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MULTILINGUAL COMPUTATIONAL LINGUISTICS

UNIVERSITY OF PASSAU

# A COMPUTATIONAL MODEL FOR THE ASSESSMENT OF MUTUAL INTELLIGIBILITY AMONG CLOSELY RELATED LANGUAGES

# INTRODUCTION

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Mein Name ist Jessica. Ich esse gerne Brot, trinke gerne Wasser und gehe gerne schwimmen.

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Mijn naam is Jessica. Ik eet graag brood, drink graag water en ga graag zwemmen.

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*'My name is Jessica. I like to eat bread, I like to drink water and I like to go swimming.'*

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## = MUTUAL INTELLIGIBILITY

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LINGUISTIC FACTORS

EXTRA-LINGUISTIC FACTORS

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### LINGUISTIC FACTORS

- Lexicon
- Orthography
- Morphology
- Phonological similarities
- Modality: spoken vs. written

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- Phonological similarities
- Modality: spoken vs. written

### EXTRA-LINGUISTIC FACTORS

- Previous exposure
- Attitude towards target language

# PREVIOUS EXPERIMENTAL WORK

- Research on mutual intelligibility involves experimental studies with participants
- Gooskens and Swarte (2017): large-scale study on mutual intelligibility of Germanic languages using a spoken and written cloze test and language background questionnaires
- Total of 954 participants with 5 different native languages (Dutch, German, English, Swedish, Danish)

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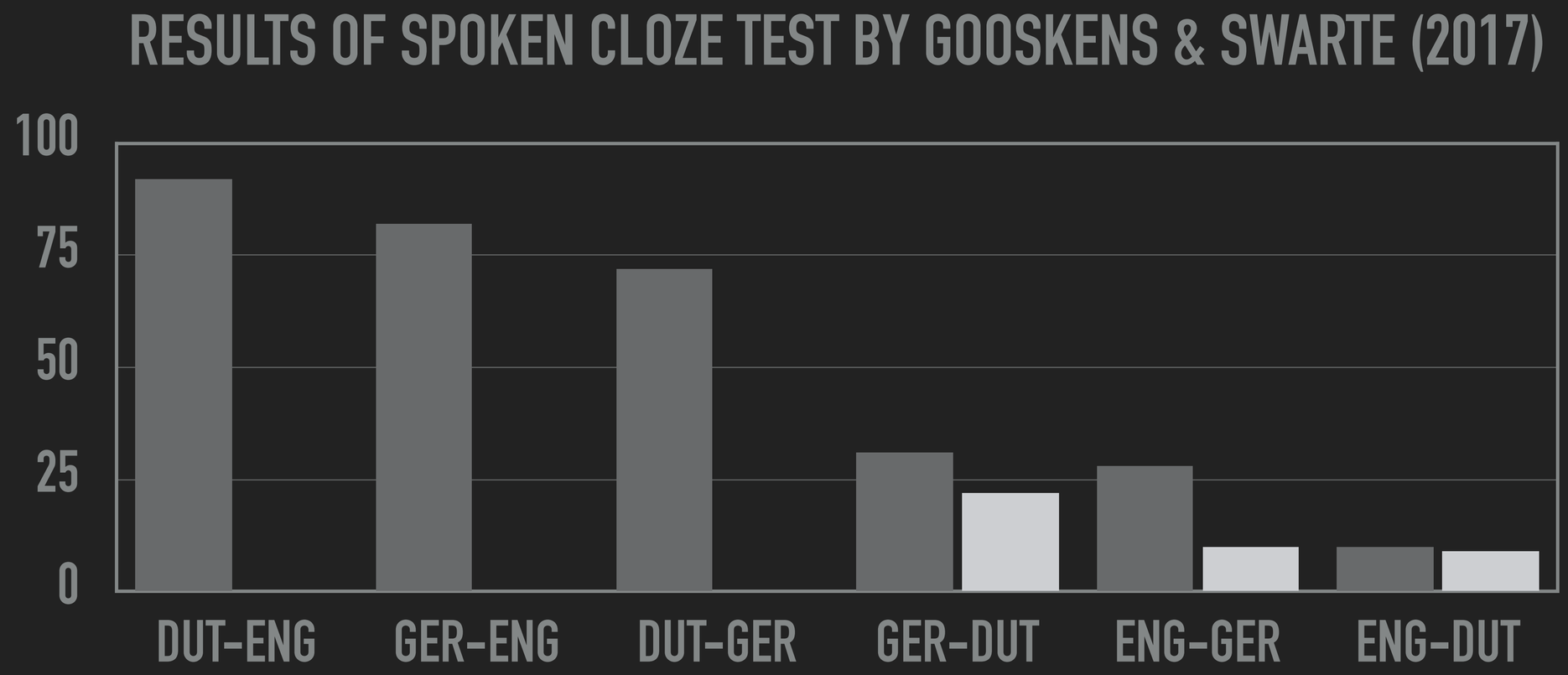

