

**Background**



## Language attitudes

**French sounds beautiful  
and romantic.**

**German sounds harsh  
and aggressive.**

## Language attitudes



# Language attitudes



# Language attitudes



# Language attitudes





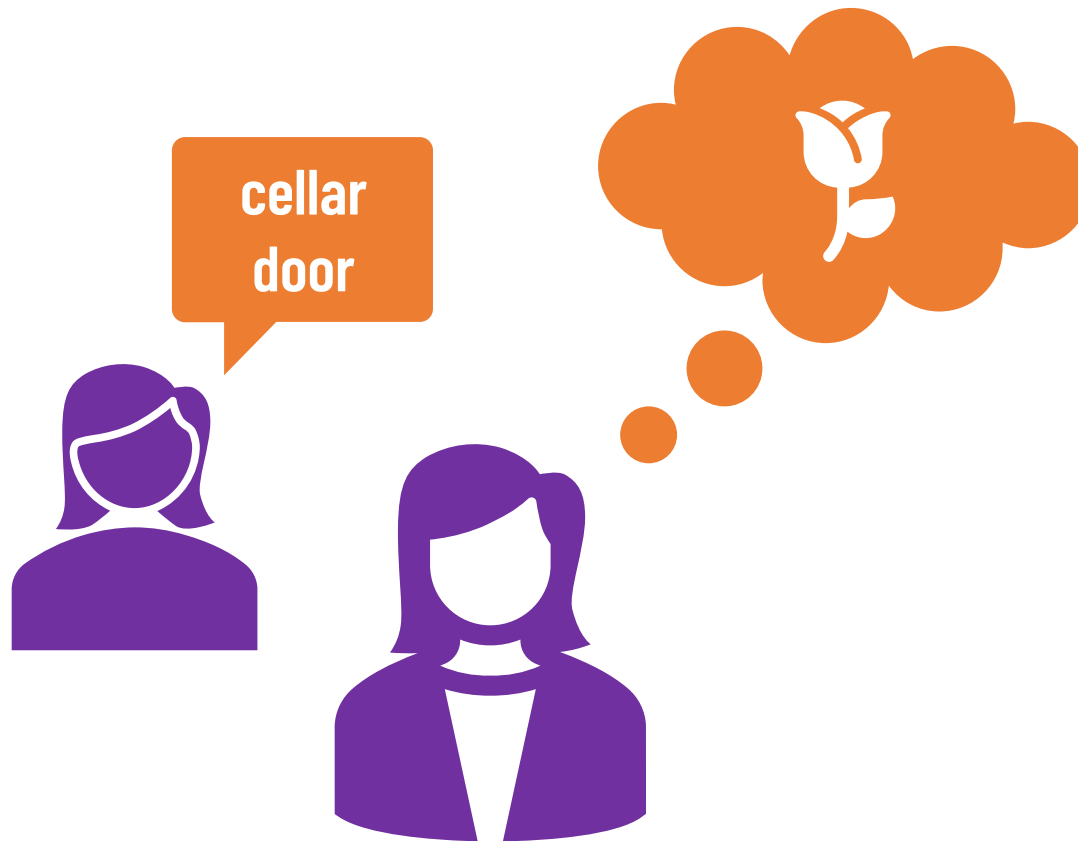
# Language attitudes



## Language attitudes



## Language attitudes



# Language attitudes





The big unsolved question

# Why attitudes?

Why do listeners have attitudes towards language?



Two groups of explanations

INDEXICALITY

ICONICITY



## Two groups of explanations

INDEXICALITY



ICONICITY



Peirce 1958; Silverstein 2003; Giles and Niedzielski 1998  
Kawahara et al. 2021; Winter et al. 2022



Some studies looking at both groups of explanations

Reiterer et al. 2020

evidence for both **social** and **phonetic/phonological** factors

Mooshammer et al. 2023

evidence for both **social** and **phonetic/phonological** factors

Anikin et al. 2023

evidence for only **social** factors

Hilton et al. 2022

evidence for only **phonetic/phonological** factors



## This series of studies:

- ▶ uses languages never heard before, created from scratch.
- ▶ can play with sounds and social attributes in a targeted way.
- ▶ isolates specific, potentially iconic phonetic-phonological properties.

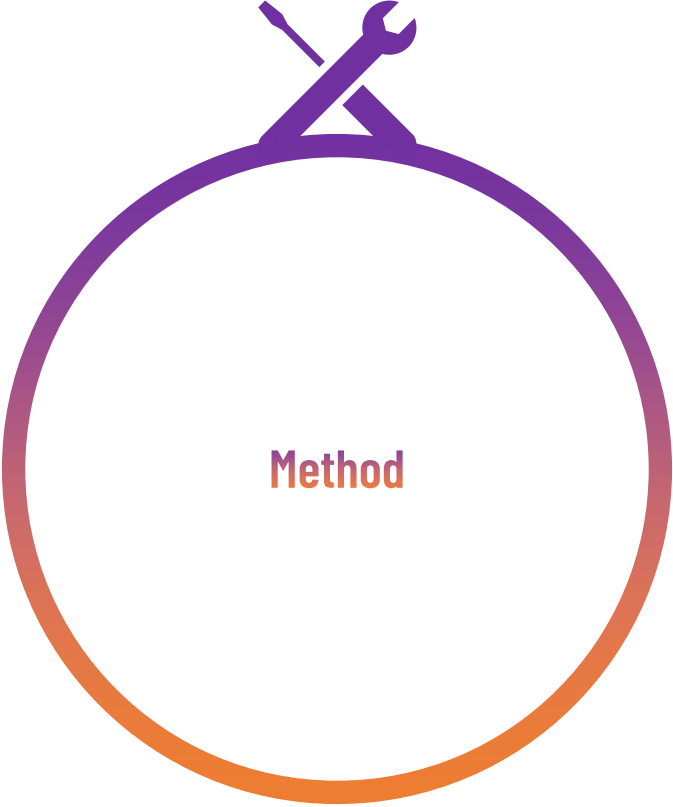
SPECIFIC  
PHONEMES

SYLLABLE  
STRUCTURE

SONORITY

...

e.g., Jacobs 2017



**Method**



# SSPG Sonority-sensitive pseudotext generator

**Sonority-sensitive pseudotext generator**

**Sound inventory** Click on a sound to **add** it to your inventory, click again to **remove** it. Non-pulmonic consonants are currently not available.

**Consonants**

	Bilabial	Labiodental	Dental	Alveolar	Postalveolar	Retroflex	Palatal	Velar	Uvular	Pharyngeal	Glottal
Plosive	p b			t d		ʈ ɖ	c ɟ	k ɡ	q ɢ		ʔ
Nasal	m	ɱ		n		ɳ	ɲ	ŋ	ɴ		
Trill	ʙ			ʀ					ʀ		
Tap or Flap		ɸ		ɾ		ɽ					
Fricative	ɸ β	f v	θ ð	s z	ʃ ʒ	ʂ ʐ	ç ʝ	x ɣ	χ ʁ	ħ ʕ	h ɦ
Lateral fricative				ɬ ɮ							
Approximant		ʋ		ɹ		ɻ	j	ɰ			
Lateral approximant				l		ɭ	ʎ	ʟ			

**Vowels**

**Syllable structures** **Probability**

- V
- CV
- CCV
- CCCV
- VC
- VCC
- VCCC
- CVC
- ...

For each chosen syllable structure, specify how likely a syllable is to have this structure. Example: You have chosen V and CV. You assign a probability of 0.1 to V and of 0.9 to CV. This means that 10 % of your syllables will have V structure and 90 % of your syllables will have CV structure.

**Sonority score** **Target average**

Parker 1-17

Fought

**Length of output text in words**

How long do you want your output text to be?

**Sonority score** **Target average**

Parker  1-17

Fought

**Max**

Enter a number specifying how many syllables your words can maximally have.

In development.  
GUI is a draft concept.



## SSPG Sonority-sensitive pseudotext generator

### Control stimuli

Consonants = ['m', 'k', 'j', 'p', 'w', 'n', 't', 'l', 's', 'b']

Vowels = ['i', 'e', 'a', 'u', 'o', 'ɔ']

TargetSonc  ty = 1

MaxSyllableNumber = 4

SyllableStructures = ['V', 'CV']

SyllableWeights = [1, 9]

TextLength = 100

SenLength = max(1, int(random.gauss(12, 5)))

### Target stimuli

Consonants = ['m', 'k', 'j', 'p', 'w', 'n', 't', 'l', 's', 'b']

Vowels = ['i', 'e', 'a', 'u', 'o', 'ɔ']

TargetSonc  ty = 17

MaxSyllableNumber = 4

SyllableStructures = ['V', 'CV']

SyllableWeights = [1, 9]

TextLength = 100

SenLength = max(1, int(random.gauss(12, 5)))

cf. Gordon 2016, Maddieson 2013, Moran et al. 2019, Goodall 2020, Parker 2008



## SSPG Sonority-sensitive pseudotext generator

Speaker	Control stimuli			Target stimuli		
	1	2	3	1	2	3
Mean sonority <b>1-17</b>	9.36	9.32	9.33	12.08	12.06	12.18
Consonants %	47.17	47.33	47.4	46.61	47.14	46.96
Obstruents %	41.09	42.39	42.21	13.75	15.38	13.77
Vowels %	52.8	52.7	52.6	53.4	52.9	53
Voicing %	61.3	59.47	60.72	90.44	88.58	89.88
Syllable structure	CV, V	CV, V	CV, V	CV, V	CV, V	CV, V
Syllable weights <b>0-1</b>	0.9, 0.1	0.9, 0.1	0.9, 0.1	0.9, 0.1	0.9, 0.1	0.9, 0.1
Number of words in text	100	100	100	100	100	100
Max number of syllables	4	4	4	4	4	4
Sound inventory	same	same	same	same	same	same



## SSPG Sonority-sensitive pseudotext generator

### Example for control condition

Kemeti sou ko pipomisi no epi enekomi. Te kepikiki esobe i sa kabu pusa kio si pousu libooo sepaputa pilo. Topeke nimeki kupuuki weo kopekupe tukitu ka tutemu ne paku mi tetu. Pu komutuso pipuji te tue kiki kuwupiba tuto kunate sota tokokui tukotuti pupikaa kopake kepobeo ti tapa tako pipotite kusi. Pu woe ketu sipekoo pe isetu okibase take pekotobu pe popibami putoi ute ba peteti. Posa pike pewoki tiki kekikeko tetu. Topo jaketi poka. Kapuki. Tipa te tasi bepi seite ikatina muto piloki upa. napoko metepu ki ki pu putetuso peteu kiti puba kasu me kepa niteti kui.



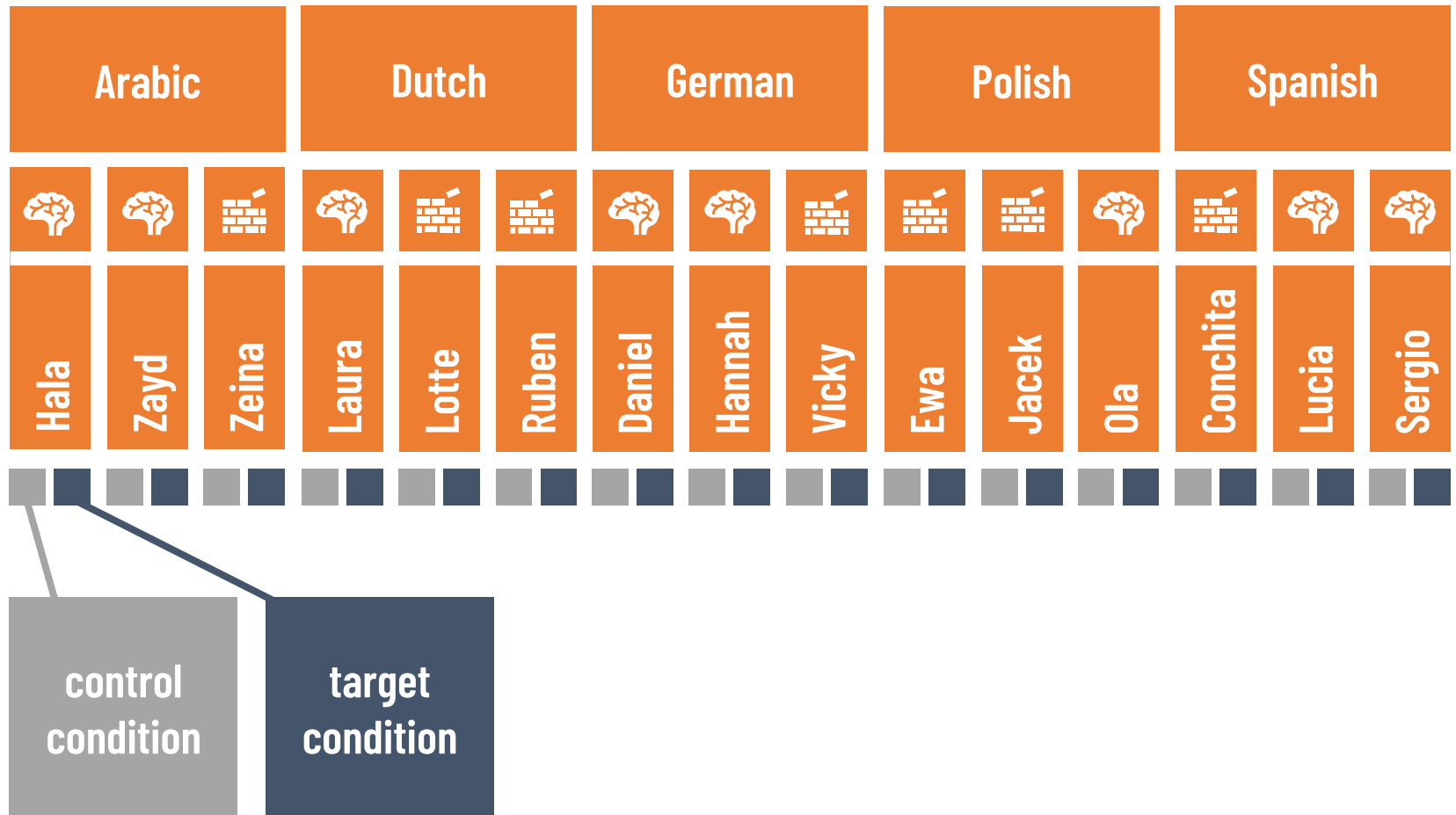
## SSPG Sonority-sensitive pseudotext generator

### Example for target condition

Bo jueno wi jeniulo iwusomu pameba nekia. Biwapo a luno simuwe awi nupiwoja somutau lujate sewajinu opeti. Jopawu joso kama sosa wumu momope momowalu kokuna lo ulojoje totojabe umuma. Ta jalowo bi lememela me u pojewuu benu. Pejaku owina ibupawe baaka wa wuwoli jujaba li libi lowakawa jo luwuba ma jaweloni. Ji eka we jelilulu abeeji ta bijana newenu lolelapu bumekawa aweja. Wiimeo jeobese jokemuja ka wu suweno lia ja naibuwa siba muwalobu bajajemo laeje woja wootao kaamala bi niilami. O tajonawa wumejo nomalowe e oluwa lajiewi we salewo wuwite jeni apa mutaku. Wemawo palula mu jalobo nalemole ta lawola.



# Speech synthesis with Amazon Polly





## Participant quota sampling by **FIRST LANGUAGE** Prolific

only monolingually raised speakers

Czech	Dutch	English	Estonian	Finnish
French	German	Greek	Hebrew	Hungarian
Italian	Korean	Polish	Portuguese	Romanian
Russian	Slovenian	Spanish	Swedish	Turkish
Vietnamese				

after cleaning



= 463 listeners



## Participant quota sampling by **FIRST LANGUAGE** Prolific

### low sonority

Czech	Dutch	English	Estonian	German
Hebrew	Hungarian	Korean	Polish	Romanian
Russian	Slovenian	Swedish	Turkish	

### high sonority

Finnish	French	Greek	Italian	Portuguese
Spanish	Vietnamese			



## Response variables

SCALE	NEGATIVE VALENCE	1	POSITIVE VALENCE	100
PLEASANTNESS	unpleasant	—	pleasant	
BEAUTY	ugly	—	beautiful	
SOFTNESS	hard	—	soft	
SHAPE	spiky	—	round	
EDUCATION	uneducated	—	educated	
INTELLIGENCE	stupid	—	intelligent	
FRIENDLINESS	unfriendly	—	friendly	
ORDINARINESS	strange	—	normal	
GOODNESS	evil	—	good	
EROTICISM	unerotic	—	erotic	



# Questionnaire

19% completed

## Rate speech

In the far future, you encounter a colony of human-like robots on a distant planet. Your task on this expedition is to try to understand robot society and communication.



Every individual robot speaks in a different language, accent, or dialect, but they can all understand each other by using internal translation programs. Some of the robots sound very similar, for example because they happened to get a similar voice program when they were built, or because their dialects happen to be close to each other. But you quickly notice that just like humans, every robot is unique.



You want to improve your ability to distinguish the robots and their roles in society based on their speech. To do this, you will listen to three pairs of robots. Each of the two robots in a pair will sound similar, but slightly different. You will try to rate the speech of each robot on different attributes.

When you are ready, click "Next."





## Questionnaire

### Rate speech

In the far future, you encounter a colony of human-like robots on a distant planet. Your task on this expedition is to try to understand robot society and communication.



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## Questionnaire



You want to improve your ability to distinguish the robots and their roles in society based on their speech. To do this, you will listen to three pairs of robots. Each of the two robots in a pair will sound similar, but slightly different. You will try to rate the speech of each robot on different attributes.

When you are ready, click "Next."





## Questionnaire

You will now listen to the first pair of robots.

Please make sure you have sound enabled on your device and click "Next".



Next



## Questionnaire



30% completed

Please listen to the recording of the first robot:

To listen, click the play button.





