Maltese Plurals: Evidence from a Nonce Word Experiment

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Maltese

- Semitic language with characteristics of Maghrebi Arabic, influenced by Sicilian, Italian and English
- National language of Malta, other official language: English
- Spoken by about 400.000 people

Maltese
Plurals

- 2 main strategies to build the plural of a noun:
  Sound Plural: concatenative via suffixation
  sptar – *sptarijiet* 'hospital(s)'
  Broken Plural: non-concatenative via internal restructuring of singular stem
  ballun – *blalen* 'ball(s)'
- There is variation within the two different plural forms:
  a number of sound plural suffixes, between 4 and 39 different broken plural patterns
- There is also variation in the choice of the plural forms:
  bandiera (sg.) *bnadar* (broken pl.) vs. *bandieri* (sound pl.) 'flag'

Maltese Plurals
Learnability

- Is it possible to predict pluralisation of novel words?
- If there are no rules governing the plural formation (Sutcliffe (1924) cited in Schembri (2012)), this means that there is no – linguistic or statistical – structure in the data that allows native speakers to generalize

Prosodic Morphology (McCarthy & Prince, 1996): Plural forms are mapped on prosodic templates (shape-invariant patterns)

- What happens in a system that shows a lot of variation?
- We find marked prosodic patterns: CCVV
- How to account for these patterns?
- Dawdy-Hesterberg & Pierrehumbert (2014):
  Ernestus & Baayen (2003) have shown that phonological features play a role for morphological generalization

CV-skeleton mapping

Has been used as description of different broken plural types in Maltese (e.g. Schembri (2012))

- How to account for sound plural forms?
- What skeletons trigger choice of plural forms?

Maltese Plurals
Previous accounts

- Common idea of these accounts: the phonotactics of the singular determines the shape of the (broken) plural
- This is a good starting point for **both** plural forms

Maltese Plurals
Hypothesis

1. The phonotactics of the singular determines the shape of the plural
2. More frequent items are more likely to be generalized than infrequent items

Maltese Plurals
Our work

- To test the hypotheses we created a corpus and conducted a production experiment
- We modeled our experimental data with the *Naive Discriminative Learner*, a cognitive learning algorithm (Baayen, Milin, Đurđević, Hendrix & Marelli, 2011) that does not rely on abstract representations like CV-structure: are generalizations possible?

Maltese Experiment
Corpus

- We created a corpus of 2369 Maltese nominals
- Words were taken from Schembri (2012) and an online corpus (MLRS Corpus Malti v. 2.0)
- Checked with Ġabra: online lexicon for Maltese (Camilleri, 2013)
- CV structure
- Corpus frequency number for each word