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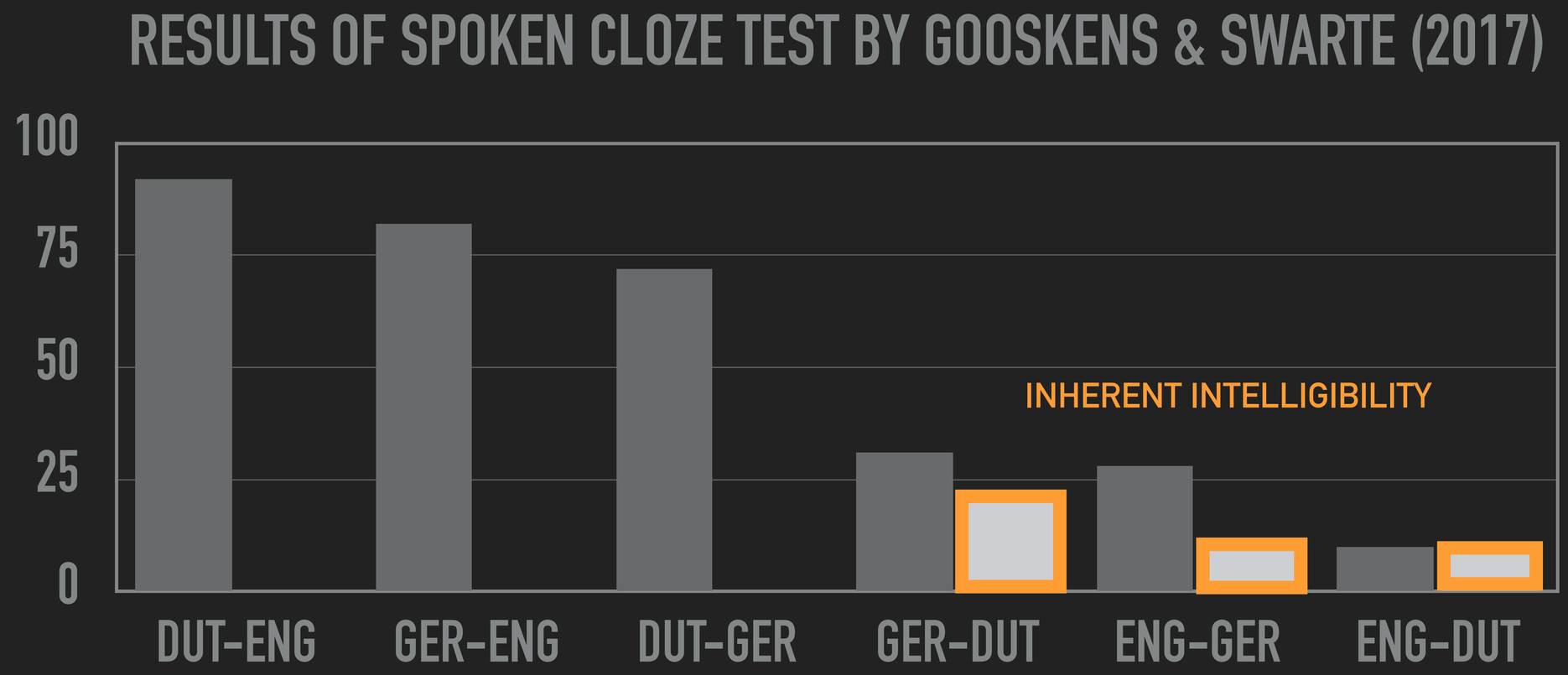