# Questionnaire

## How does the robot sound?





## Questionnaire

**How familiar does this language sound to you?**

not at all familiar



very familiar

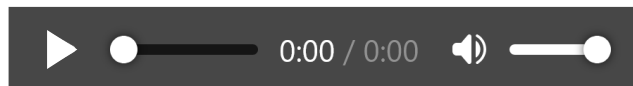
**Which real language or dialect, do you think, does this language resemble the most?**



## Questionnaire

Please listen to the recording of the second robot:

To listen, click the play button.





# Modeling

cf., e.g.,  
Hilton et al. 2022  
Anikin et al. 2023  
Reiterer et al. 2020  
Mooshammer et al. 2023



## Modeling **One model with all scales**

**RATING** ~ **SONORITY \* LISTENER SONORITY +**  
**RECOGNITION +**  
**FAMILIARITY +**  
**LANGUAGE +**  
**LISTENER GENDER \* VOICE GENDER +**  
**POLYGLOT +**  
**AGE + MUSICALITY + LINGUISTICS +**  
**INPUT + OUTPUT + LOCATION +**  
**SCALE +**  
**(1 | PARTICIPANT)**

cf., e.g.,  
 Hilton et al. 2022  
 Anikin et al. 2023  
 Reiterer et al. 2020  
 Mooshammer et al. 2023

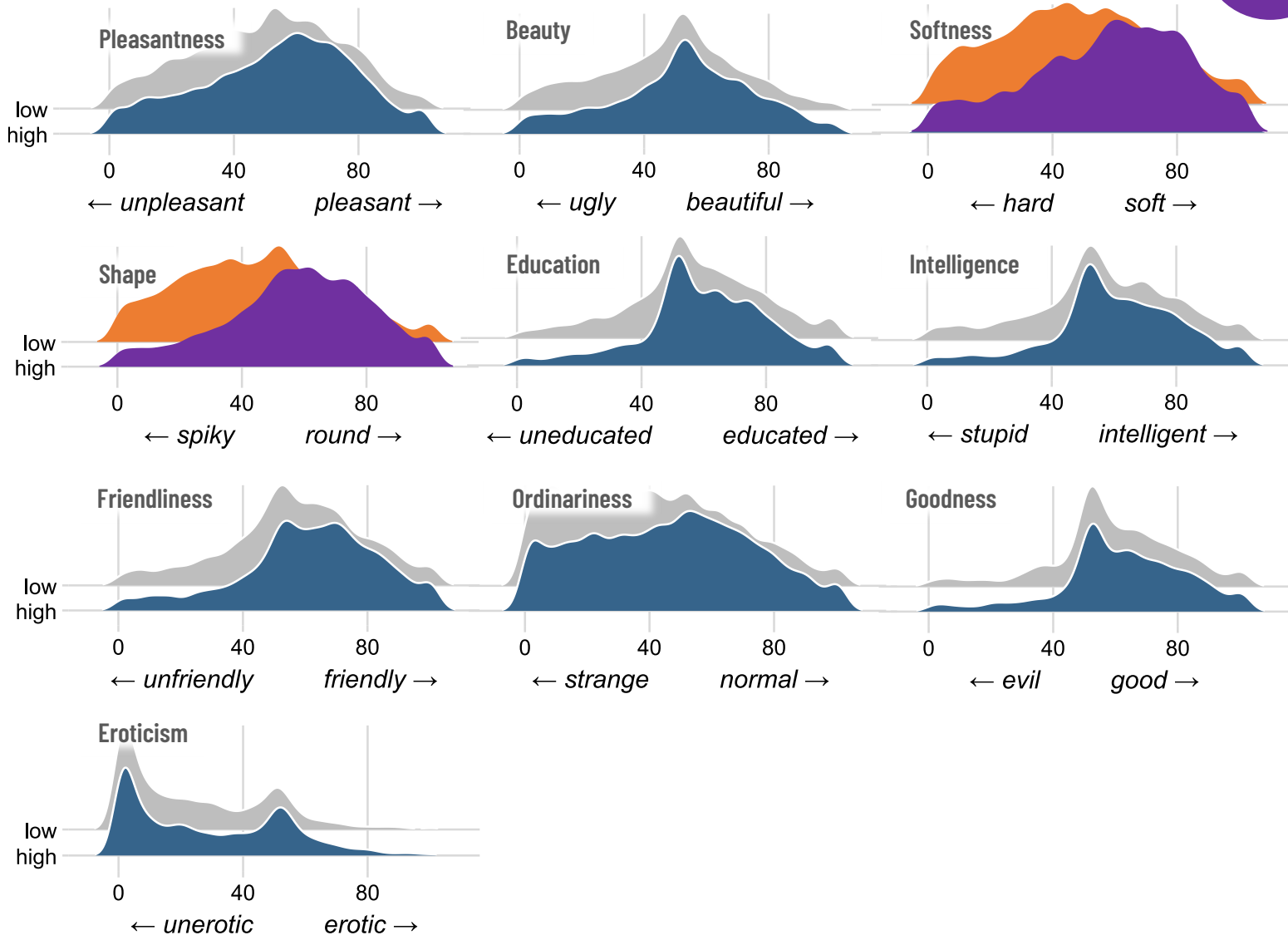


## Modeling **One model for each scale**

**PLEASANTNESS** ~ **SONORITY \* LISTENER SONORITY +**  
**RECOGNITION +**  
**FAMILIARITY +**  
**LANGUAGE +**  
**LISTENER GENDER \* VOICE GENDER +**  
**POLYGLOT +**  
**AGE + MUSICALITY + LINGUISTICS +**  
**INPUT + OUTPUT + LOCATION +**  
**(1 | PARTICIPANT)**

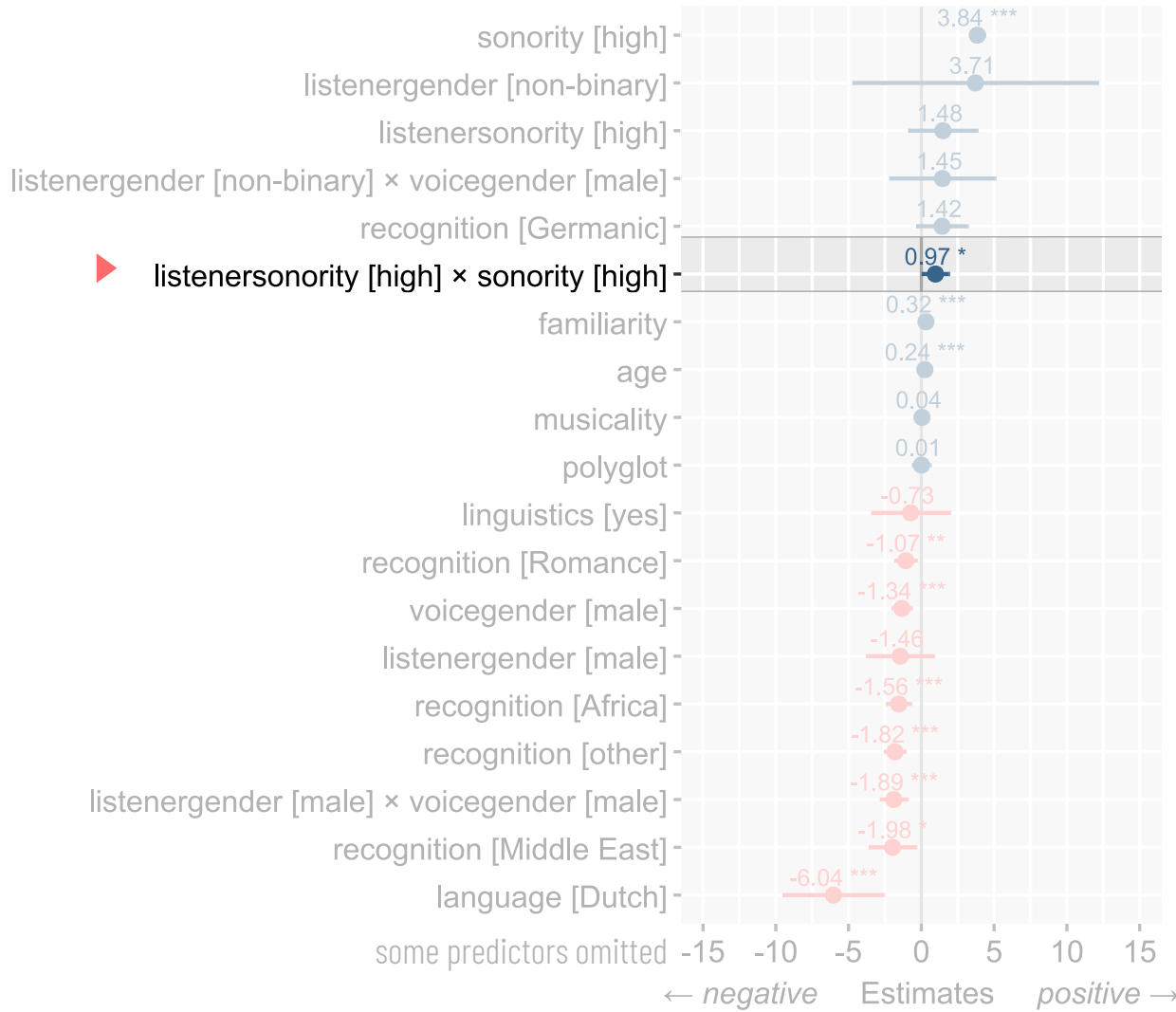
cf., e.g.,  
Hilton et al. 2022  
Anikin et al. 2023  
Reiterer et al. 2020  
Mooshammer et al. 2023





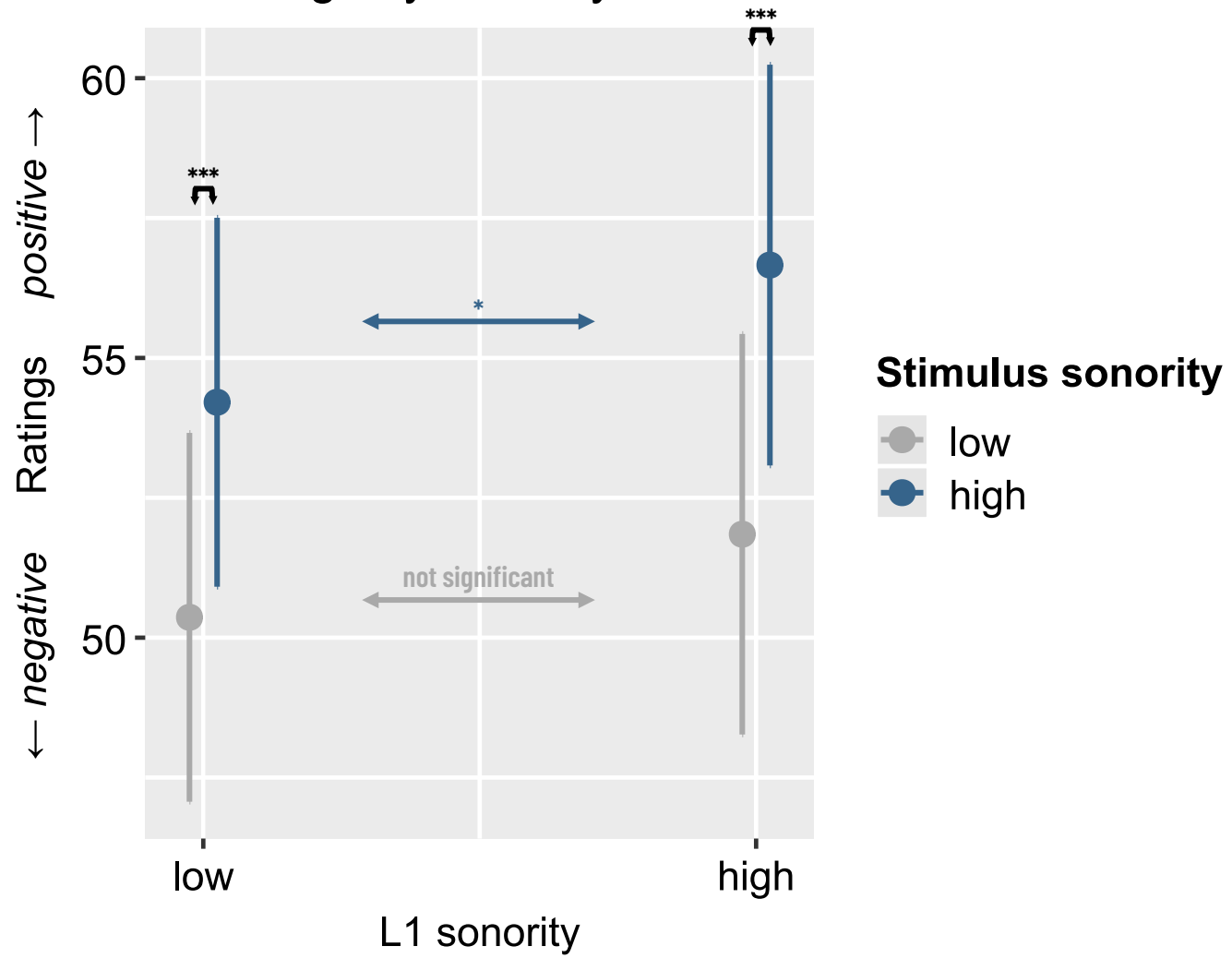
Distribution of ratings by sonority for each scale