Maltese Experiment

Plurals in Corpus

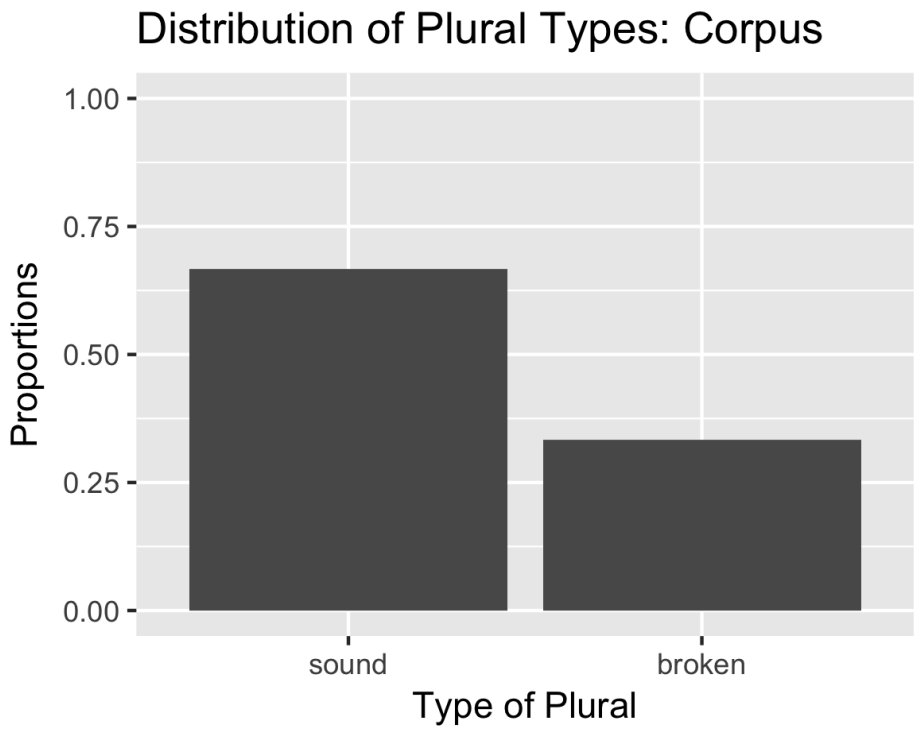

Figure 1: Distribution of Plural Types in our Corpus

Maltese Experiment
Method

- Production task with visual presentation
- Maltese native speakers were asked to produce plural forms for existing Maltese singulars and phonotactically legal nonce singulars (Berko, 1958)
- Nonce forms were constructed from words of our corpus of 2369 Maltese nominals by changing either the consonants or the vowels or both systematically, e.g.: *sema* ‚sky', $\rightarrow$ *fera soma fora*
- The results are three lists of wug words: C, V, CV
- The words of our corpus used as base had either a sound plural form, a broken plural form or both plural forms: SP, BP, BOTH

Maltese Experiment
Stimuli

We chose **90 nonce words**:

- 30 from list C
  - 10 Base Broken Plural
  - 10 Base Sound Plural
  - 10 Base Both
- 30 from list V
  - 10 Base Broken Plural
  - 10 Base Sound Plural
  - 10 Base Both
- 30 from list CV
  - 10 Base Broken Plural
  - 10 Base Sound Plural
  - 10 Base Both

And **22 existing nouns**:

- 5 frequent sound plural words, 5 infrequent sound plural words
- 5 frequent broken plural words, 5 infrequent broken plural words
- 2 training items (1 sound plural, 1 broken plural)

Maltese Experiment
Procedure

- Participants: 80 adult native speakers of Maltese: 50 female, 30 male (mean age 24.6), recruited at the University of Malta
- We recorded the plural answers of the participants
- Steps: training phase, instructions in Maltese, test phase
- Stimuli were presented in randomized order

Maltese Experiment
Procedure

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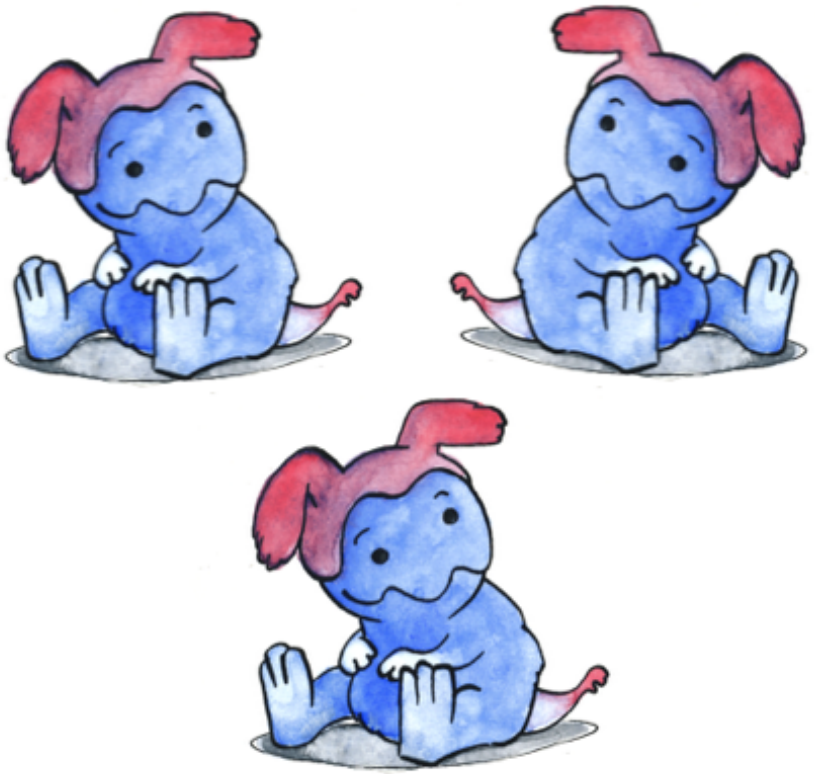
Maltese Experiment
Procedure



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Maltese Experiment

Results - Variation

	Plurals Forms given by Participants			
Nonce Singular	Speaker A	Speaker B	Speaker C	Speaker D
xogol	*xgiegel*	*xogolijiet*	*xogliet*	*xogoli*
tolluq	*tlielaq*	*tolluqijiet*	*tlieqi*	*tolluqi*
żepelp	*żepelpijiet*	*żepelpi*	*żpiepel*	*zepelpi*
follu	*folol*	*folli*	*follijiet*	*folliet*

There is a lot of variation in our data: different plural forms per item (broken plural= red, sound plural=green)

Maltese Experiment

Results - List

Does the change of consonants, vowels or both to build nonce words have an effect on the produced plural type of the nonce words?