# PREVIOUS EXPERIMENTAL WORK

- Previous language exposure strongest factor for mutual intelligibility scores
- When focusing on minimum of exposure (i.e. inherent intelligibility), lexical distances and orthographic distances are the most important factors

# THIS STUDY

- A computer-assisted method to assess mutual intelligibility in Germanic languages (Dutch, German, English)

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- A computer-assisted method to assess mutual intelligibility in Germanic languages (Dutch, German, English)
  - Uniform method that can be adapted to various languages
  - Testing human participants is a time- and resource-consuming effort
  - Finding participants with no exposure to another language is almost impossible
  - Testing linguistic factors only

# THE COMPUTATIONAL FRAMEWORK

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## LINEAR DISCRIMINATIVE LEARNING

- Based on Discriminative Lexicon framework by Baayen et al. (2019)
- Model of language processing exploring cognitive mapping mechanisms involved in language learning
- Provides method to model word comprehension

# THE COMPUTATIONAL FRAMEWORK

- Word comprehension in LDL: mapping of form onto meaning

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#D_DO_OG_G#

Animate, four legs, fur, floppy ears…

{0.1, 0.2, 0.11, 0.45…}

# THE COMPUTATIONAL FRAMEWORK

- Word comprehension in LDL: mapping of form onto meaning
- Implemented as multivariate regression using phonological form matrix **C** and semantic matrix **S**
- Association weight between cues are specified in training, model predicts semantic vector during testing
- Predicted vector used for comprehension accuracy = measures how well a form is understood

# PHONOLOGICAL CUES

- Cognate sets derived from Kluge (2002): total of 340 word forms in German with reflexes in Dutch and English
- Added phonetic transcriptions and phonetic alignments using EDICTOR (List, 2021)
- Reduced phonetic detail using Dolgopolsky sound classes (Dolgopolsky, 1986)
- two different representations of word forms: full forms and trimmed forms (=bare stems; Blum & List, 2023)

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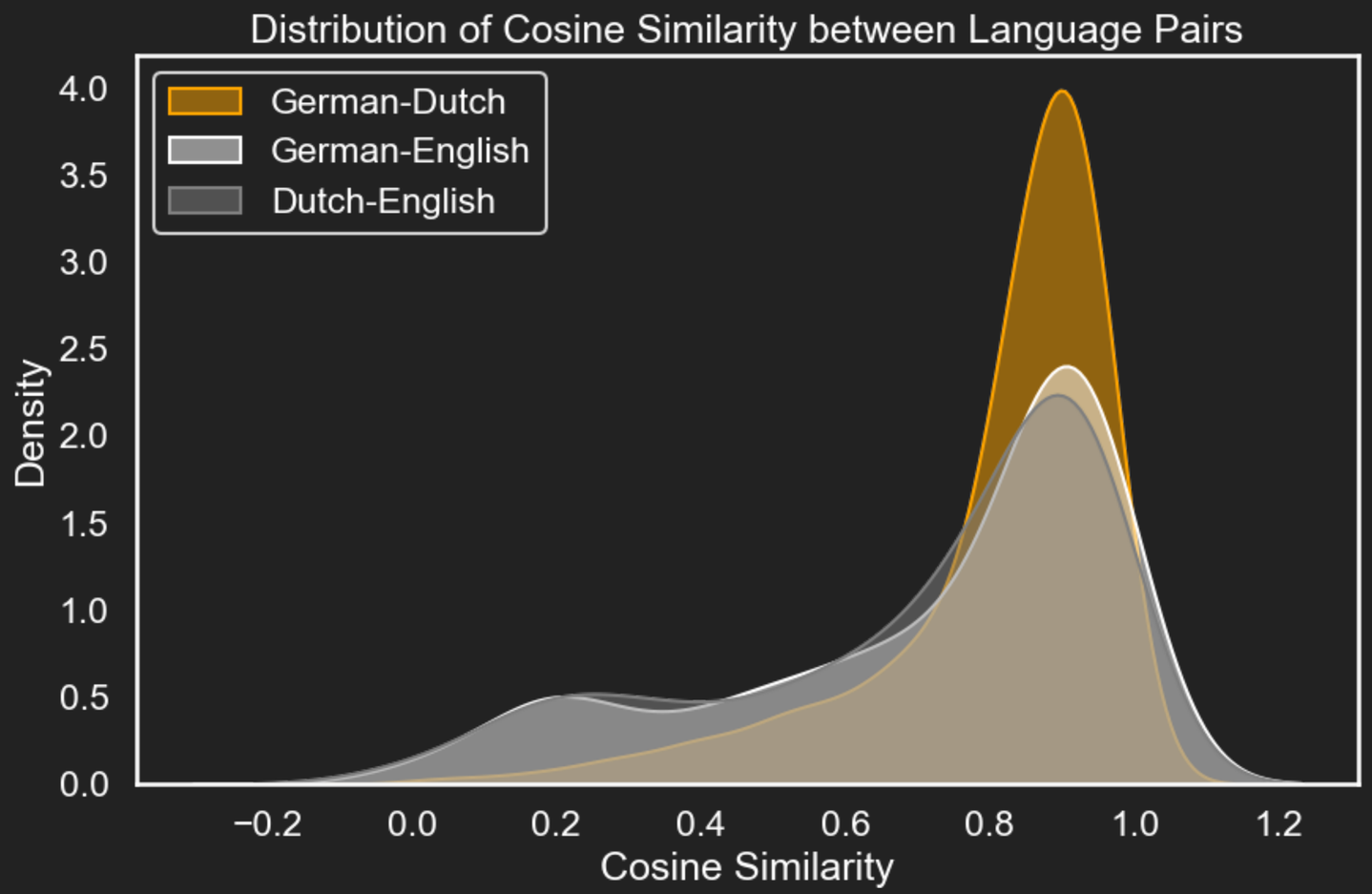
- Reduced phonetic detail using Dolgopolsky sound classes (Dolgopolsky, 1986), **e.g. T R V N K vs. T R V N K V N**
- Two different representations of word forms: full forms and trimmed forms (=bare stems; Blum & List, 2023) , **e.g. T R V N K vs. T R V N K V**