Effects across all rating scales

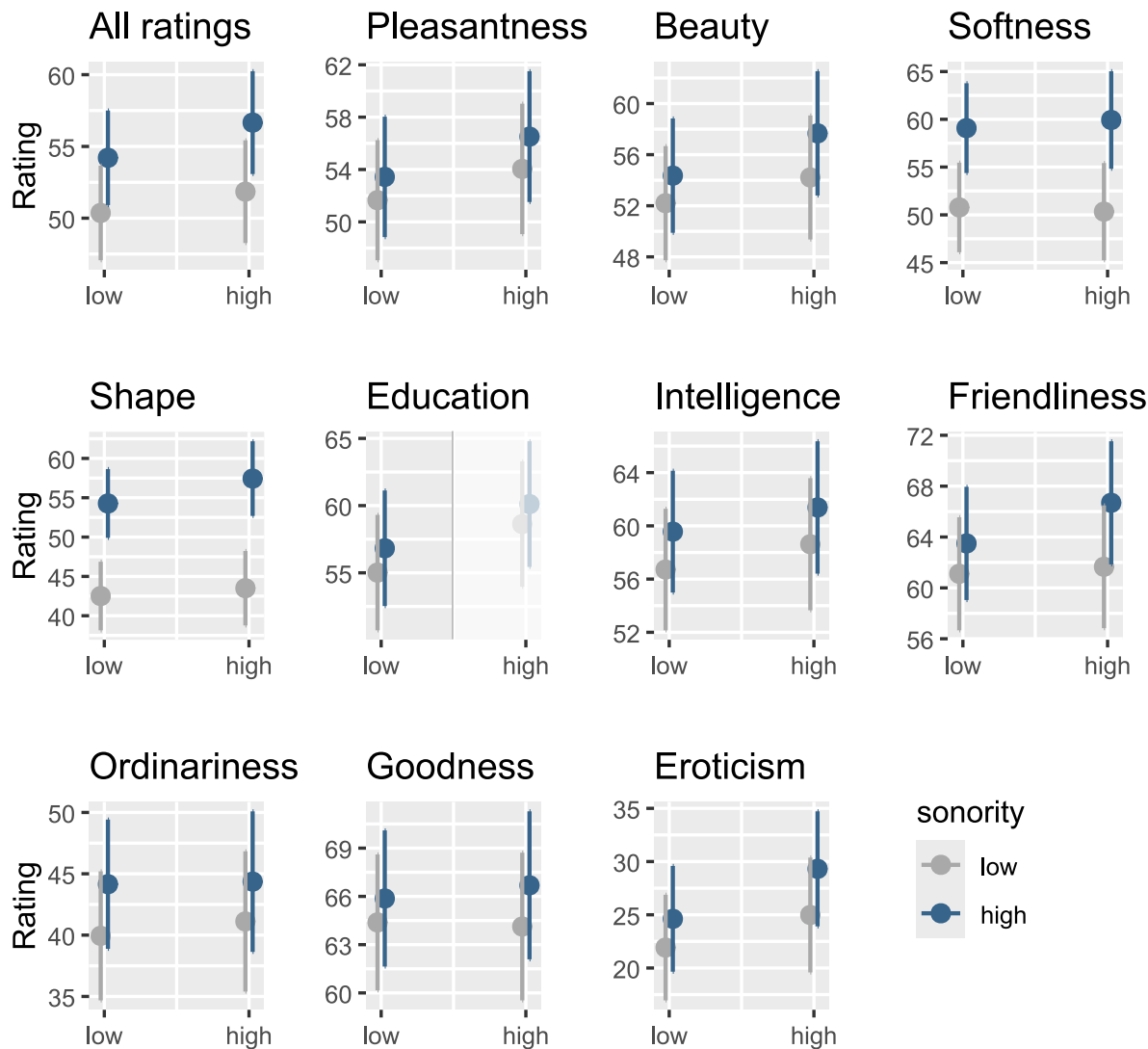


Overview of model with all scales

All ratings by sonority

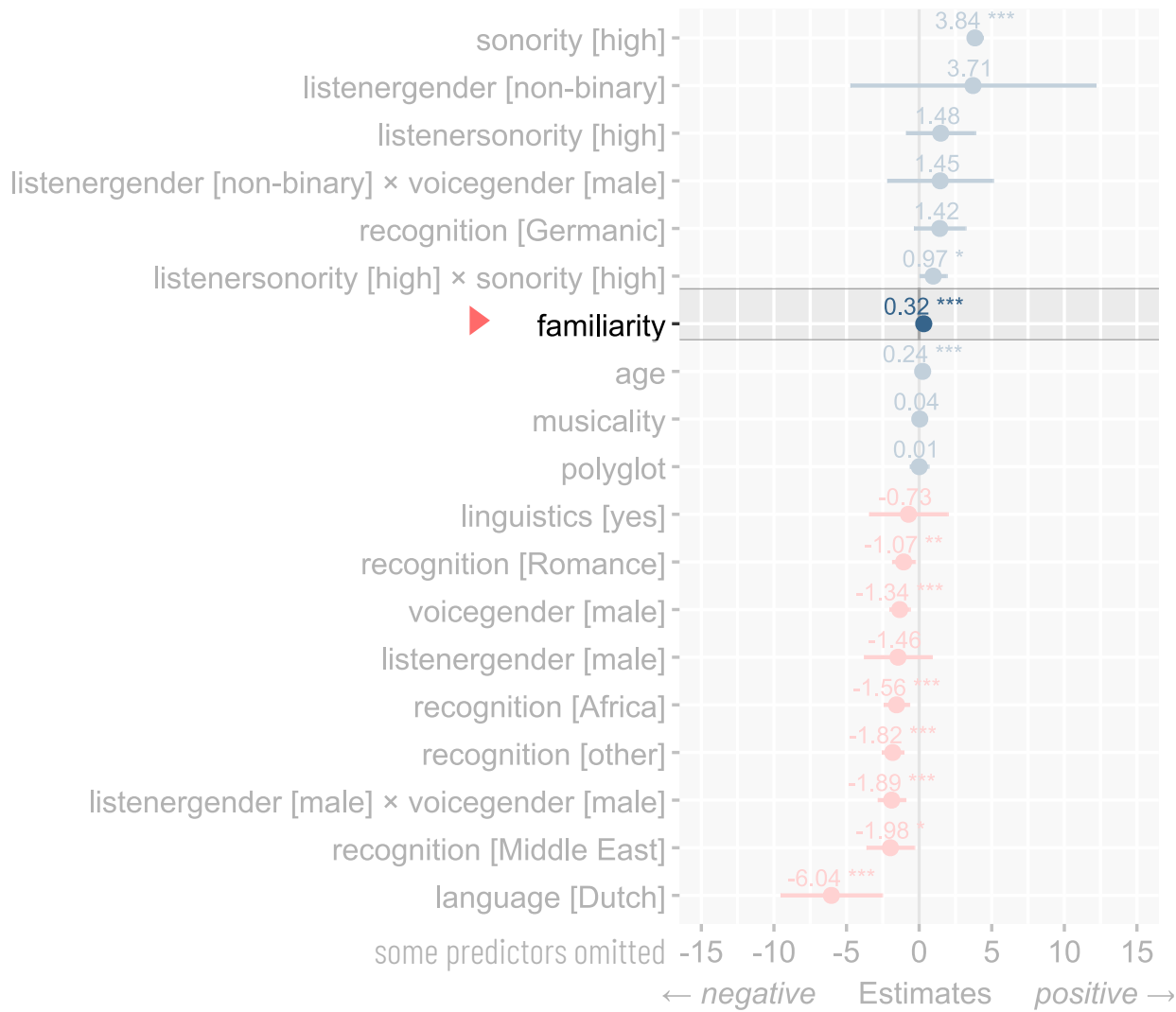


Condition by exposure for model with all scales

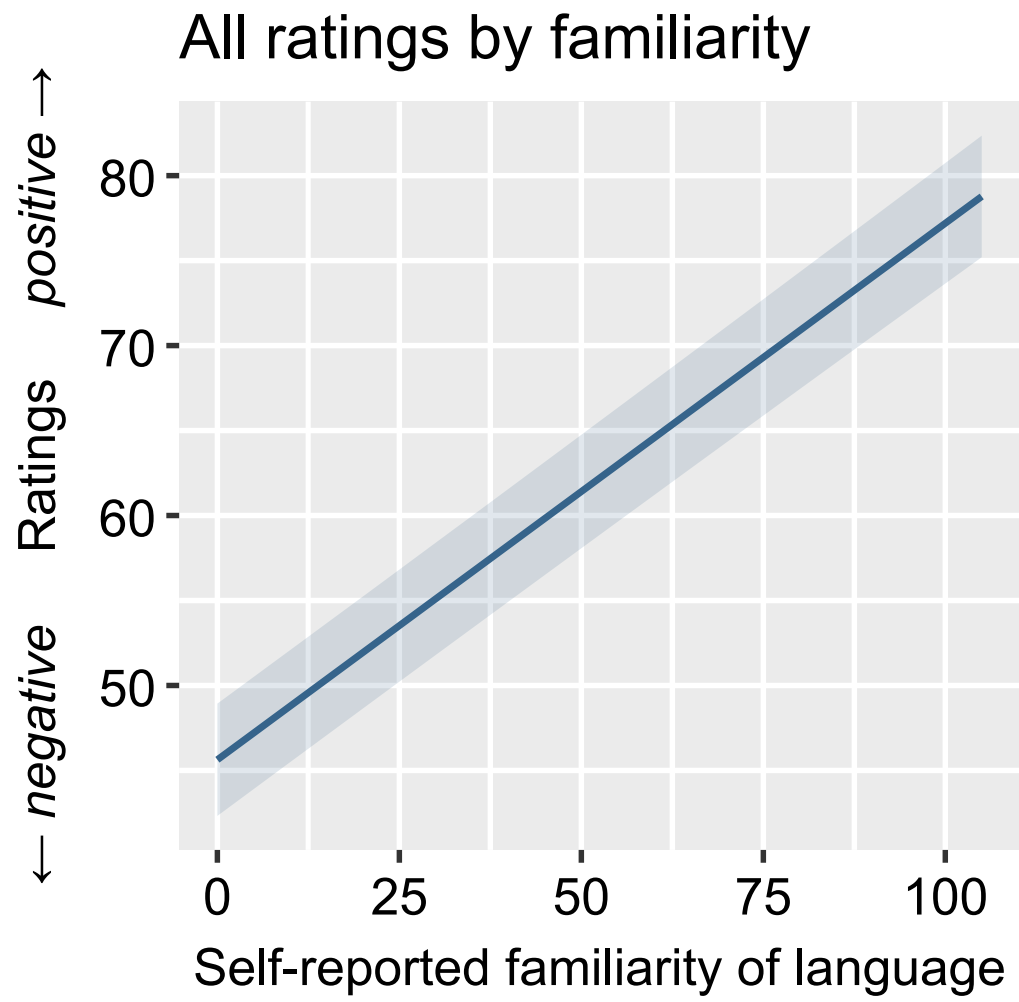


Overview of condition by exposure

### Effects across all rating scales



Overview of model with all scales

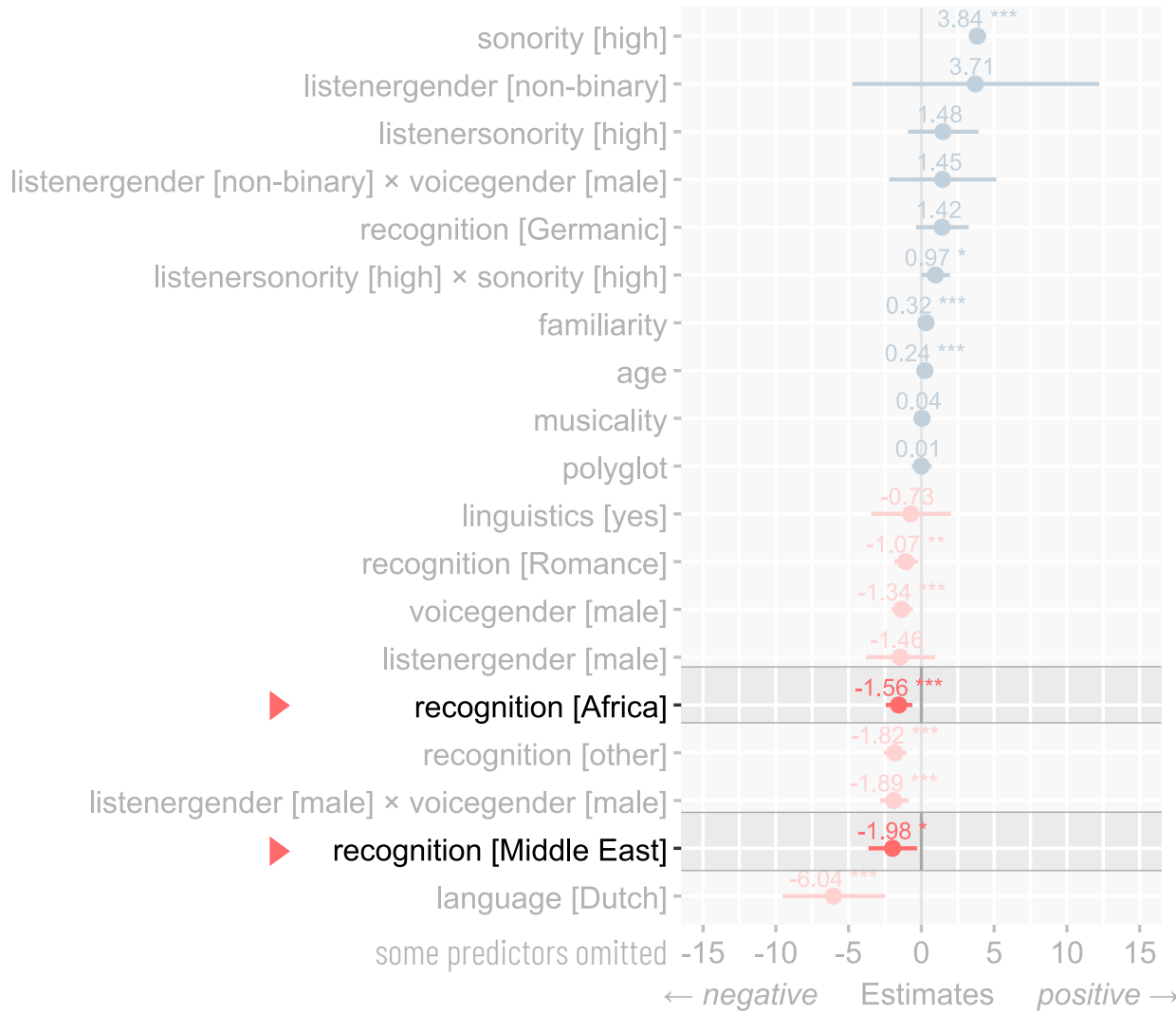


Familiarity for model with all scales



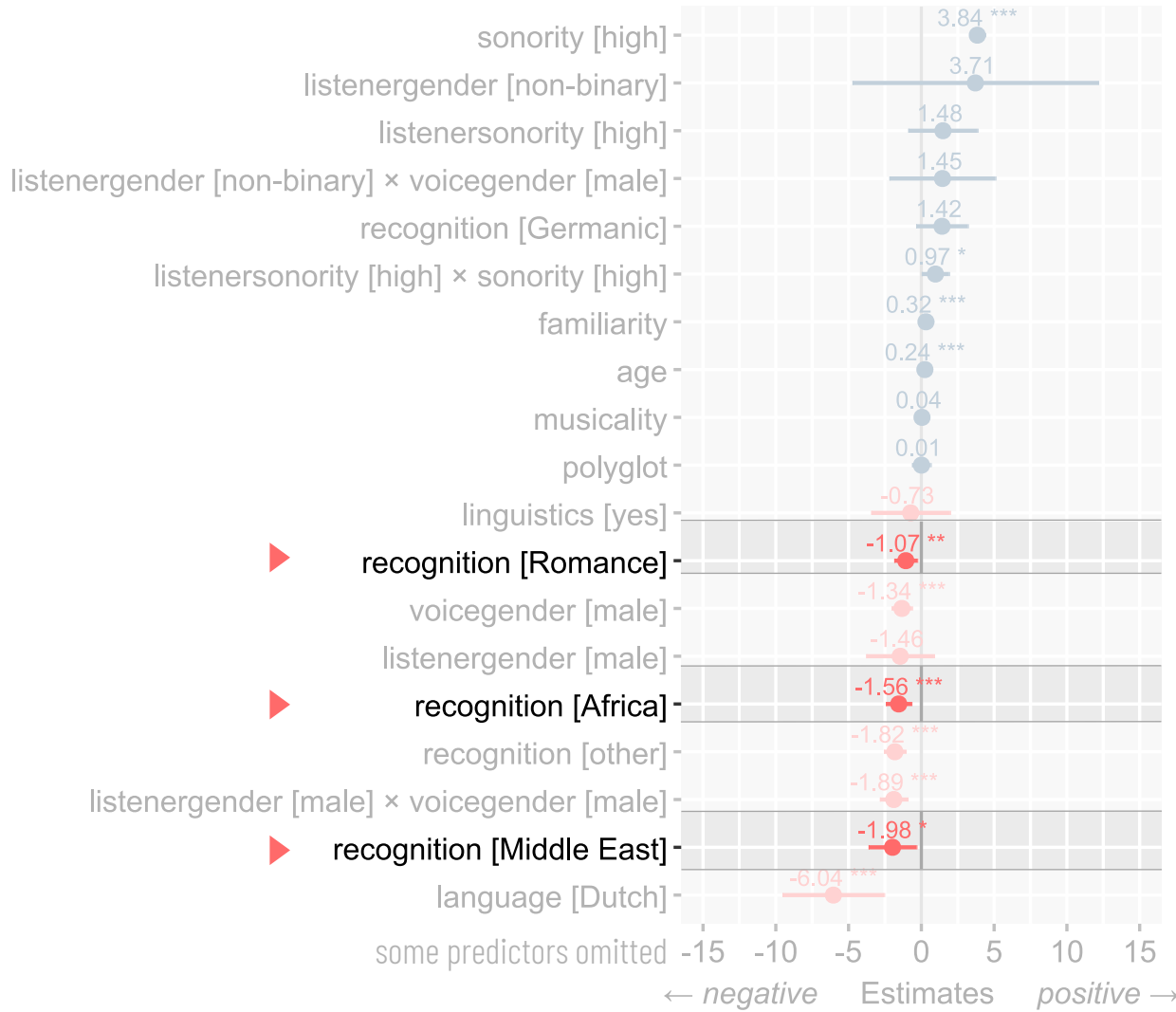
**Overview of familiarity**

Effects across all rating scales



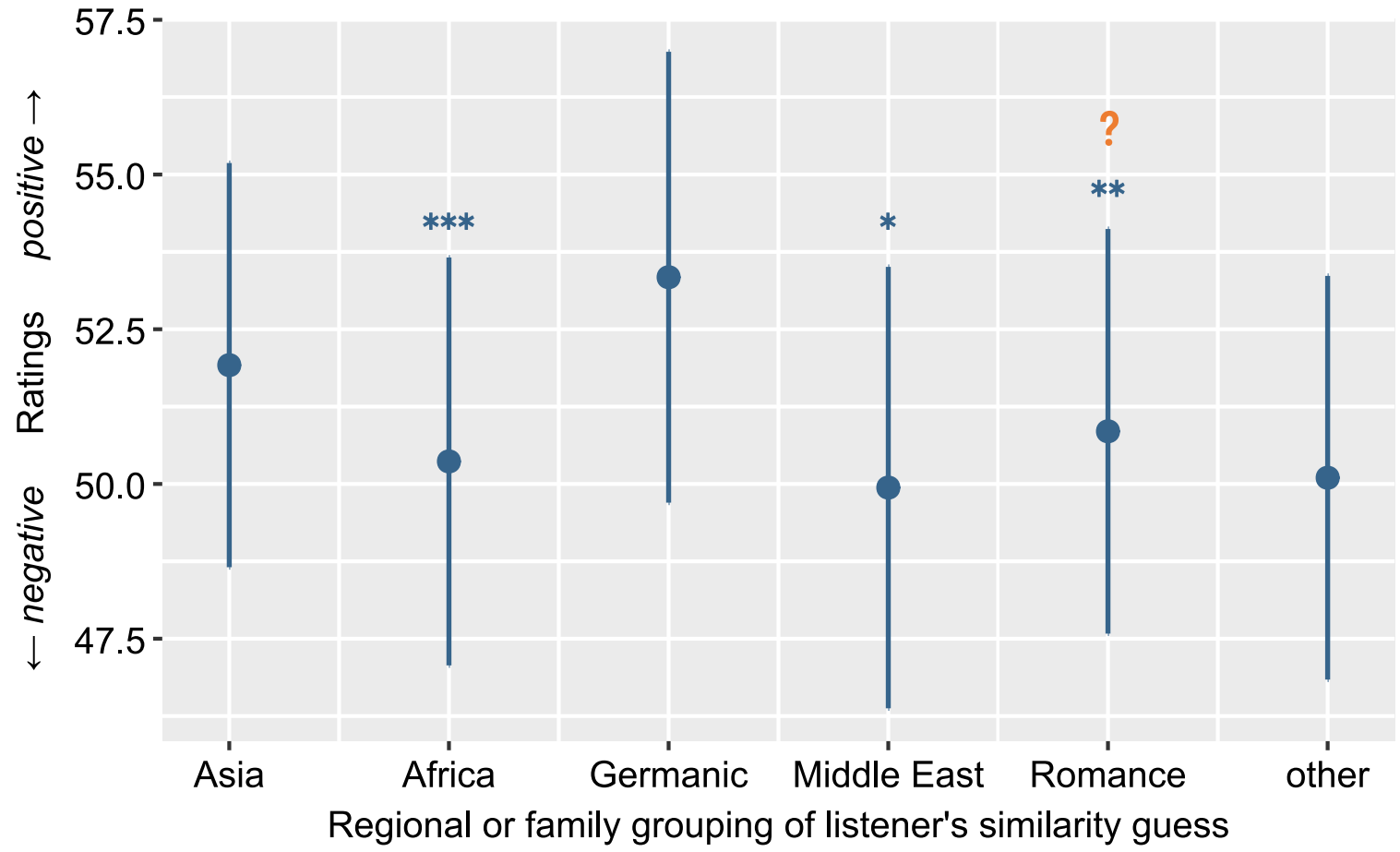
Overview of model with all scales

Effects across all rating scales



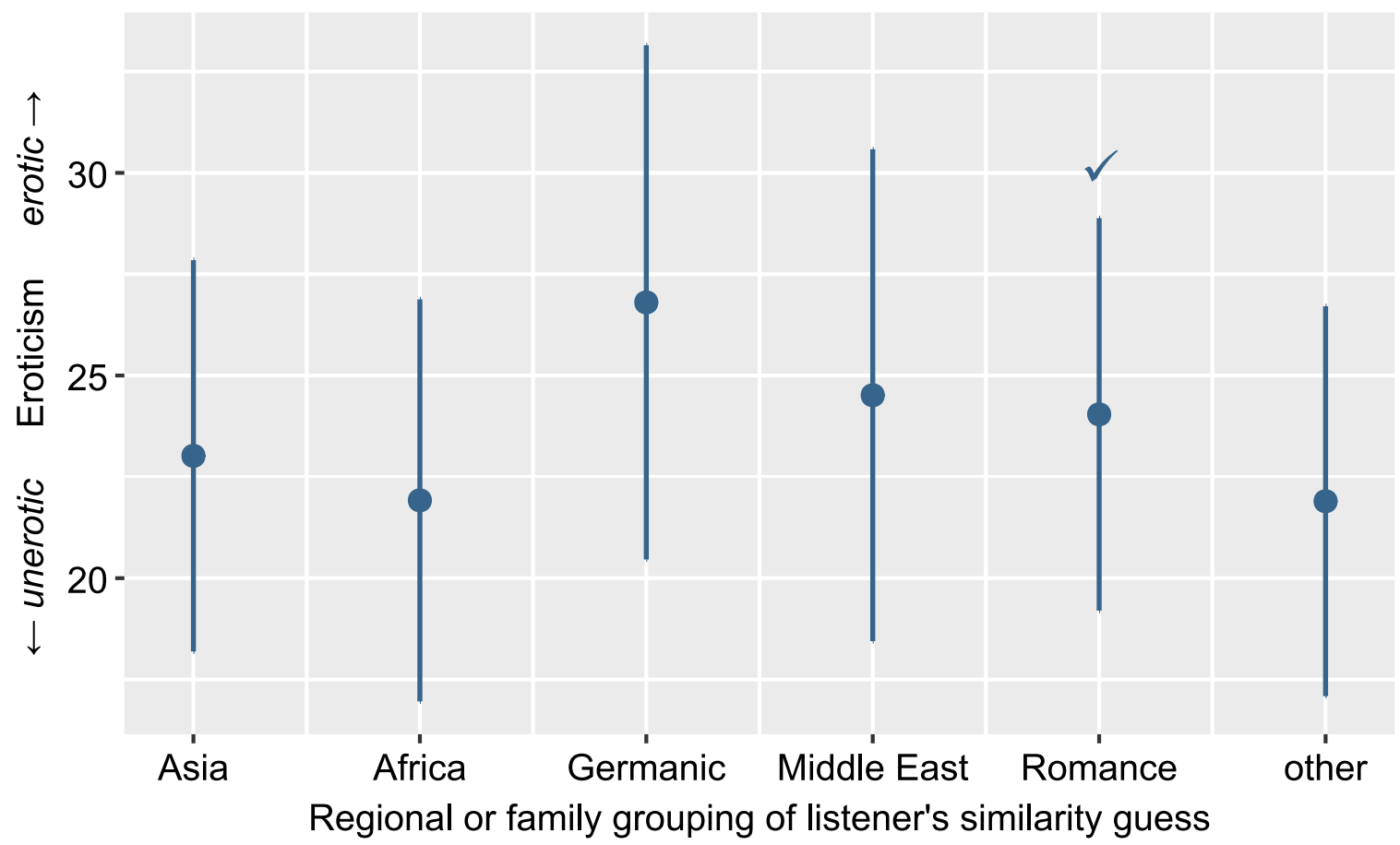