Maltese Experiment

Results - List

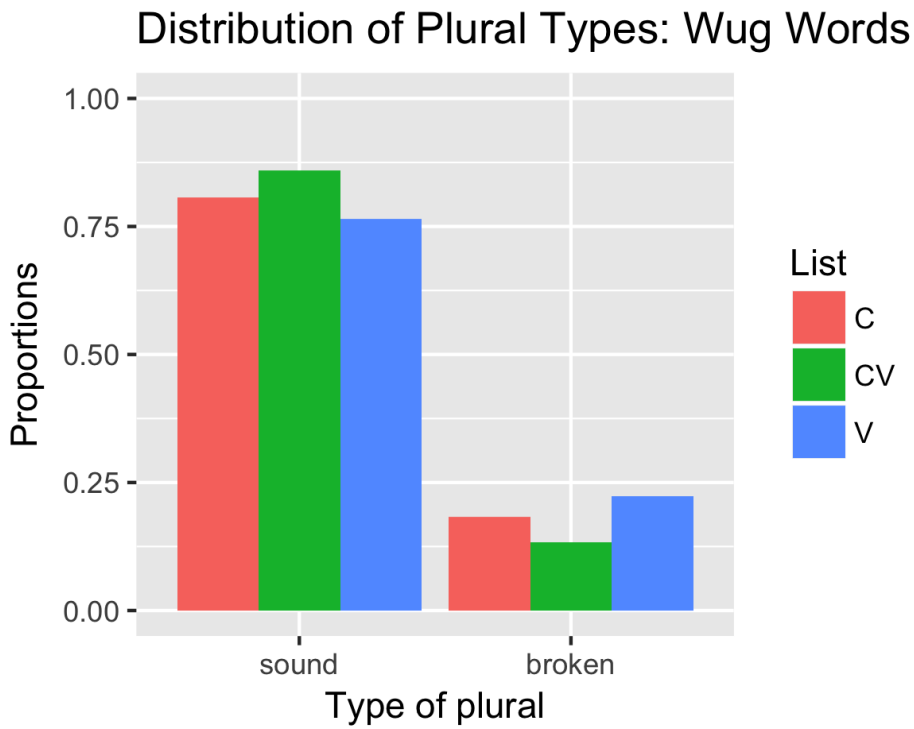


Figure 2: Distribution of Plural Types within the lists C, CV and V

Maltese Experiment
Results - List

glmer with lme4 package (Bates, Mächler, Bolker & Walker, 2015)

- dependent variable:
  Answers of participants (binary, Sound or Broken Plural)
- independent variables:
  List = C, V, CV
  Base =SP, BP, BOTH
- random effects:
  Singular, Speaker