# MEANING REPRESENTATIONS

- As meaning representation we used the multilingual ConceptNet Numberbatch word embeddings version 19.08 from Speer et al. (2017)

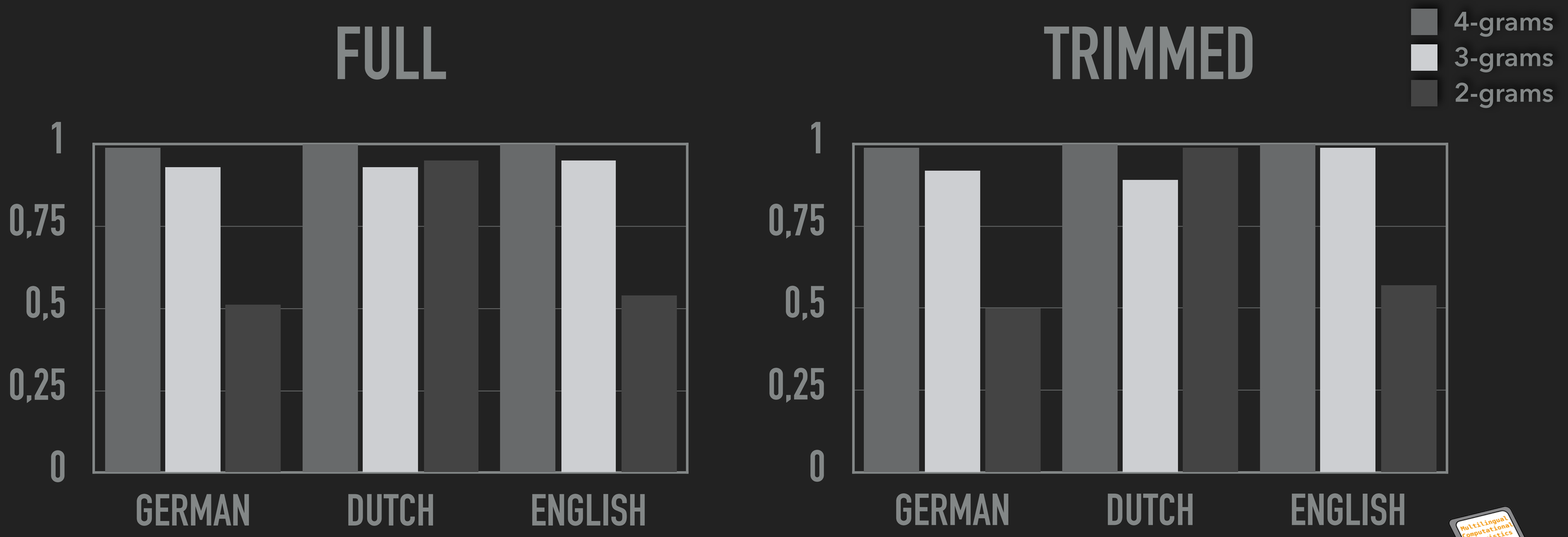
# MEANING REPRESENTATIONS – COSINE SIMILARITY