Overview of model with all scales

All ratings by similarity guess



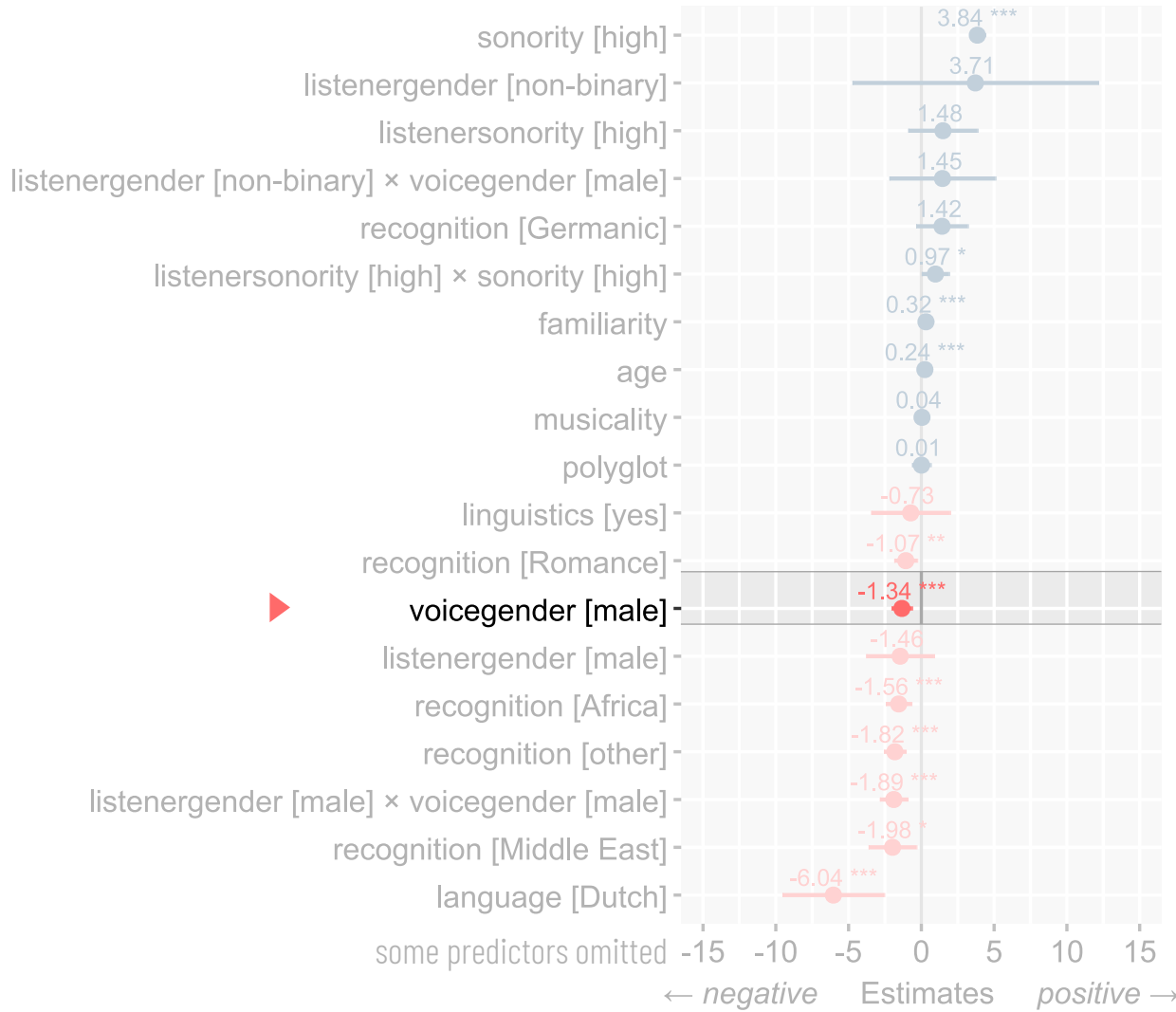
Recognition for model with all scales

### Eroticism by similarity guess

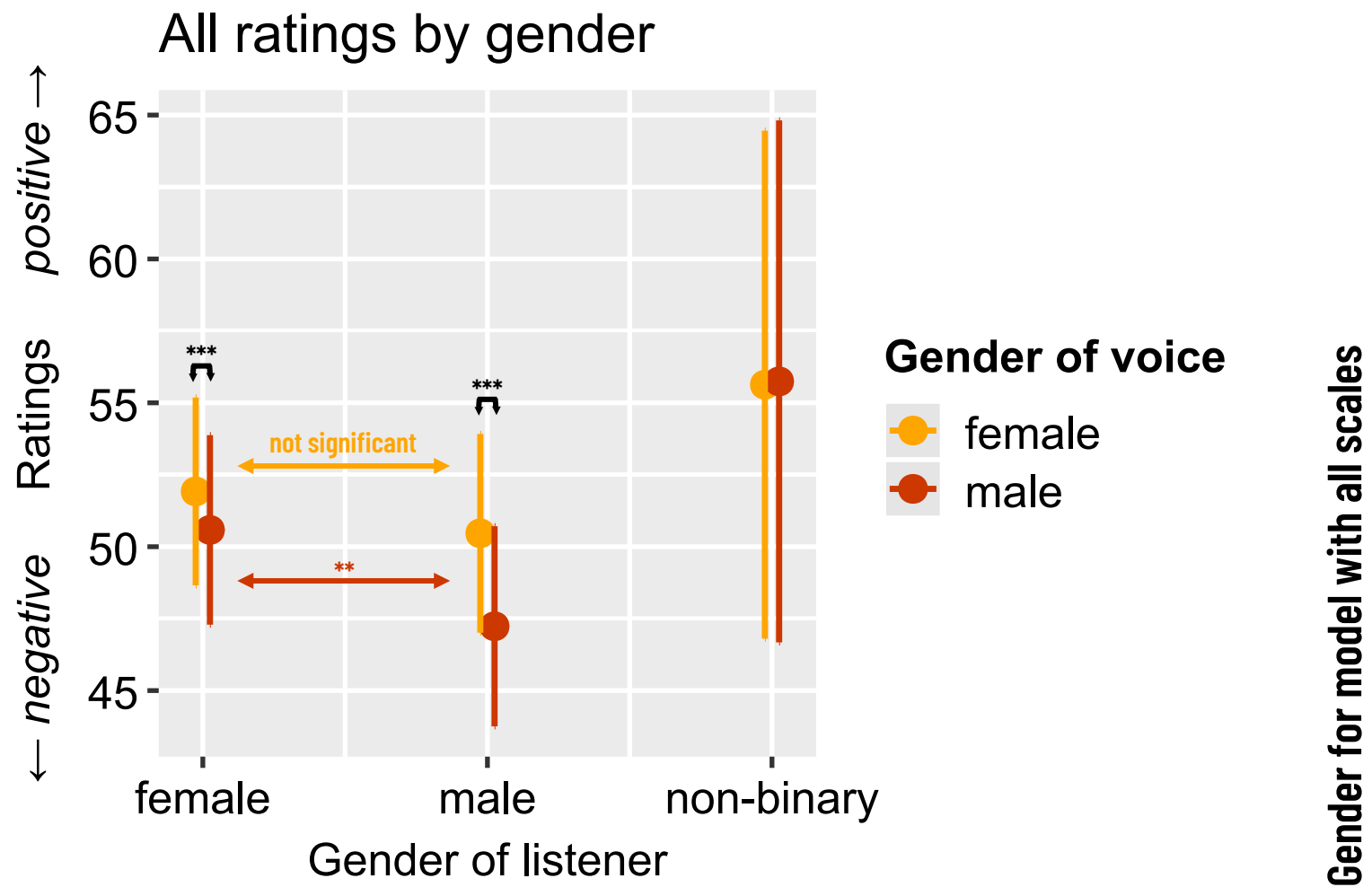


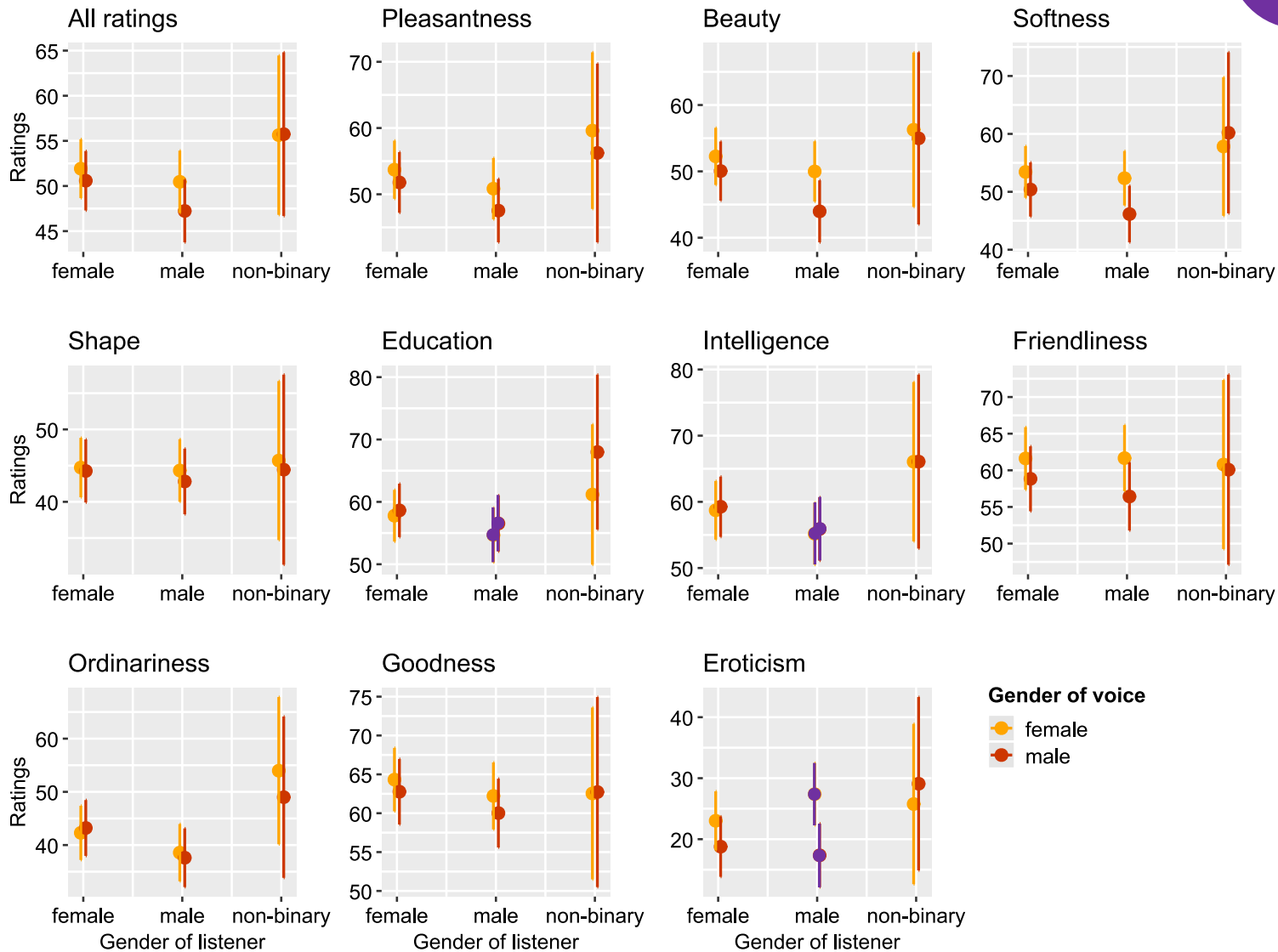
Recognition for eroticism model

Effects across all rating scales



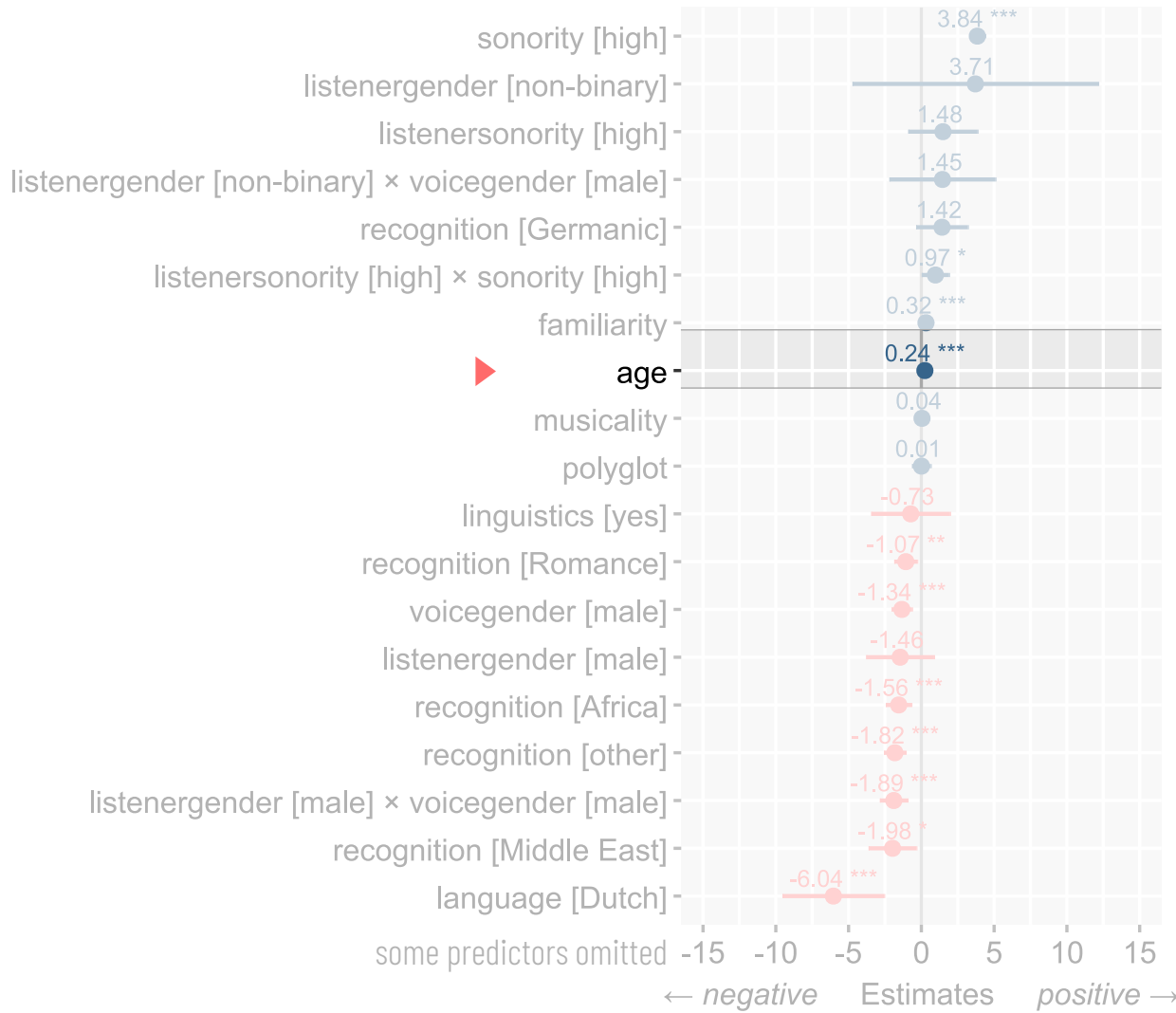
Overview of model with all scales





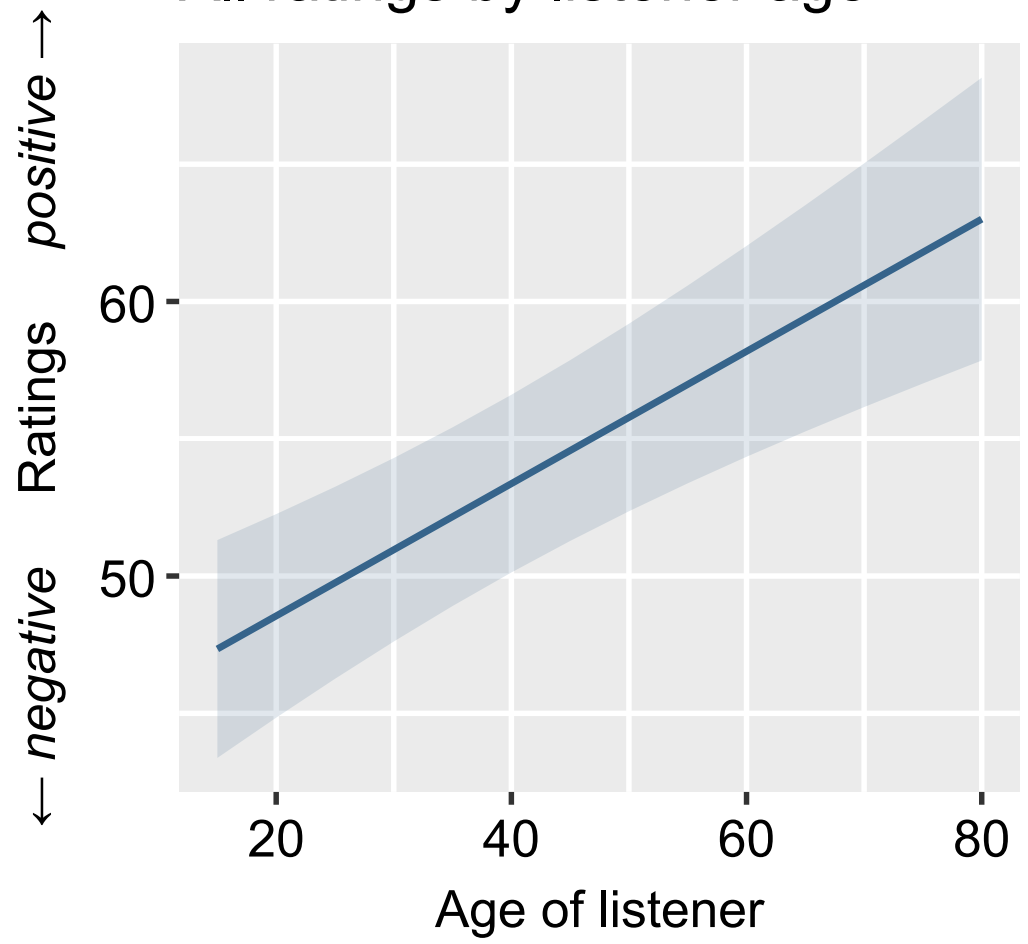
Overview of gender

Effects across all rating scales

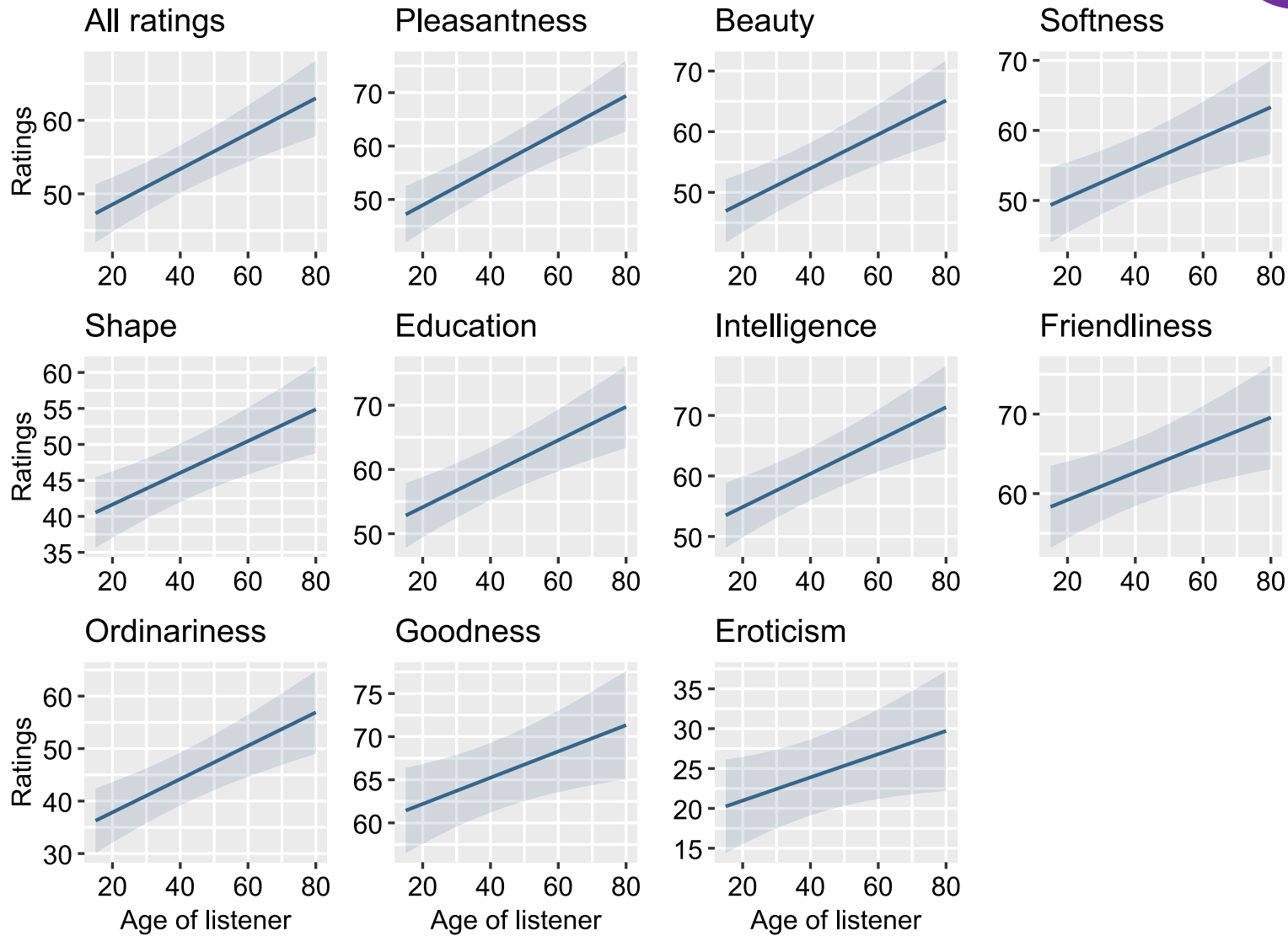


Overview of model with all scales

### All ratings by listener age

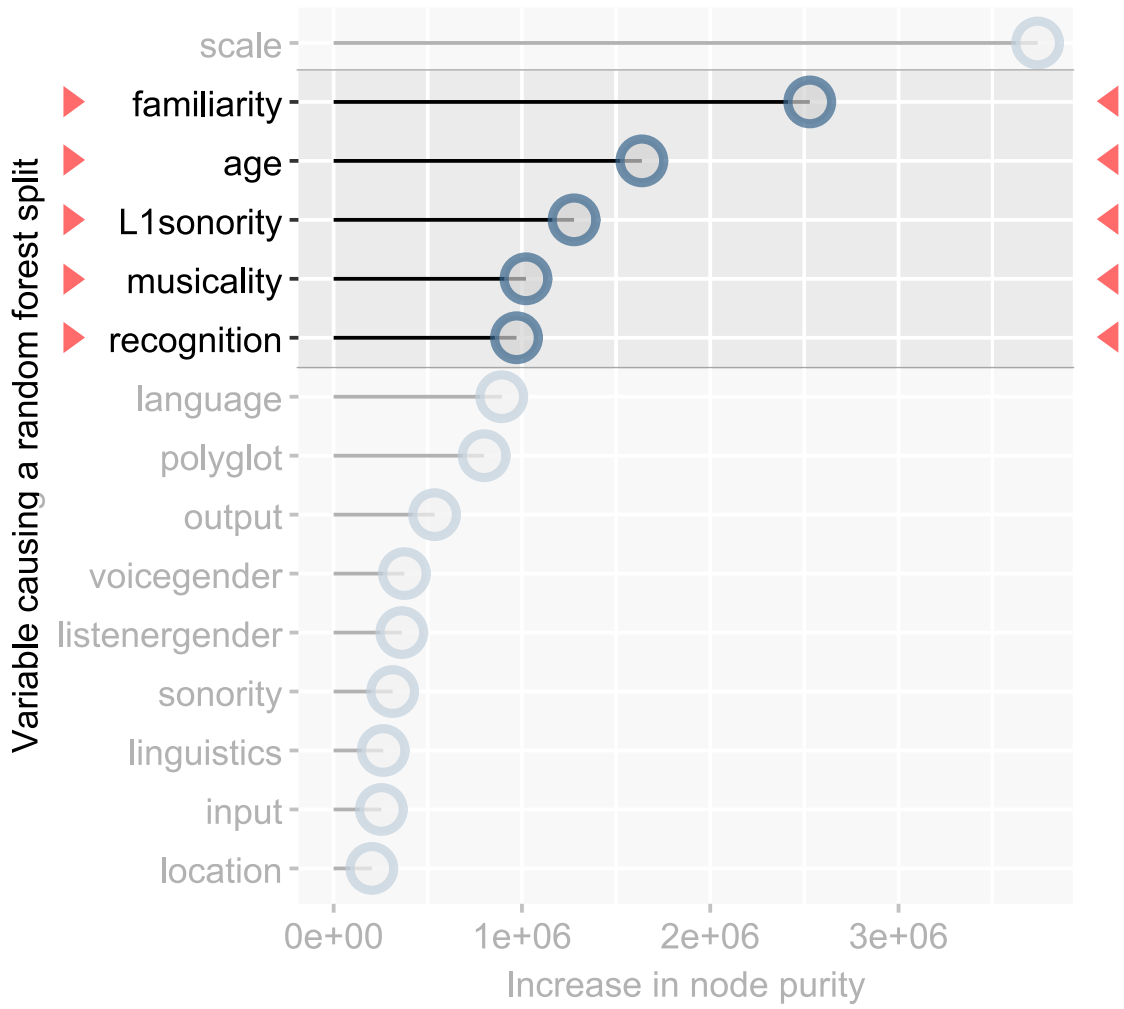


Age for model with all scales