Maltese Experiment

Results - List

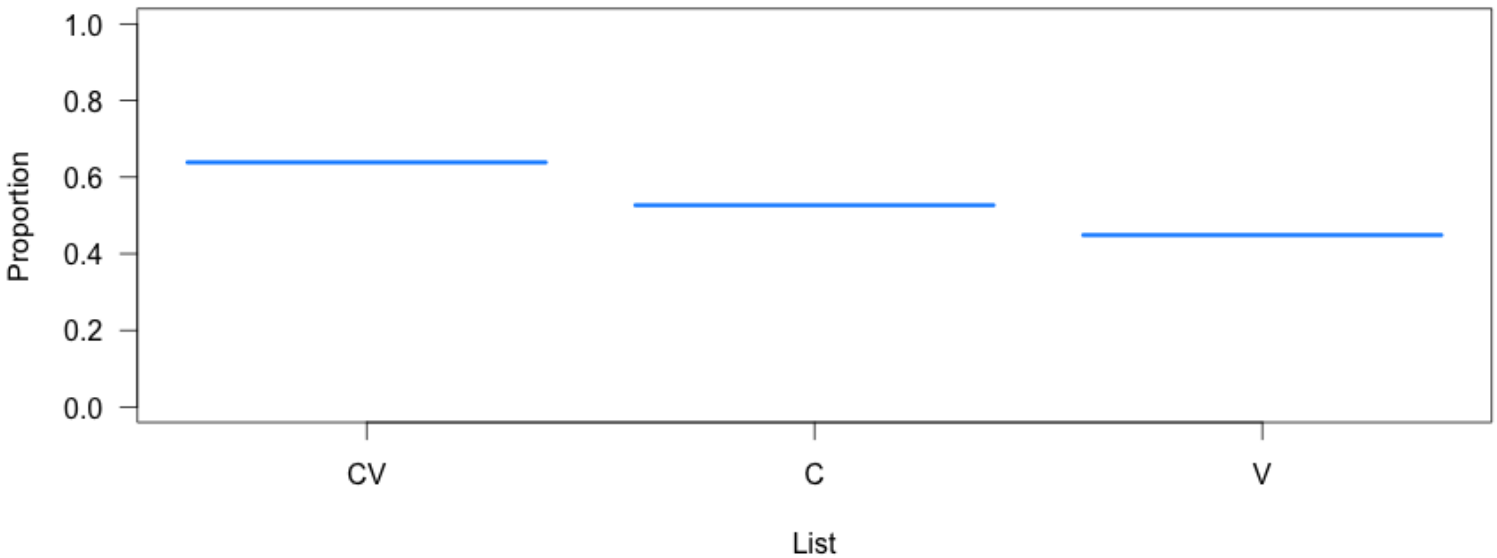


Figure 3: Results of glmer model with variable: List

Significant difference between List CV and List V ($p<0.001$)

Maltese Experiment

Results - Base

Does the plural form of the existing word that has been used as a base for the nonce word have an effect on the produced plural type of the nonce words?