# LINEAR DISCRIMINATIVE LEARNING MODEL

- Step 1:
  - Evaluation on cognate data of individual languages
  - 339 forms in total due to a missing form in Dutch
  - 4-gram, 3-gram and 2-gram chunks of sound classes
  - Full word forms vs. Trimmed forms

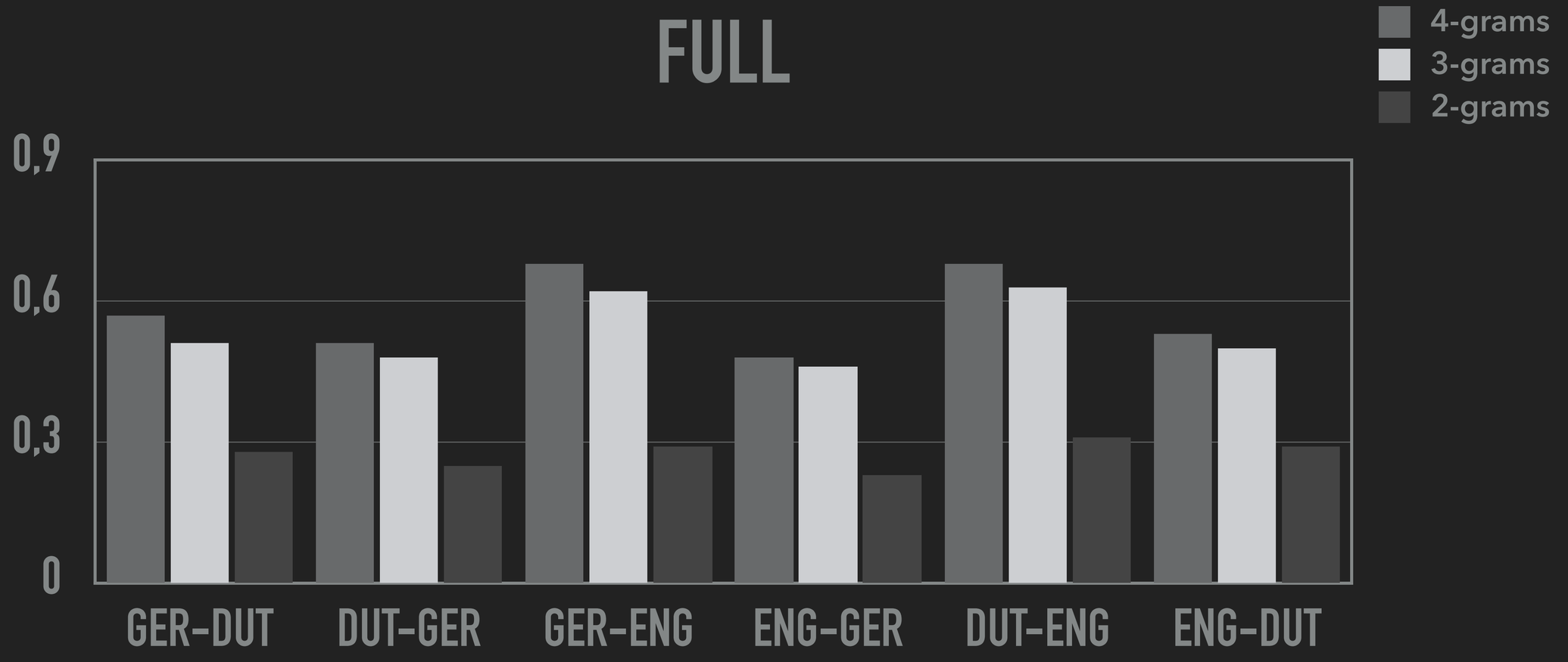
# RESULTS


FULL
TRIMMED
4-grams
3-grams
2-grams
1
0,75
0,5
0,25
0
GERMAN
DUTCH
ENGLISH
1
0,75
0,5
0,25
0
GERMAN
DUTCH
ENGLISH