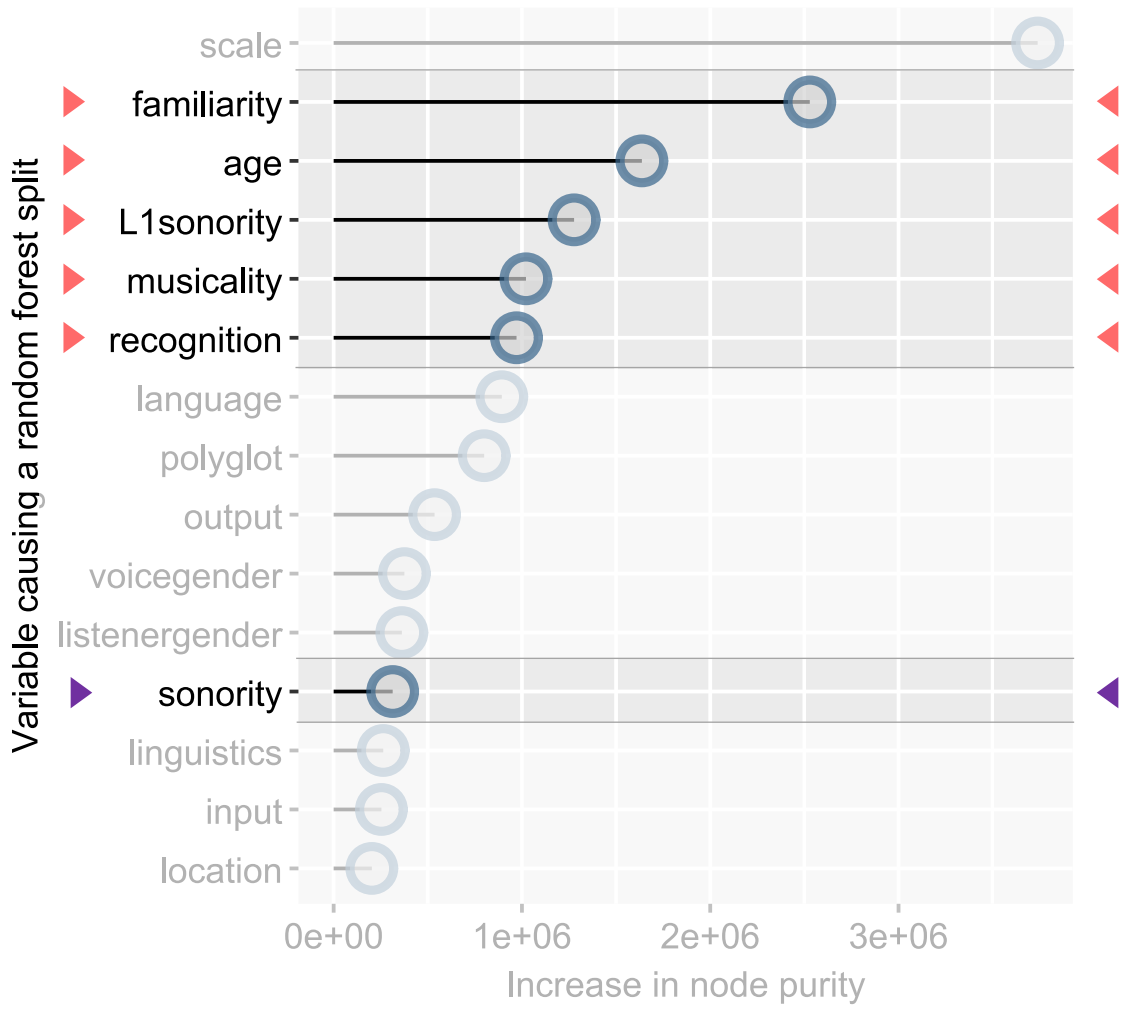
Overview of age

Importance of variables across scales

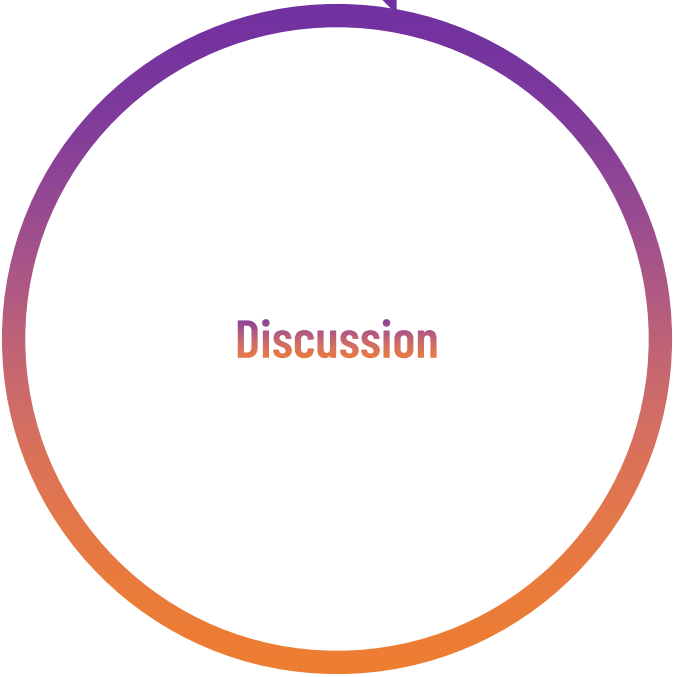


Random forest for model with all scales

### Importance of variables across scales



Random forest for model with all scales



**Discussion**



## Indexicality versus iconicity

**High-sonority** stimuli are rated **better**.

- ▶ They were rated better by listeners with **both high- and low-sonority L1s**.
- ▶ Sonority can predict ratings regardless of exposure.

On some scales, **only high-sonority** stimuli are rated **better** by participants with **high-** compared to **low-sonority L1s**.

- ▶ This suggests an **exposure effect** on top of a phonetic-phonological effect.