Maltese Experiment

Results - Base

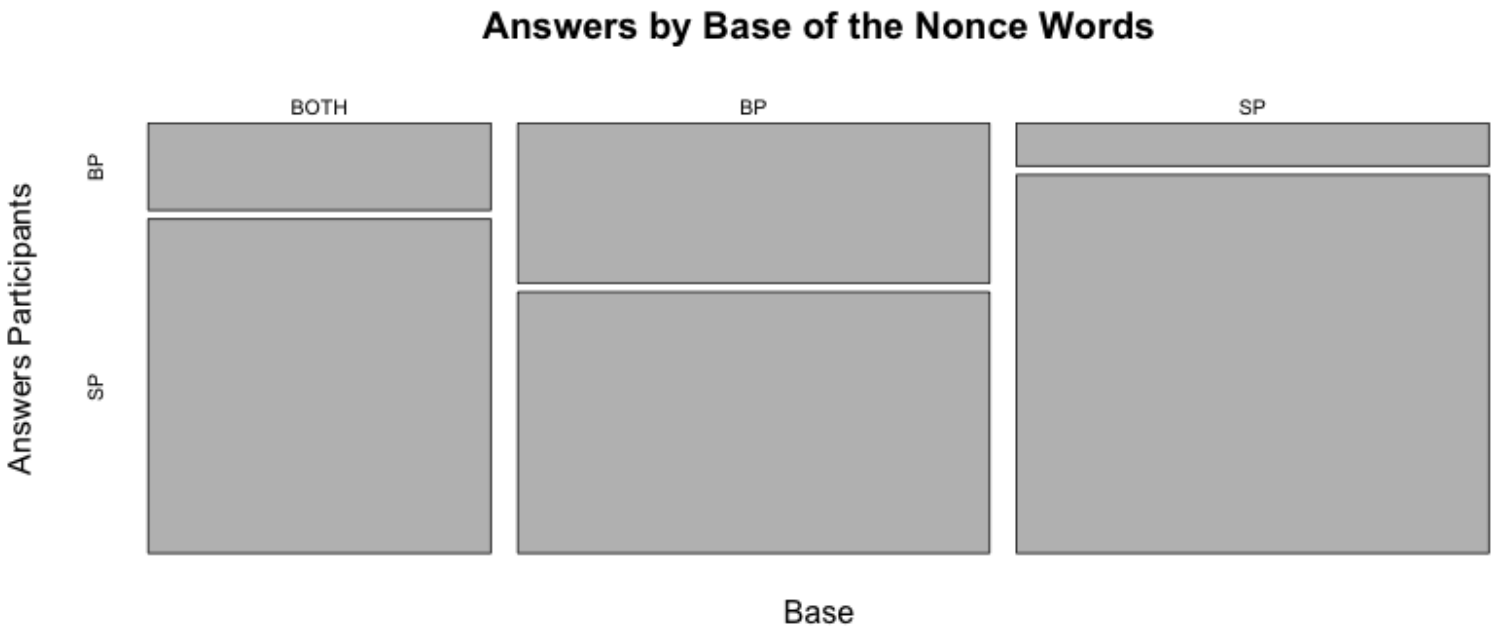


Figure 4: Distribution of Plural Types - Base