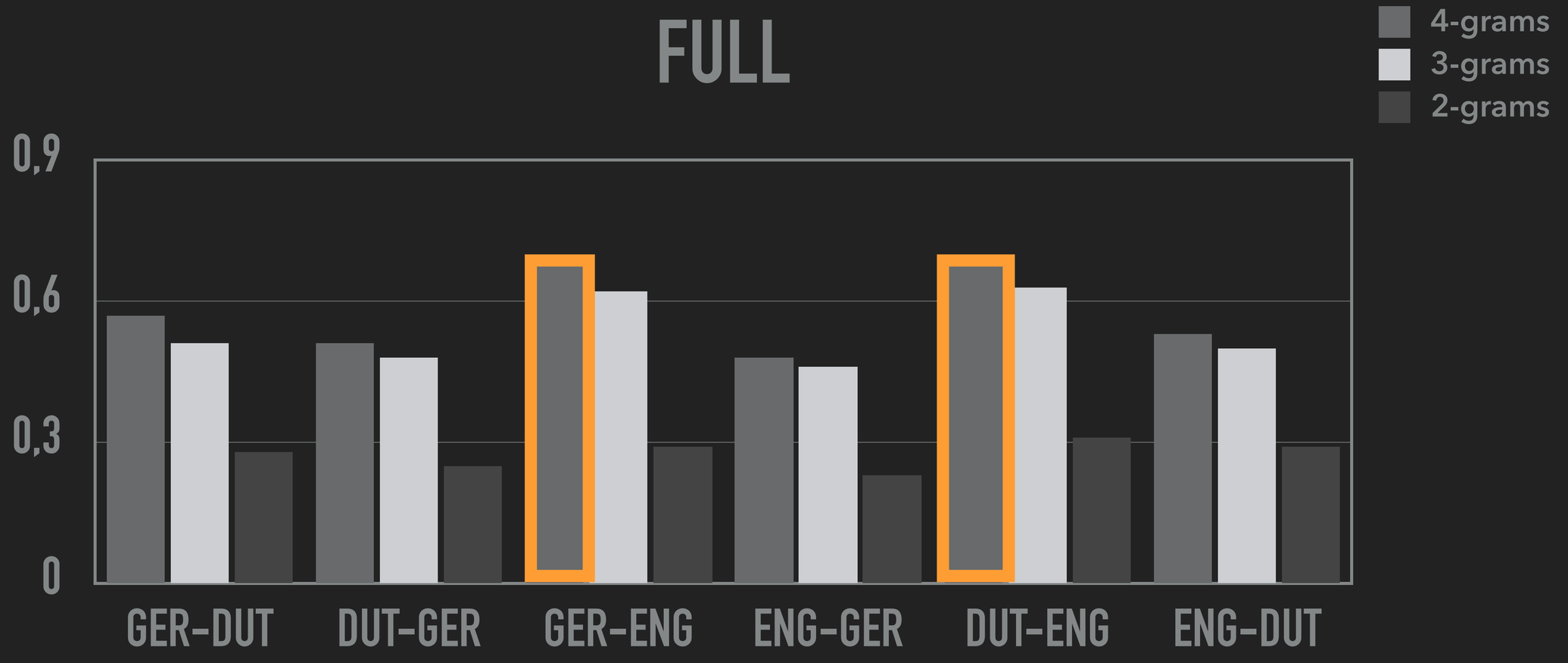
# LINEAR DISCRIMINATIVE LEARNING MODEL

- Step 2:
  - Evaluation on cognate data across languages
  - 339 forms in total due to a missing form in Dutch
  - 4-gram, 3-gram and 2-gram chunks of sound classes
  - Full word forms vs. Trimmed forms