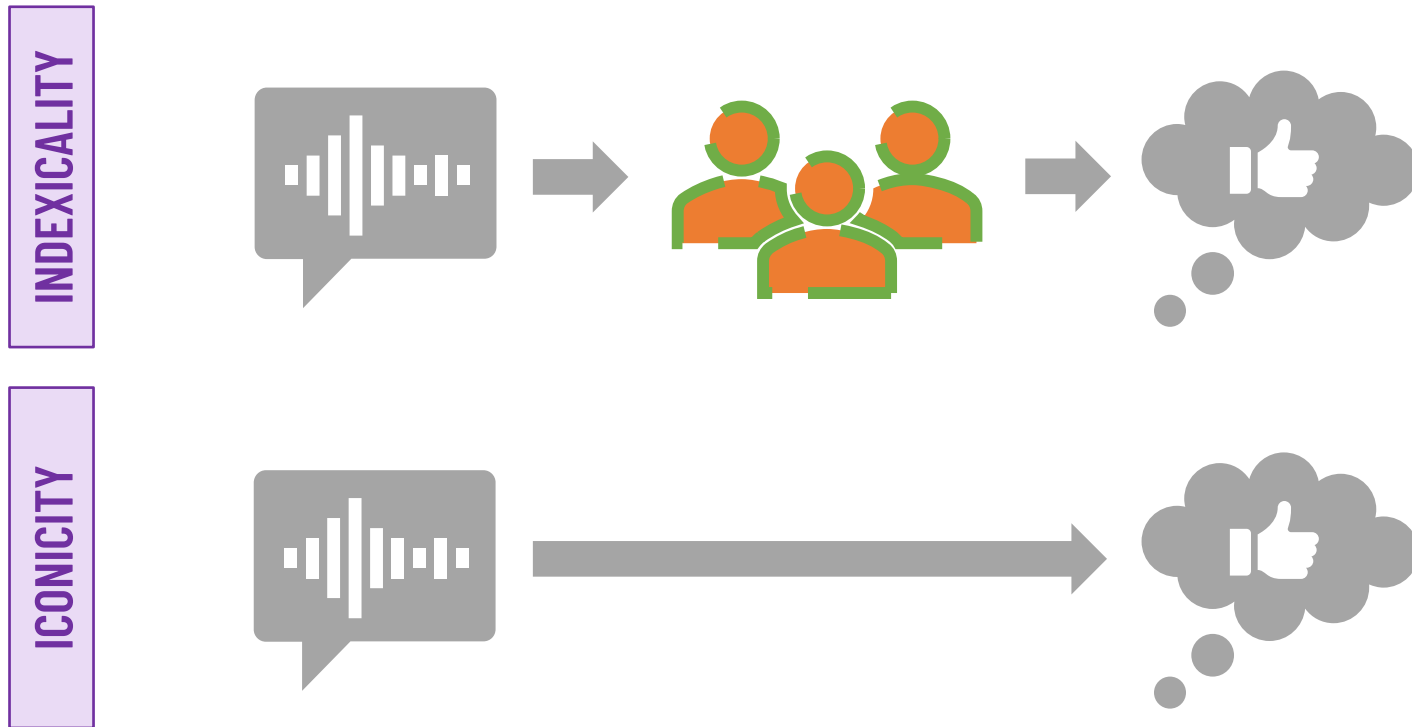
The strongest predictors are **sociocultural** in nature.

- ▶ Listeners may rate languages **worse** if:
  - ▶ they are **male** and **young**,
  - ▶ they perceive the language as being **less familiar**.
  - ▶ they *felt* it resembled a language from a specific **region**.

compare, e.g., Reiterer et al. 2020, but see Mooshammer et al. 2023



## Indexicality versus iconicity



## pluripotentiality

Dragojevic & Goatley-Soan 2022; McLean & Motamedi 2022; Winter et al. 2019

Peirce 1958; Silverstein 2003; Giles and Niedzielski 1998

Kawahara et al. 2021; Winter et al. 2022



\*makes a low-sonority sound\*

say it's  
from French:

say it's  
from German:



adapted from  
Grice's Maxmemes



## Indexicality versus iconicity

### INDEXICALITY

- ▶ **imposed norm hypothesis, social connotations hypothesis**

differences in power

differences in prestige

cultural stereotypes

social conditioning

### ICONICITY

- ▶ **inherent value hypothesis, sound-driven hypothesis**

co-occurrence

evolved associations

shared properties

patterns

context

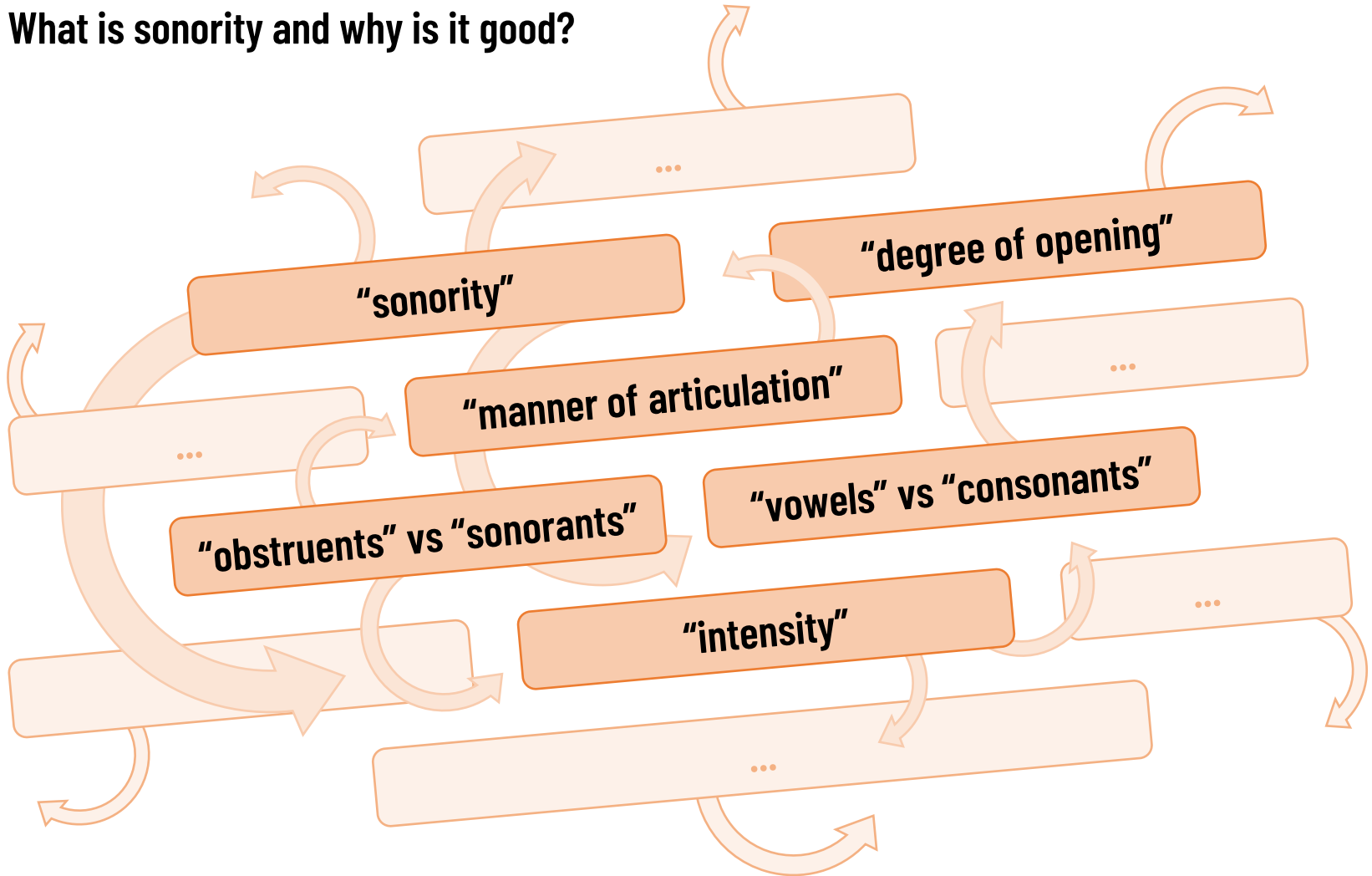
embodiment and imitation

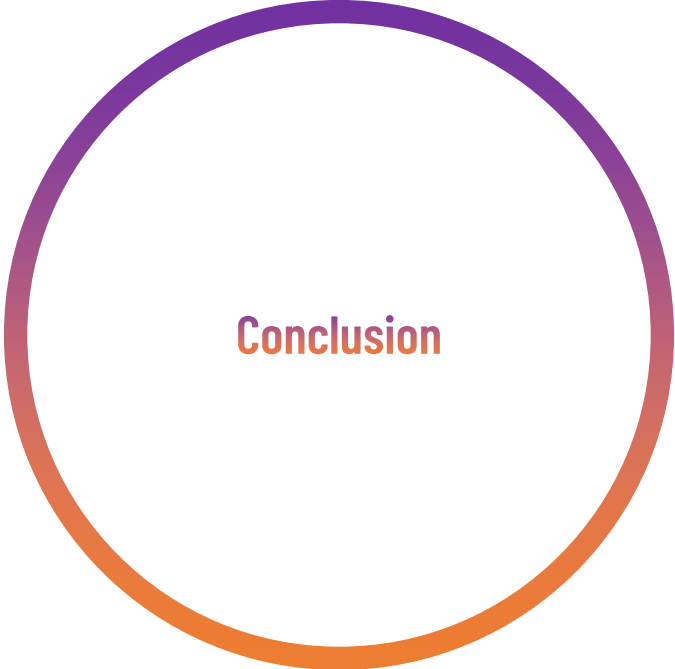
**Both can conspire to ontogenetically and phylogenetically bootstrap language**

Giles et al. 1979; 1974;  
Giles and Niedzielski 1998;  
Podhorodecka 2007; Baker & Bozic 2024;  
but see Li & Roberts 2023; Rácz et al. 2020  
Berthele 2010; Madden 2014; Reiterer et al. 2020



# What is sonority and why is it good?





**Conclusion**



We really **like** when language is **sonorous**!

... because of how it **sounds**,  
but also because of who we **are**.



THANK YOU





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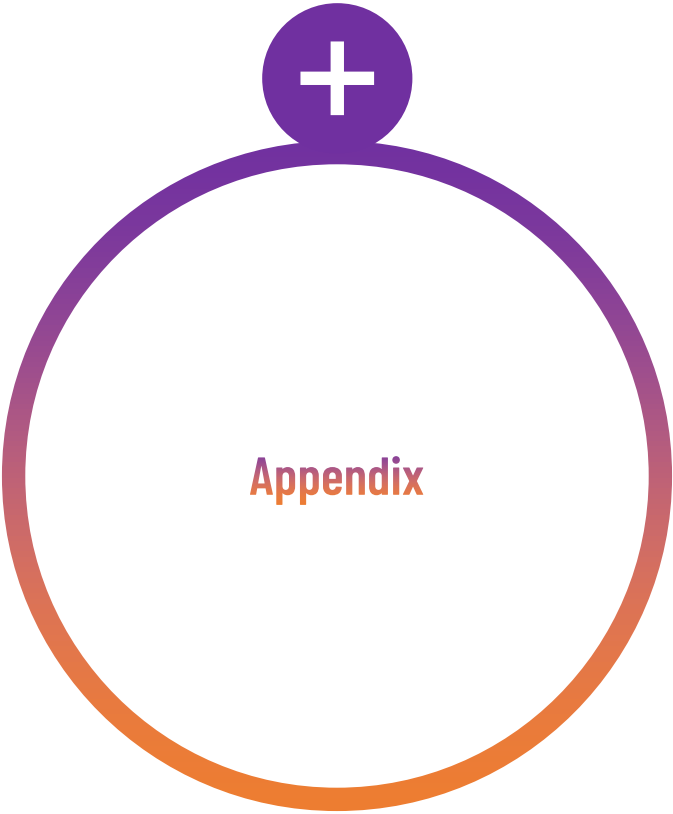
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**Appendix**



# SOUNDS, ATTITUDES, AND MEANING

hhu  
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Universität  
Düsseldorf

Funded by

DFG

Deutsche  
Forschungsgemeinschaft  
German Research Foundation



## Some consequences:

- ▶ **linguistic profiling**
- ▶ **housing discrimination**
- ▶ **disadvantages in the judicial system**
- ▶ **effects on rating of pupils by teachers**
- ▶ **social disadvantages and harassment**
- ▶ **employment and workplace marginalization**
- ▶ **discrimination in adoption procedures**
- ▶ **effects on credibility and cooperation of speakers**
- ▶ **linguistic self-hatred**
- ▶ **reinforcement in literature and the media**
- ▶ **language attitudes affect language change and loss**
- ▶ **LLMs reproduce attitudes**

Fasoli & Maass 2020, Wright & McGowan 2018, Rickford & King 2016, Lippi-Green 2012, Kristiansen 2011, Lev-Ari and Keysar 2010, Munson 2007, Baugh 2003, Dixon et al. 2002, Purnell et al. 1999, Sachdev et al. 1998, Chambers 1995, Cargile et al. 1994, Kristiansen and Giles 1992, Giles et al. 1981, Kalin et al. 1980, Williams 1973, Stein 2023; Hofmann et al. 2024

## Evidence for each group of explanations

### INDEXICALITY

listeners associate sounds with **groups of people** and corresponding perceived **regions, race, ethnicity, gender, sexual orientation, socioeconomic status, character traits, ...**

### ICONICITY

listeners associate sounds with meanings like *maluma, bouba* 'round, positive', *takete, kiki* 'spiky, negative', /p, b/ 'full', /i/ 'small', /a/ 'large', /g/ 'hard', /s, ʃ/ 'flying', /b, d, g, z/ 'negative, dark', /p/ 'fairy, cute', /w, j, r, .../ 'not swearsy', /r/ 'rough', ...

e.g., Lambert et al. 1960, Preston 2017, Baugh 2003, Giles & Powesland 1975, Stewart et al. 1985, Thomas & Reaser 2004, Munson 2007, ...  
 e.g., Köhler 1929, Ramachandran & Hubbard 2001, Domizi 2024, Winter & Perlman 2021, Wong et al. 2022, Kawahara et al. 2021, Winter et al. 2022, ...

## Some studies looking at both groups of explanations

INDEXICALITY

Europeans rate European languages differently depending on **both** familiarity and phonetic variables like sonority, vocalic share

Reiterer et al. 2020

Germans rate several existing conlangs more positively or negatively depending on **both** sounds and phonological familiarity

Mooshammer et al. 2023

ICONICITY

Natlangs are rated as more or less beautiful depending on familiarity, **not sounds**, phonetics doesn't play a role

Anikin et al. 2023

Presumably unexposed Chinese students rate Swedish as more pleasant than Danish, likely due to intonation, **not social factors**

Hilton et al. 2022



## SSPG Sonority-sensitive pseudotext generator

Low vowels	17
Mid peripheral vowels (not ə)	16
High peripheral vowels (not i)	15
Mid interior vowels (ə)	14
High interior vowels (i)	13
Glides	12
Rhotic approximants (ɹ)	11
Flaps	10
Laterals	9
Trills	8
Nasals	7
Voiced fricatives	6
Voiced affricates	5
Voiced stops	4
Voiceless fricatives	3
Voiceless affricates	2
Voiceless stops	1

Parker 2008



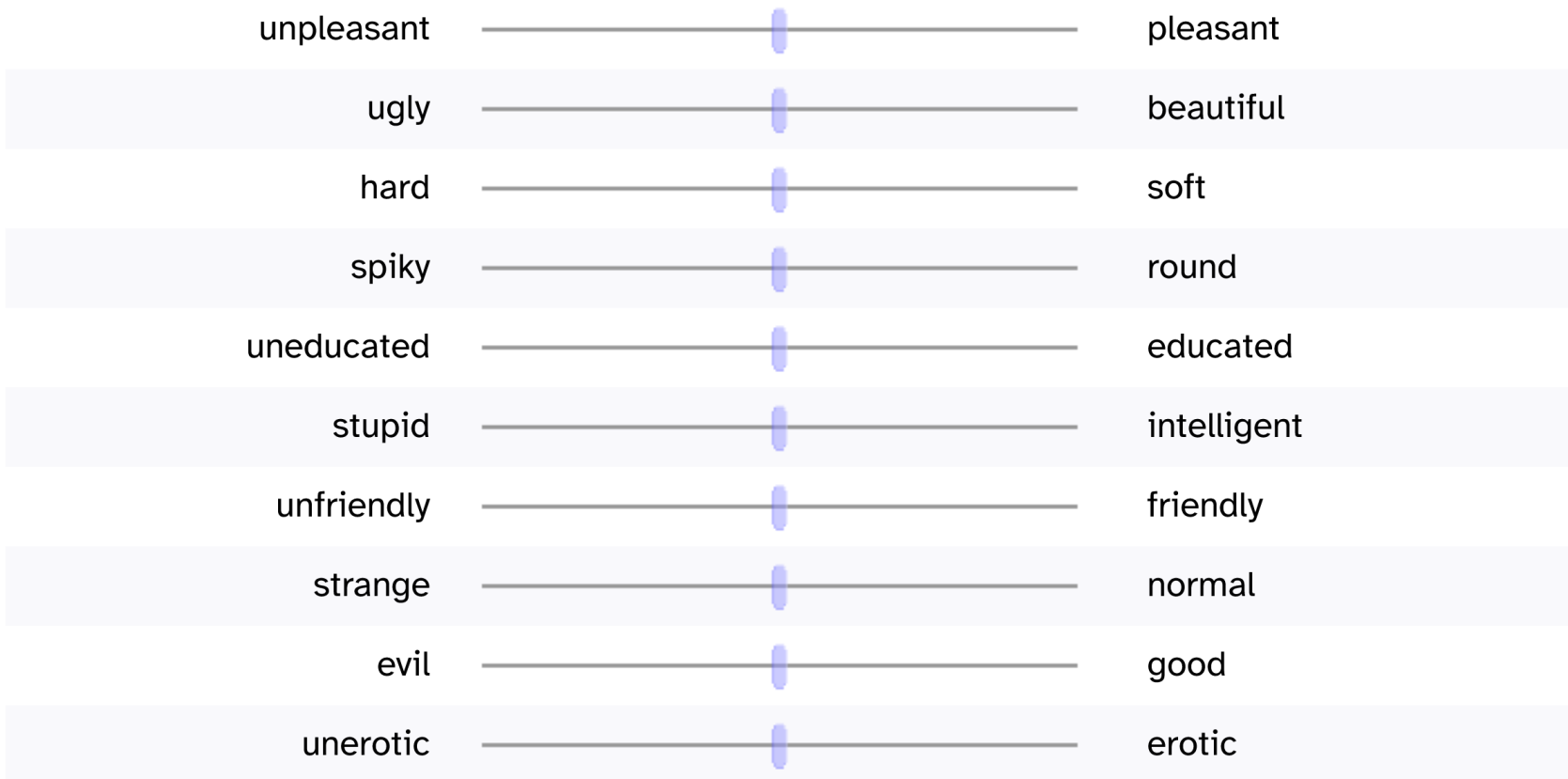
## SSPG Sonority-sensitive pseudotext generator

- ▶ The SSPG is able to let the user set a **target sonority** that affects random weighted sampling of sounds.
- ▶ The SSPG can create words with syllables that adhere to the **SSP**:  
vowels > glides > liquids > nasals > obstruents



## Questionnaire

How does the robot sound?