Maltese Experiment

Results - Base

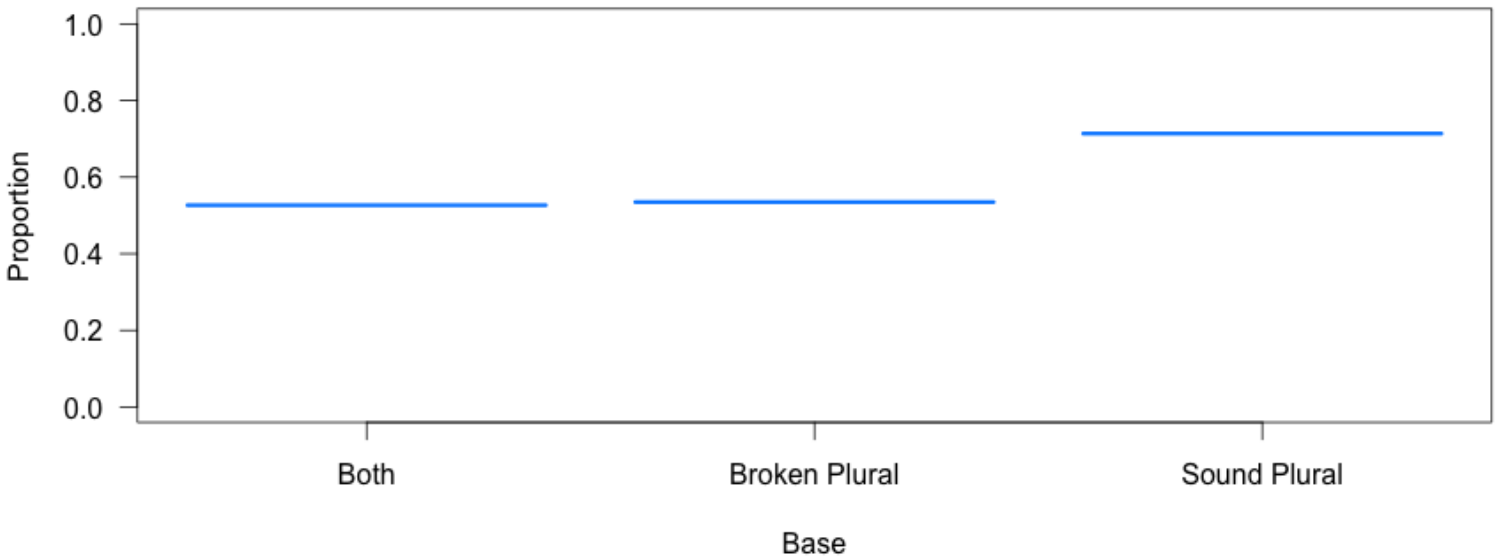
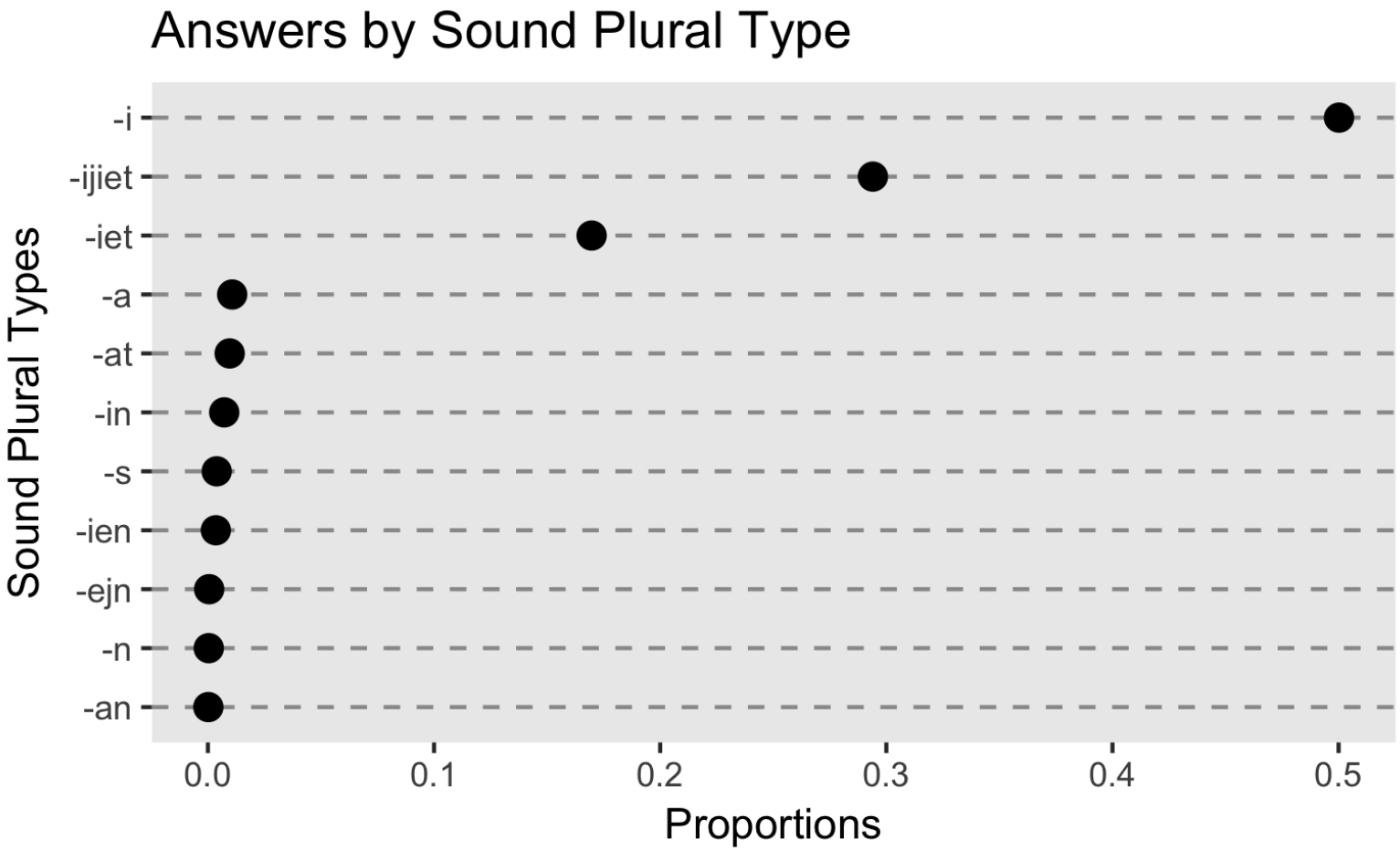