# RESULTS

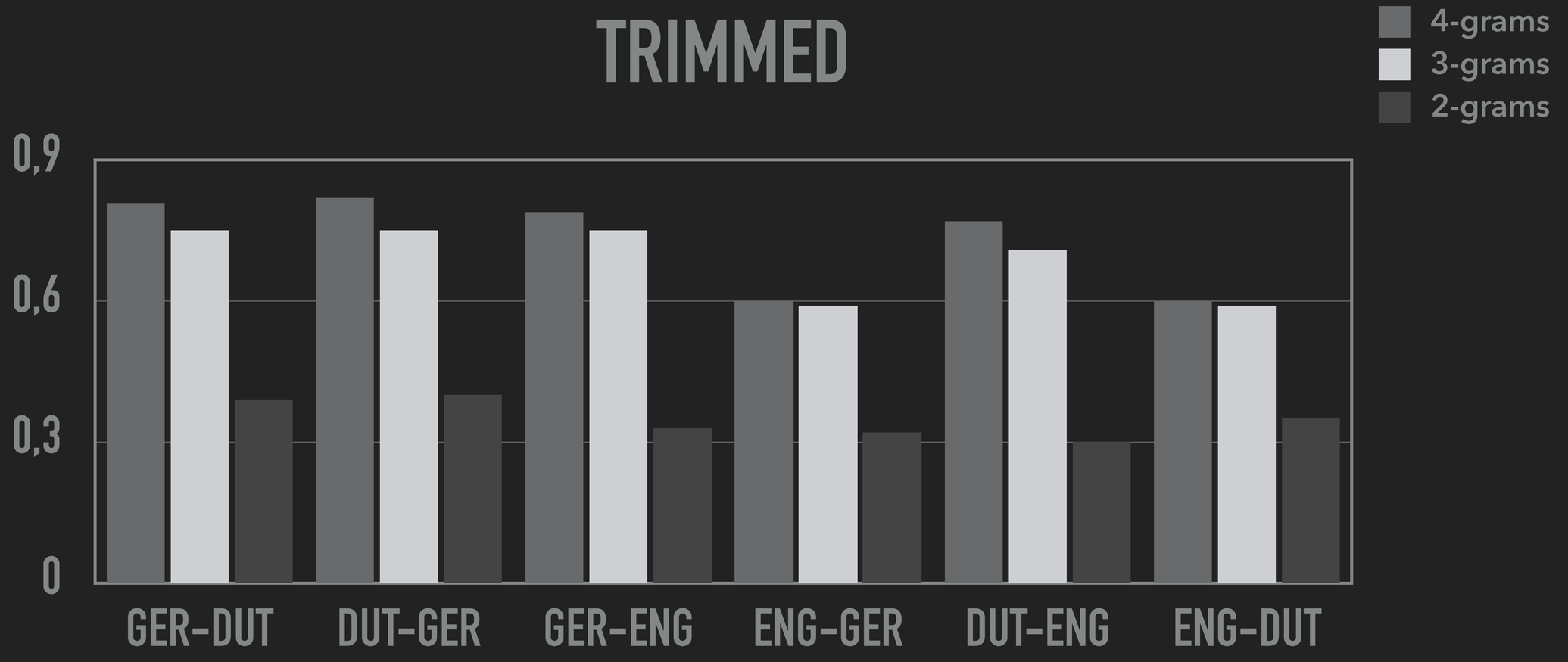

FULL
4-grams
3-grams
2-grams
0,9
0,6
0,3
0
GER-DUT
DUT-GER
GER-ENG
ENG-GER
DUT-ENG
ENG-DUT

# RESULTS




IN LINE WITH GOOSKENS & SWARTE (2017)