## Questionnaire

---

**How familiar does this language sound to you?**

not at all familiar



very familiar

**Which real language or dialect, do you think, does this language resemble the most?**

Next

## Questionnaire

You will now listen to the second pair of robots.

Please make sure you have sound enabled on your device and click "Next".

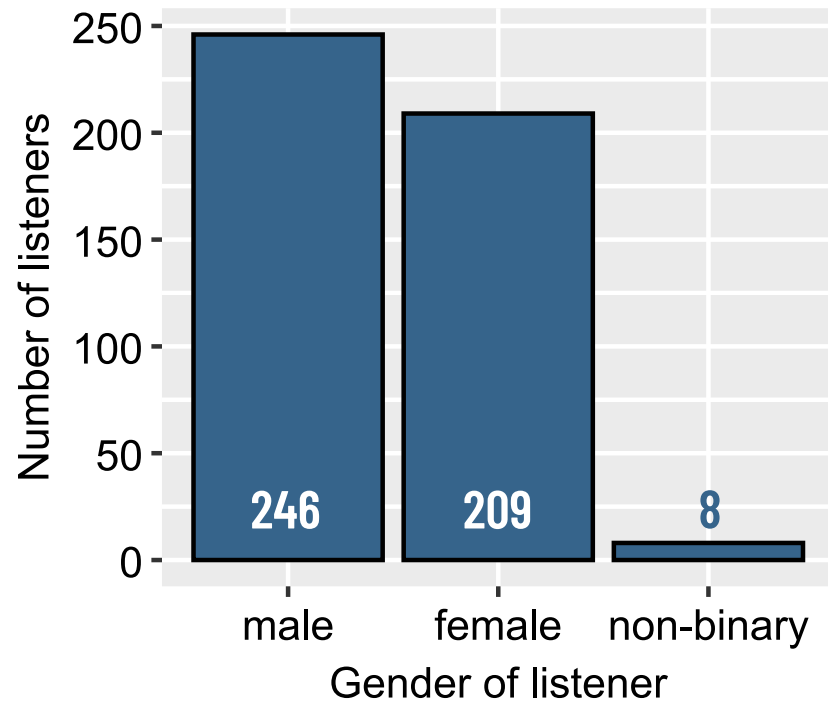


Next



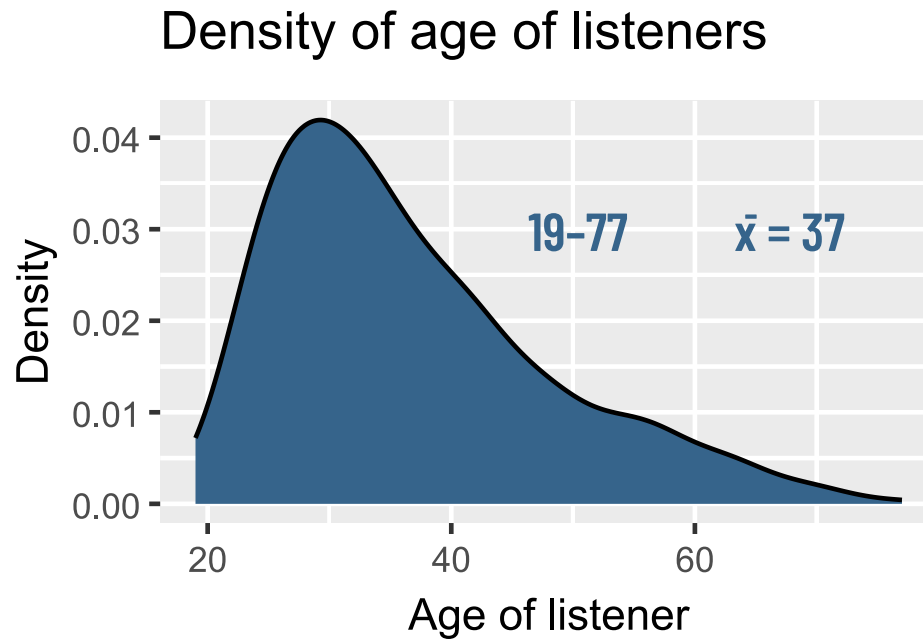
## Participant demographics $n = 463$

Number of listeners by gender





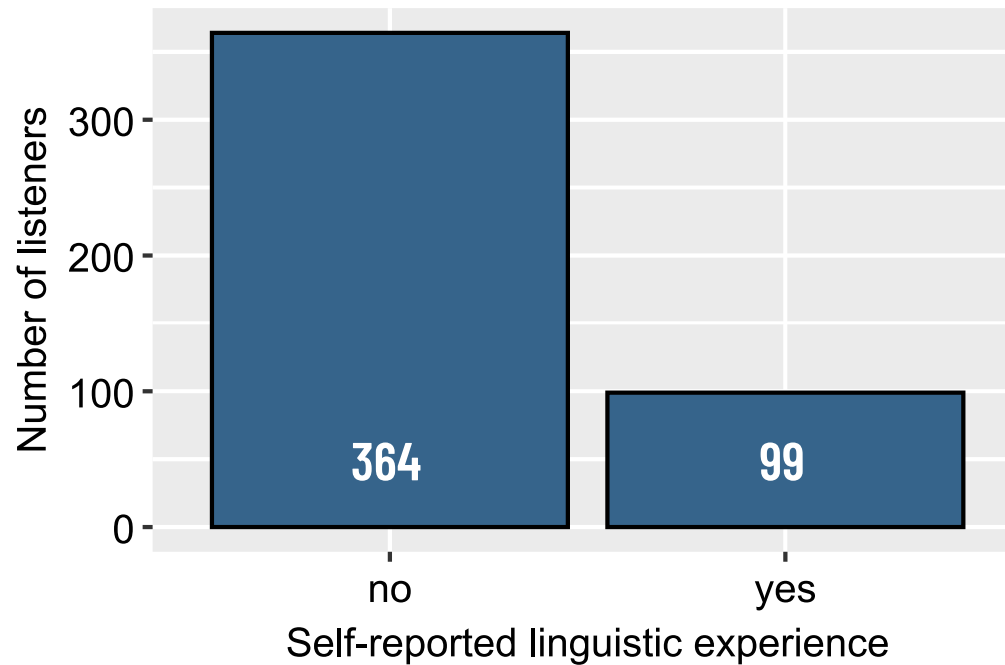
## Participant demographics $n = 463$





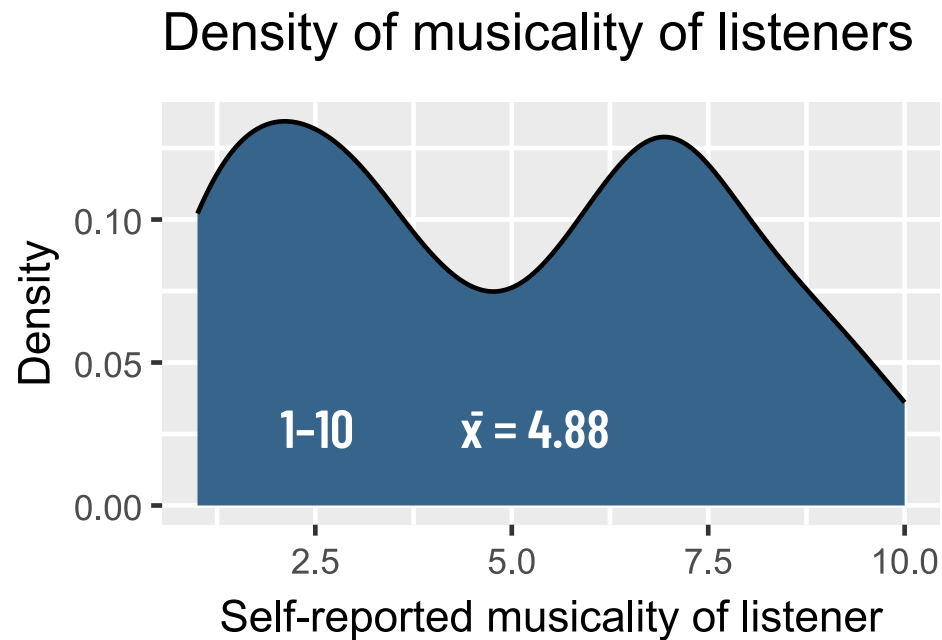
## Participant demographics $n = 463$

Number of listeners by linguistics





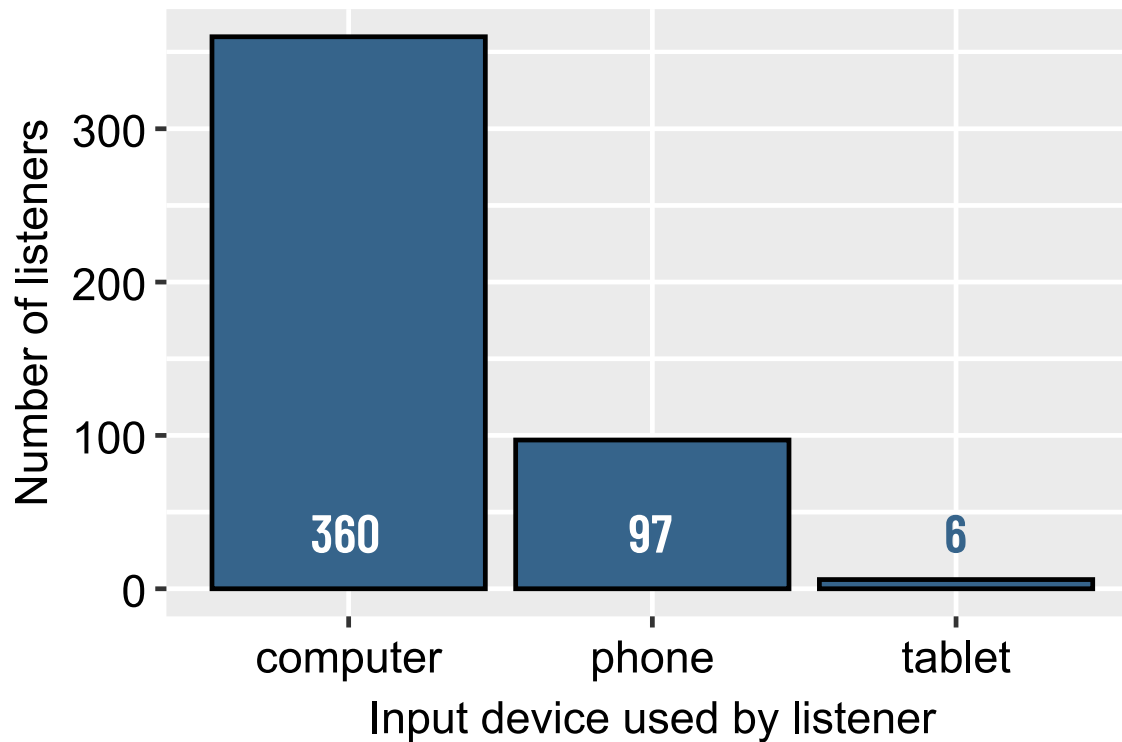
## Participant demographics $n = 463$





## Participant demographics $n = 463$

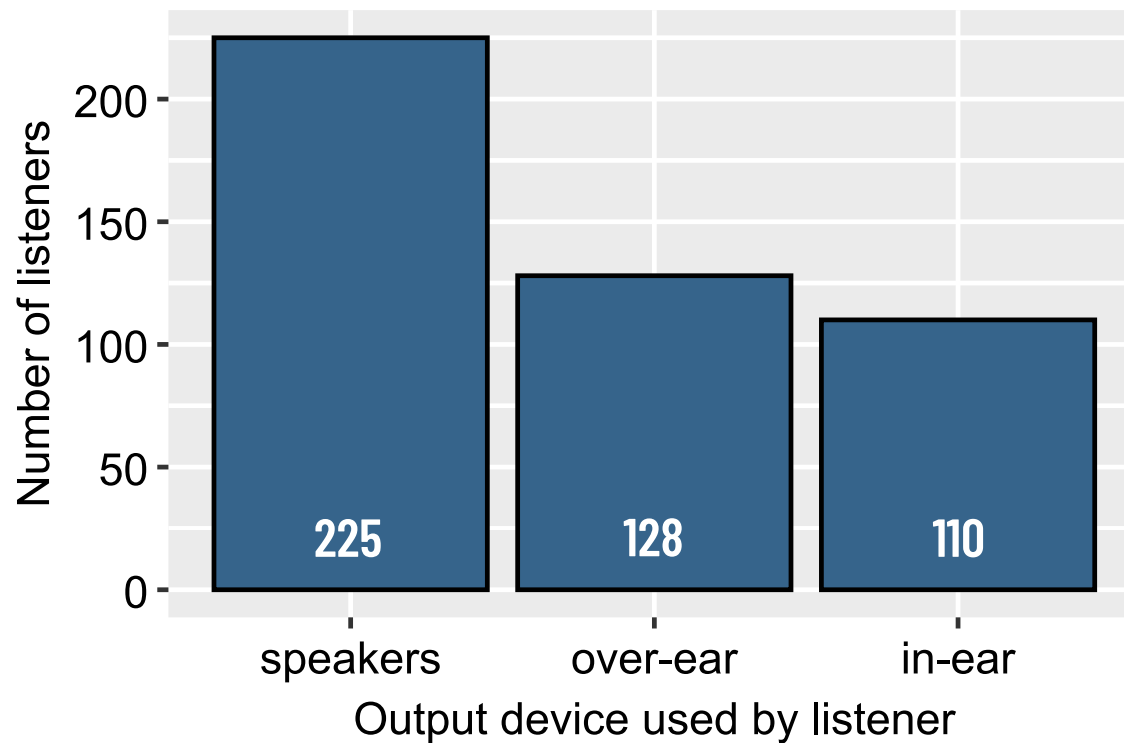
