experimental findings in theoretical analyses of Greek stress

Thank you for your attention!

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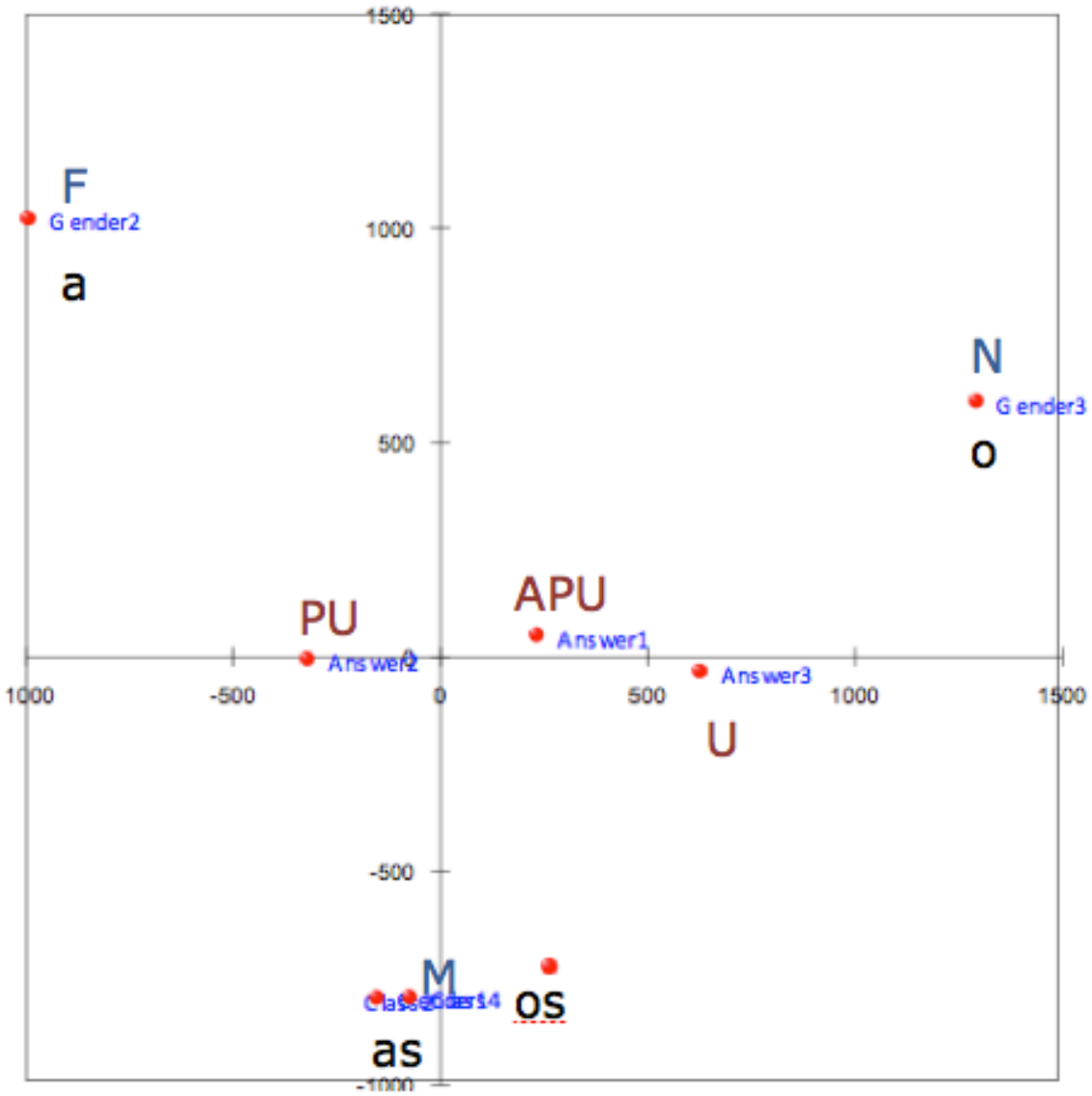

Interpretation: 74.96%

Fig. 9. First factorial level (e_1,e_2)