Figure 5: Results of glmer model with variable: Base

Significant difference between Base Broken and Base Sound ($p<0.001$)

Maltese Experiment

Results - Sound Plurals

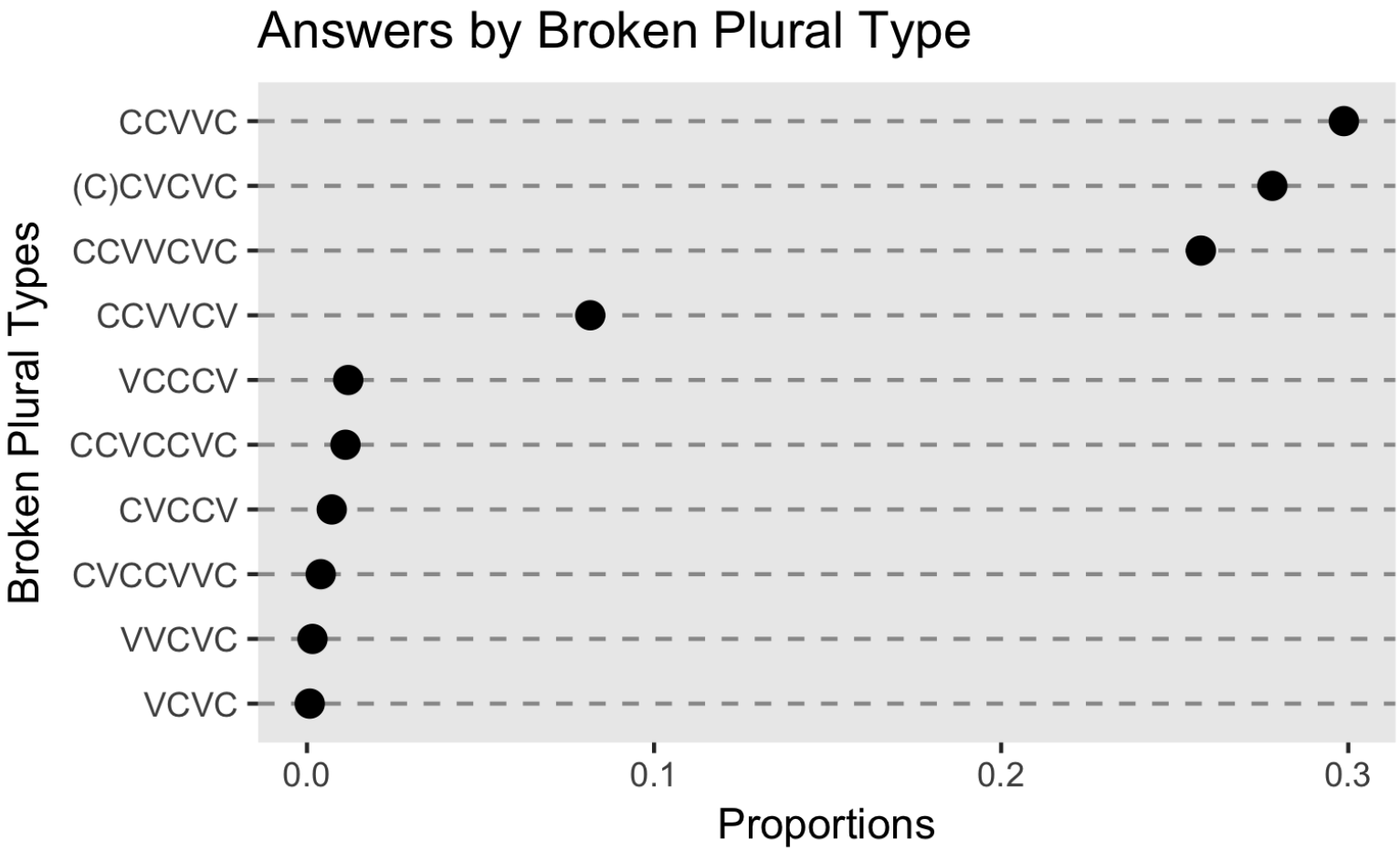


Maltese Experiment
Results - Sound Plurals

- -*i* and -*ijiet* are the most common suffixes in our corpus, too
- One participant of the experiment said:
  „When we [=the Maltese native speakers] do not know the word, we just put an -*i* or -*ijiet* on it. That will leave the word as it is and we avoid mistakes.“

Maltese Experiment

Results - Broken Plurals



Maltese Experiment

Results - Broken Plurals

Patterns	Wug Words (sg.-pl.)
CCVVC	telleb – tlieb
CCVVCVC	peżna - pżieżen
CVCVC	baċċa - baċeċ

Table 1: Most frequent broken plural patterns in our data

- According to Schembri (2012) these patterns are highly productive in Maltese

Maltese Experiment

Results - Existing Words

Non-canonical frequent		Non-canonical infrequent	
Sound	Broken	Sound	Broken
5(of 400)	1(of 400)	14(of 400)	177(of 400)
1,3%	0,3%	3,5%	44,3%

Table 2: Proportion of non-canonical plural forms for existing singular nouns

- Non-canonical plural forms = forms we do not find in the dictionary

Summary: Results so far

- Changing consonants and vowels influenced the choice of plural forms
- The plural form of the existing word used as base for nonce words influenced the choice of plural
- Participants produced broken plurals for nonce words with the most frequent CV structure, sound plurals for nonce words with most common suffixes

Naive Discriminative Learning

Baayen (2011), Baayen et al. (2011)

- Computational model of morphological processing
- NDL simulates a learning process
- Supervised learning
- Has been used successfully to model language acquisition (Ramscar, Yarlett, Dye, Denny & Thorpe, 2010)
- Central idea: learning = exploring how events are inter-related, they become associated (see also Plag & Balling (2016))
- inter-related events: *Cues* and *Outcomes*

Naive Discriminative Learning

Baayen (2011), Baayen et al. (2011)

- Based on Rescorla-Wagner equations that are well established in cognitive psychology (Rescorla & Wagner, 1972)
- Associations between cues and outcomes at a given time, whereas the strength of an association, the association weight, is defined as follows (Evert & Arppe, 2015):
  - No change if a cue is not present in the input
  - Increased if the cue and outcome co-occur
  - Decreased if the cue occurs without the outcome
- Danks (2003) equilibrium equations: define association strength when a stable state is reached = „adult state of the learner“ (Baayen, 2011)
- Implementation as R package *ndl*

Naive Discriminative Learning

Baayen (2011), Baayen et al. (2011)

