Modeling MorphologyWiSe 22/23
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Implementation Task

1 Introduction to prior research into the topic

Word segments which are smaller than morphemes, yet still convey related, sometimes iconic meanings across different semantic fields are called *phonaesthemes* (sometimes also phonesthemes). Their existence remains debatable and most of the literature dealing with research on their existence is restricted to Indo-European languages, most notably English and German. Two phonaesthemes denoting the associated meaning of LIGHT and NOSE are shown below:

(1) *English gl-:* glow, glint, gloss, glare, glaze, glee, glad, glimpse, glance, gloom

(2) *English sn-:* sniff, snort, sneeze, snore, snuff, snarl, sneer, snoop, snub, snob

(Kwon, 2017: 79)

Otis & Sagi (2008) use the computational model *Infomap* (Edler *et al.*, 2014) to model phonaesthemes in a vector space in order to see whether the semantic fields that phonaesthemes are claimed to span across are indeed backed up by statistical data. And indeed, the authors not only find positive correlations between phonaesthemes and their meanings, but their model was also able to examine the validity of a proposed phonestheme. So following the findings that Otis & Sagi have made, this little experiment aims to recreate parts of the results, using *naive discriminative learning.* That is, the goal of this study is to train a discriminative model to successfully identify the phonesthematic part of a word.

2 Methodology of the implementation

Since naive discriminative learning (henceforth: NDL) makes use of a *cue-and-outcome* structure for its model implementation, it was important to decide what information should function as a cue and which form it should have when given to the model to train. The procedure is as follows: The model would be trained on diphone cues which mapped to phoneasthematic meanings as their outcomes. The weight matrix and an activation matrix would then show how strongly every diphone was correlated with each phoneasthematic meaning and hopefully, the diphones would correlate with the phonaesthemes themselves.

In order to keep this experiment simple, only four of the 47 phonaesthemes used by Otis & Sagi were adapted, which are the phonaesthemes */bl-/, /cr-/, /cl-/ and /dr-/.* The phonaesthemes' entries in the *Dictionary of English phonaesthemes* (Shisler, 1997) were referenced in order to build a corpus. All words under each entry were selected, and parantheses and explanation text removed. By the end, the corpus consisted of 150 words, each belonging to either of the eight phonesthematic meanings SWELLING OF THE LIPS, BUBBLE SOUNDS, BLOWING AND SWOLLENNESS, ABRUPT ONSET, TWISTEDNESS, JARRING AND GRATING SOUND, DOWNWARD MOTION, and LIQUID MOTION.These categories were added to the corpus file manually after preprocessing.

word	PHONAESTHEMIC MEANING
blister	SWELLING OF THE LIPS
clatter	ABRUPT ONSET
creeps	TWISTEDNESS
crawls	TWISTEDNESS

Table 1: Excerpt of the words in the corpus with their phonaesthematic meanings

The entire corpus was then processed in python with the *pyndl* package (Sering *et al.*, 2017) into an event file in which the cues were stored as underscore delimited diphones and the outcome consisted of the phonaesthematic meanings.

cue	outcome
`is_#b_li_er_te_r#_bl_st_blister`	SwellingOfTheLips
`#c_tt_at_er_te_cl_r#_la_clatter`	AbruptOnset
`re_#c_ee_cr_s#_ep_ps_creeps`	Twistedness
`aw_#c_cr_s#_ls_wl_ra_crawls`	Twistedness

Table 2: Excerpt of the event file

This file was used to then train a model and create a weight matrix and an activation matrix.

3 Results

No statistical tests were run in order to verify the significance of the following results. The weight matrix showed that for four of the eight meaning categories, the cue with the highest weight correlated with the phonaestheme that was supposed to represent it, while the other four categories were correlated with an onset diphone cue which would also belong to the anticipated phonaestheme.

```
weight_matrix.idxmax(axis=1)
```

```
outcomes
BubbleSound               #b
BlowingAndSwelling        #b
SwellingOfTheLips         bl
AbruptOnset               cl
Twistedness               #c
JarringHarshGratingSound  #c
DownwardMotion            dr
LiquidMotion              dr
```

Figure 1: The diphone cues which had the strongest weights for each meaning

```
weight_matrix[['#b','bl','#c','cl','cr','#d','dr']]
```

cues outcomes	#b	bl	#c	cl	cr	#d	dr
BubbleSound	0.056804	0.055341	-0.007561	-0.006364	-0.001196	-0.001208	-0.001208
BlowingAndSwelling	0.078441	0.076562	-0.005287	-0.006142	0.000855	-0.002501	-0.002501
SwellingOfTheLips	0.100667	0.108546	-0.007465	-0.007849	0.000384	-0.002769	-0.002769
AbruptOnset	0.000000	0.000376	0.125939	0.202946	-0.077007	0.000112	0.000112
Twistedness	0.000000	-0.000860	0.143051	0.000000	0.143051	-0.011480	-0.011480
JarringHarshGratingSound	0.000000	-0.000437	0.149103	0.000000	0.149103	-0.011864	-0.011864
DownwardMotion	0.000000	0.007208	0.000000	0.000000	0.000000	0.126459	0.126459
LiquidMotion	0.000000	0.000000	0.000000	0.000000	0.000000	0.081970	0.081970

Figure 2: Details on the weights, showing how close the values for #b and bl were

A simple comparision as presented in figure 2 shows that the weights between `#b` and `bl` as well as `#c` and `cr` are similarily high for the outcome meanings they were meant to represent.

When searching the activation matrix for the highest activation for each outcome, the results can be intuitively confirmed to be words which are especially iconic into these respective directions of meaning.

PHONESTHEMIC MEANING	highest activation
BubbleSound	blisters
BlowingAndSwelling	blore
SwellingOfTheLips	blabber
AbruptOnset	clam
Twistedness	crimps
JarringHarshGratingSound	crook
DownwardMotion	drag
LiquidMotion	drip

Table 3: The words that had the highest activation with each meaning category

4 Conclusion

In this little experiment I have explored whether NDL is able to identify diphones which are most likely to have a certain phonaesthematic meaning, based on how often the sounds appear in words that are associated with certain meanings. While the size of the dataset and the lack of baseline to compare the findings to make it difficult to make any generalisations on the results, I can report that I was able to model phonaesthemes with a discriminative model.

This experiment has only focused on four dihpone phonaesthemes which are found at the onset position of words. The original list by Otis & Sagi contained rhyme and coda phonaesthemes, some of which were represented as triphones as well, hence there is a high chance of making different findings if one were to perform the same experiment on the whole set of phonaesthemes.

References

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Otis, Katya, & Sagi, Eyal. 2008. Phonaesthemes: A corpus-based analysis. *Proceedings of the annual meeting of the cognitive science society*, **30**(30).

Sering, Konstantin, Weitz, Marc, Künstle, David-Elias, Schneider, Lennart, & Shafaei-Bajestan, Elnaz. 2017. *Pyndl: Naive discriminative learning in python.*

Shisler, Benjamin K. 1997. *Dictionary of English Phonesthemes.*

5 Appendix

The full code as well as the files used to do this experiment can be found on my [github page].