# RESULTS


TRIMMED
4-grams
3-grams
2-grams
0,9
0,6
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0
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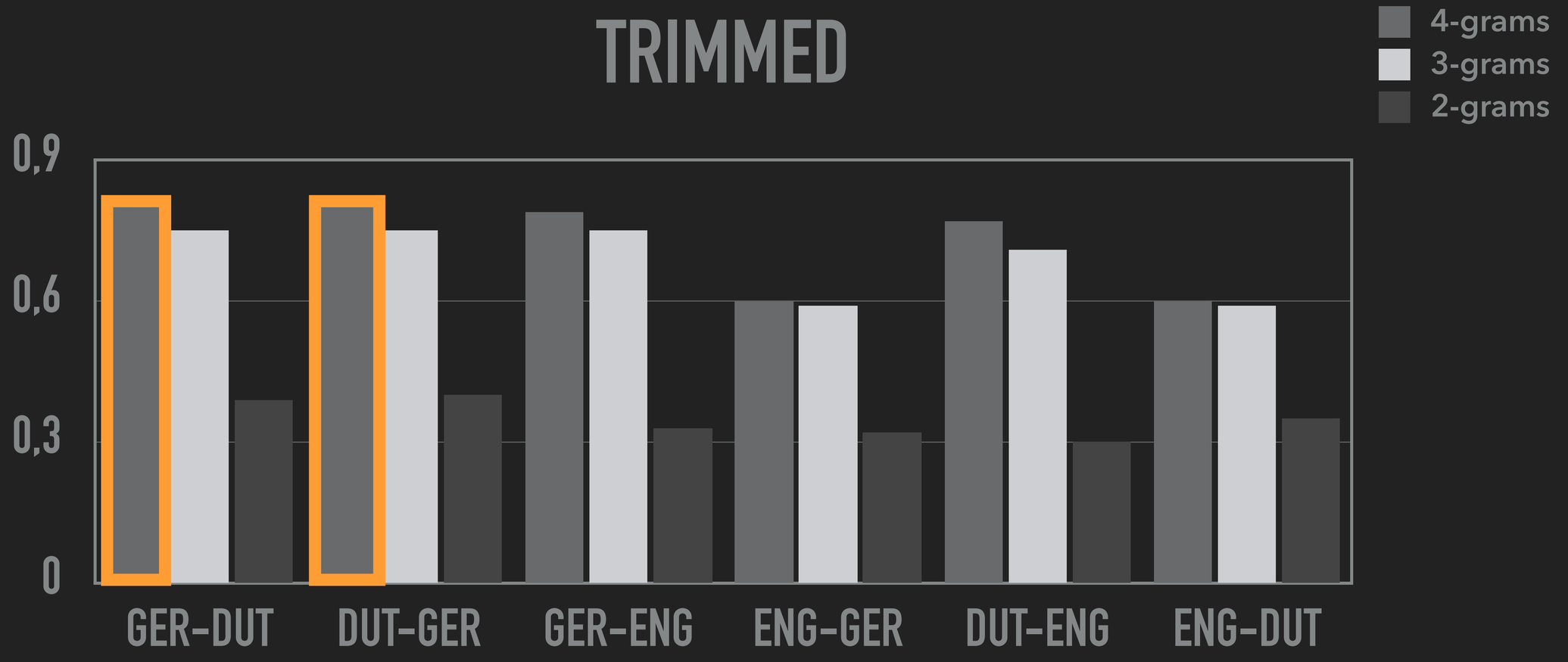
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0,9
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0
GER-DUT
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GER-ENG
ENG-GER
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ENG-DUT

# DISCUSSION

- Best results with 4-grams and 3-grams
- Better results for trimmed than for full words
- Full word forms: best results Dutch-English, in line with Gooskens and Swarte (2017)
- Trimmed word forms: best results for Dutch-German
- English least advantageous native language in our and Gooskens and Swarte (2017)'s setting

# DISCUSSION

- Higher accuracy for German-English than German-Dutch (in line with Gooskens and Swarte, 2017) for full forms but opposite effect for trimmed
- Dutch-English better than Dutch-German for full forms but again opposite picture for the trimmed version

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**MORPHOLOGICAL KNOWLEDGE AFFECTS COMPREHENSION**

# DISCUSSION

- We present a computational approach to test mutual intelligibility across languages using LDL
- Our data shows similarities to human comprehension results, making it a useful tool to assess mutual intelligibility

# LIMITATIONS

- We tested 3 Germanic languages only, this needs to be extended to other languages and language families
- We tested cognate data only, this needs to be extended to non-cognate data

# THANK YOU, GRAZZI ĦAFNA, DANKE AND DANK JE WEL!

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