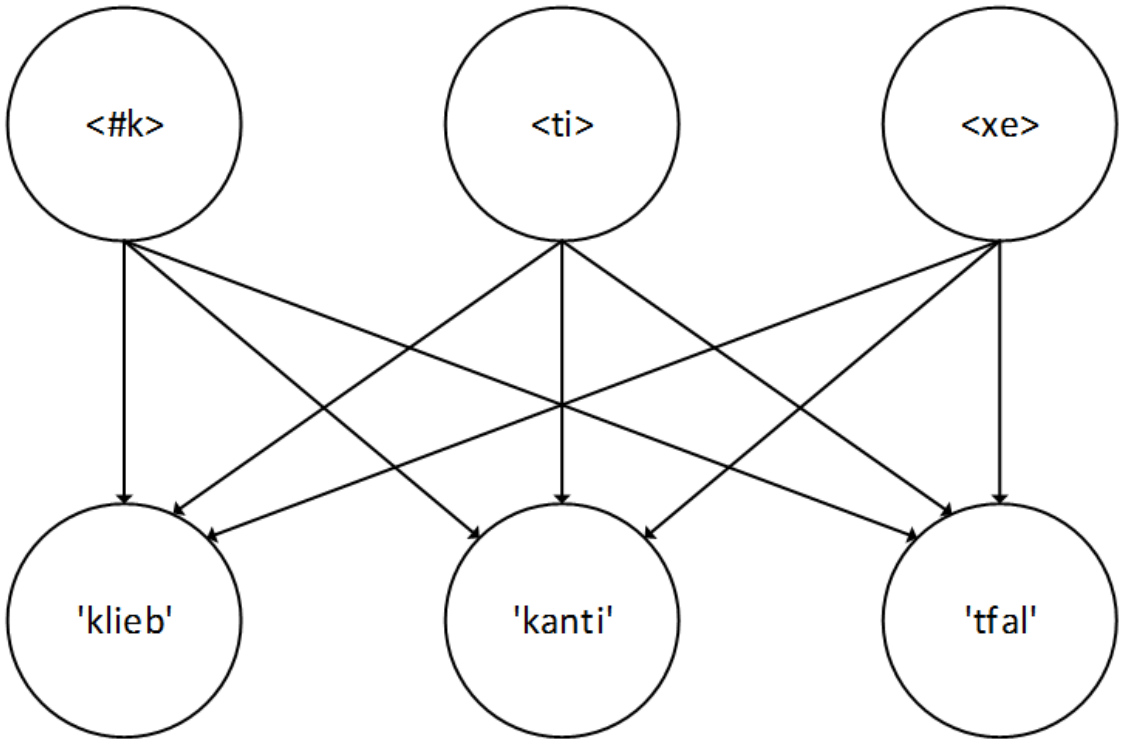


Figure 6: Association between Cues and Outcomes

Modeling our Data: Naive Discriminative Learning

- We trained the NDL model on our corpus
- We formulated our singular nonce words in bigrams and calculated how the NDL learner would classify them
  - Cues: singulars in bigrams, #k – ke - el - lb - b#
  - Outcomes: plural types, # k = sound, ke = broken...
- The associations between cue and outcome are weighted
- We used NDL to predict classification of nonce words

Modeling our Data: Naive Discriminative Learning

Cue	Broken Plural	Sound Plural
#k	−0.12	0.62
ke	0.42	−0.42
el	0.17	−0.17
lb	0.17	−0.16
b#	0.42	0.07
sum	1.06	−0.06

Table 3: Example for NDL association weights predicting outcome „broken“ for singular *kelb*

Modeling our Data: Naive Discriminative Learning

Results

- We compared the classification of participants with NDL
- NDL correctly classified 65,3 % of our observations

	broken	sound
broken	0.60	0.40
sound	0.33	0.67

Table 4: Classification of nonce words by NDL

Modeling our Data: Naive Discriminative Learning

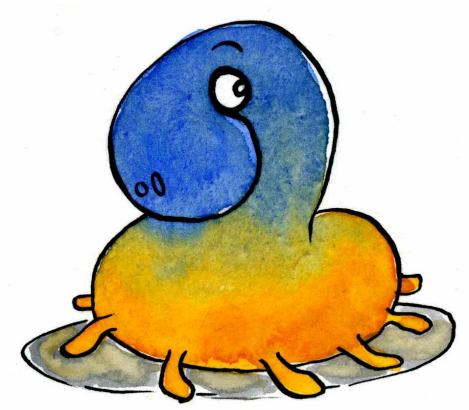
Results

- Let´s compare our results with other models that have been used with Arabic broken plural nouns:
  Dawdy-Hesterberg & Pierrehumbert (2014) used modified versions of the Generalised Context Model (Nakisa, Plunkett & Hahn (2001), Albright & Hayes (2003))
- Accuracy of the models ranged between 55.31 – 65.97%
- Our NDL analysis: 65.3%

Discussion

- There is structure in our data
- Native speakers are able to inflect novel nouns
- Participants produced more broken plural words when we just changed the vowels of existing singulars to create nonce words
- When both, consonants and vowels, were changed, participants produced the highest number of sound plural forms
- Consonants and vowels are important for the generalizations of broken plurals: evidence for tier separation
- Phonotactics of the singular determines the plural form
- Plurals are generalizable!

Grazzi ħafna!



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