Number of listeners by input device





## Participant demographics $n = 463$

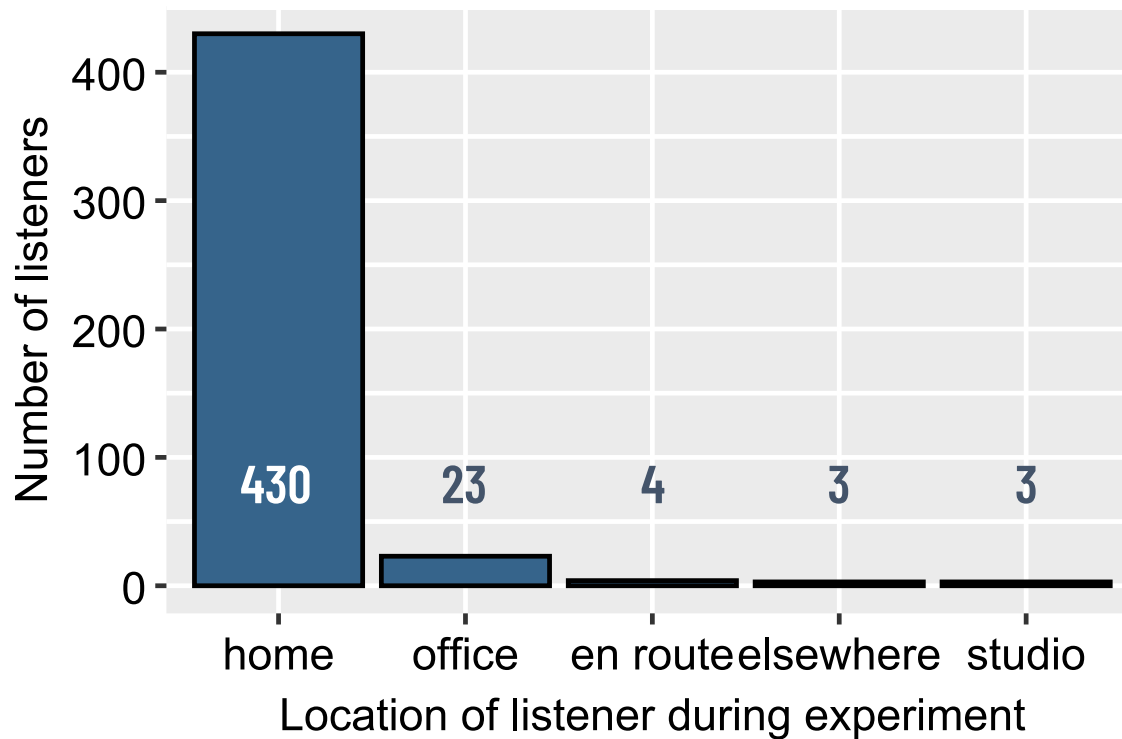
Number of listeners by output device





## Participant demographics $n = 463$

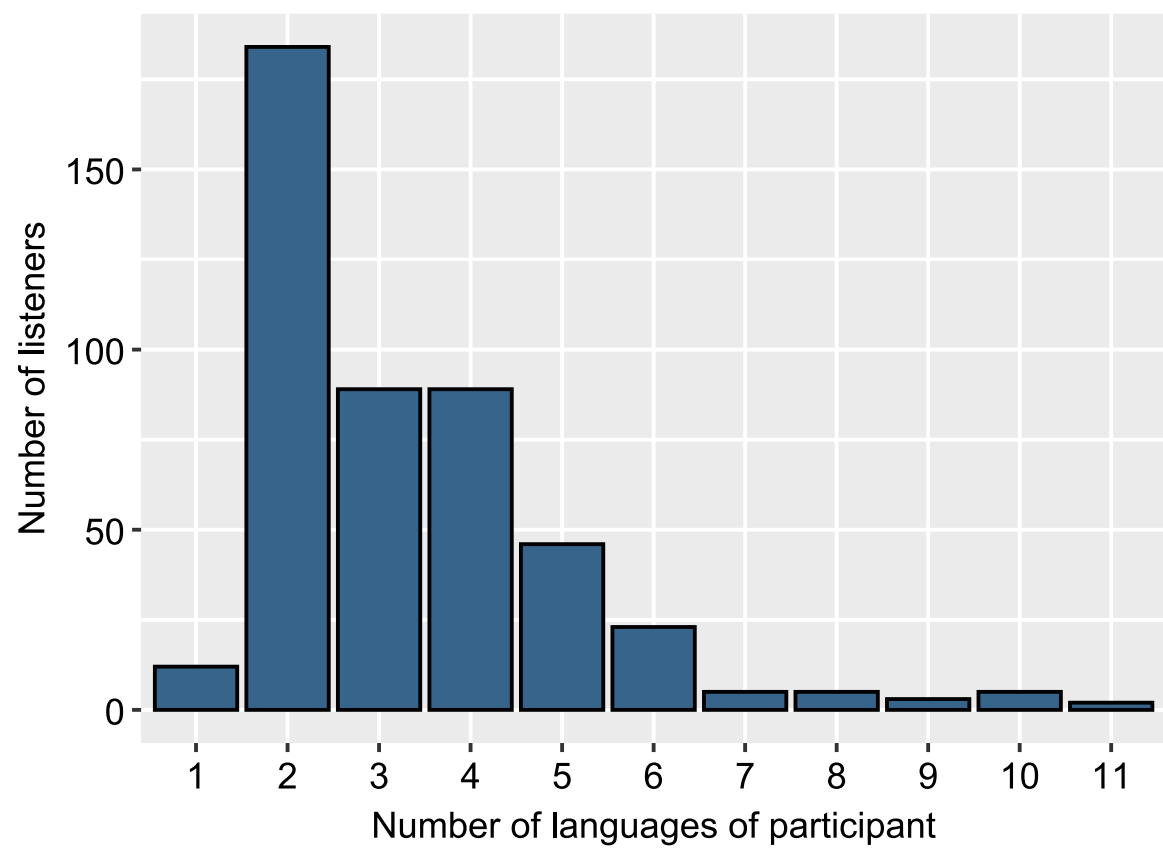
### Number of listeners by location

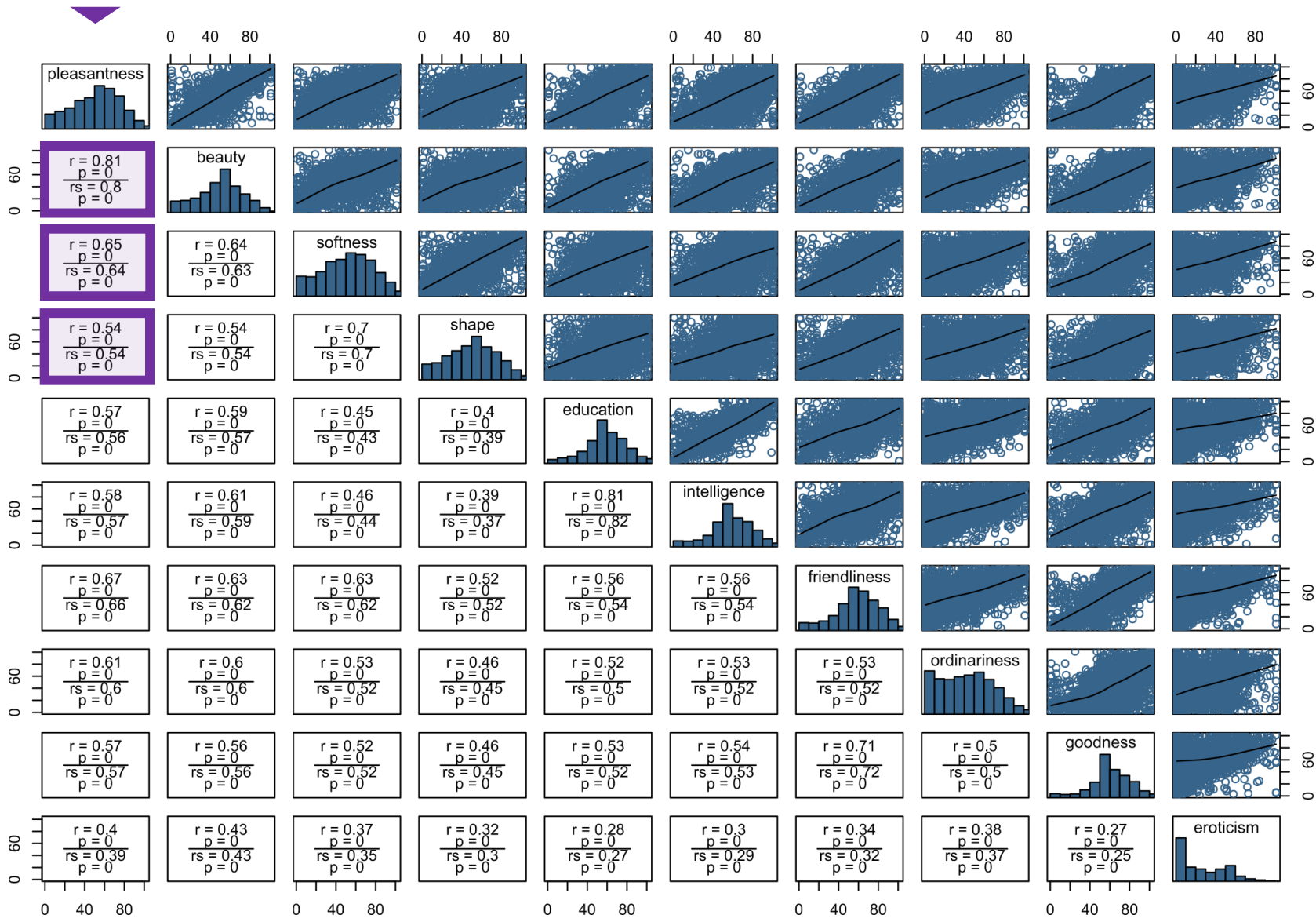




# Participant demographics **n = 463**

## Number of listeners by polyglot factor





Correlation matrix of all semantic scales



Correlation matrix of all semantic scales



Correlation matrix of all semantic scales

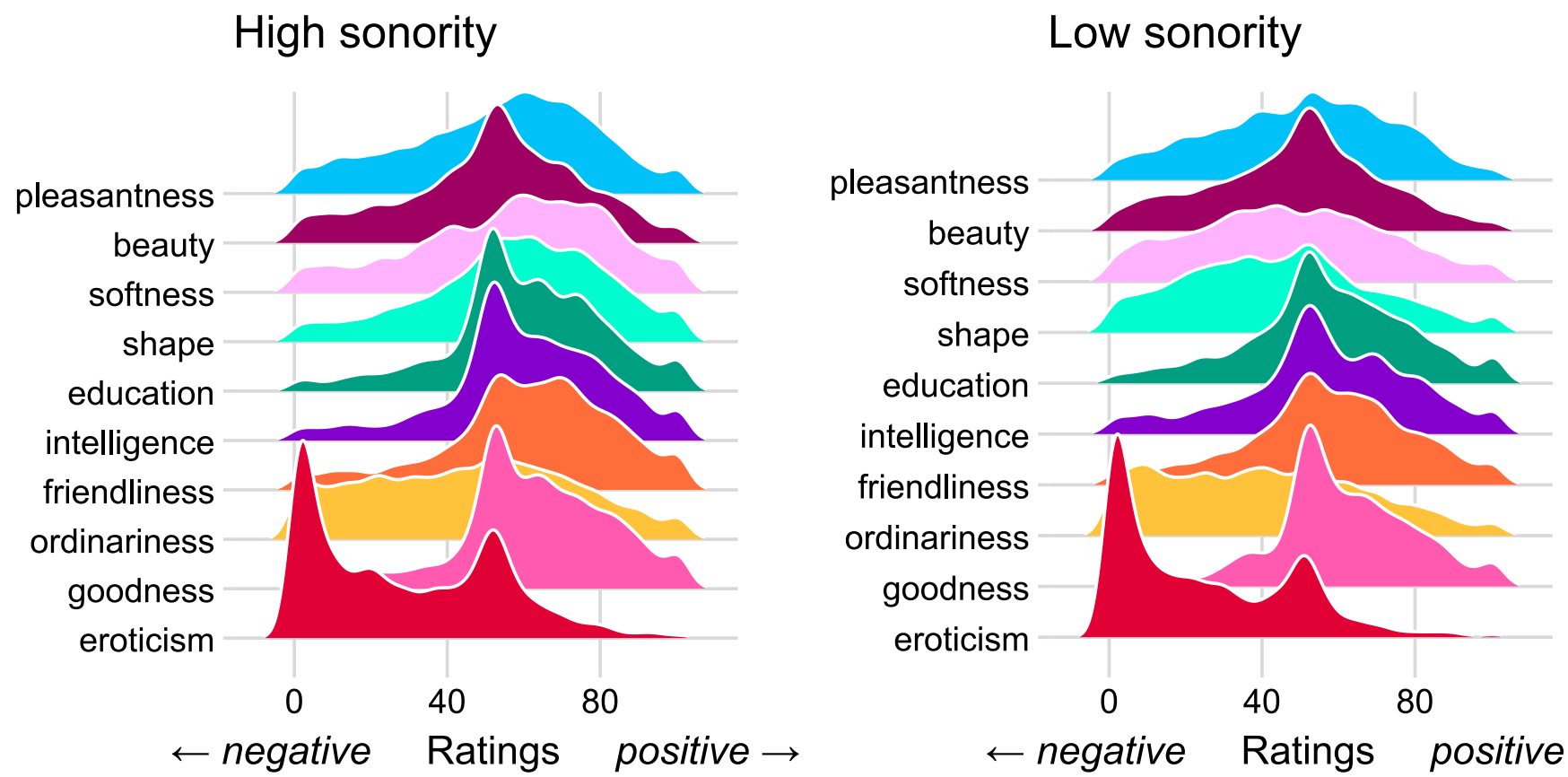


Correlation matrix of all semantic scales

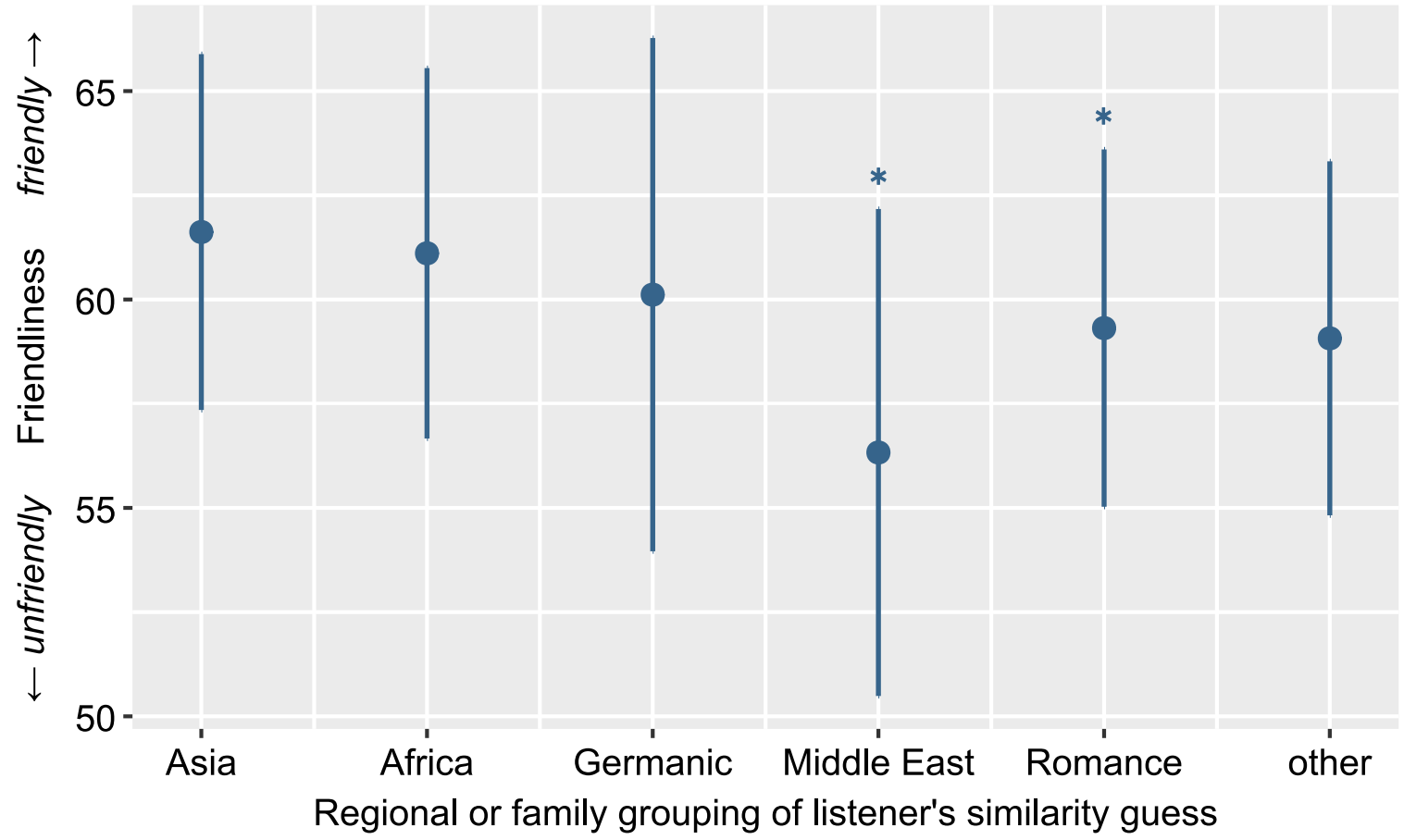


Correlation matrix of all semantic scales

## Distribution of ratings by scale for each condition

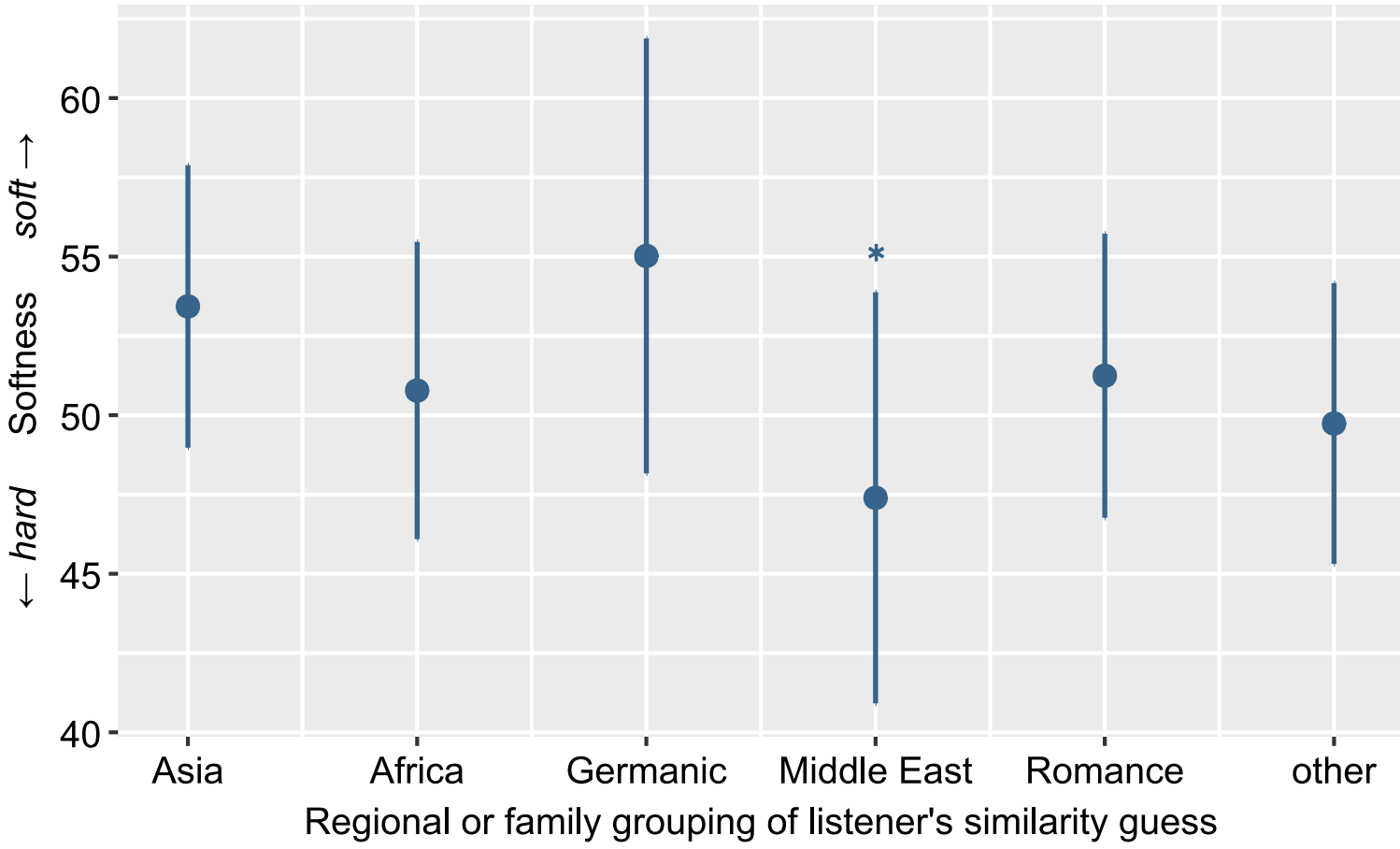


### Friendliness by similarity guess



Recognition for friendliness model

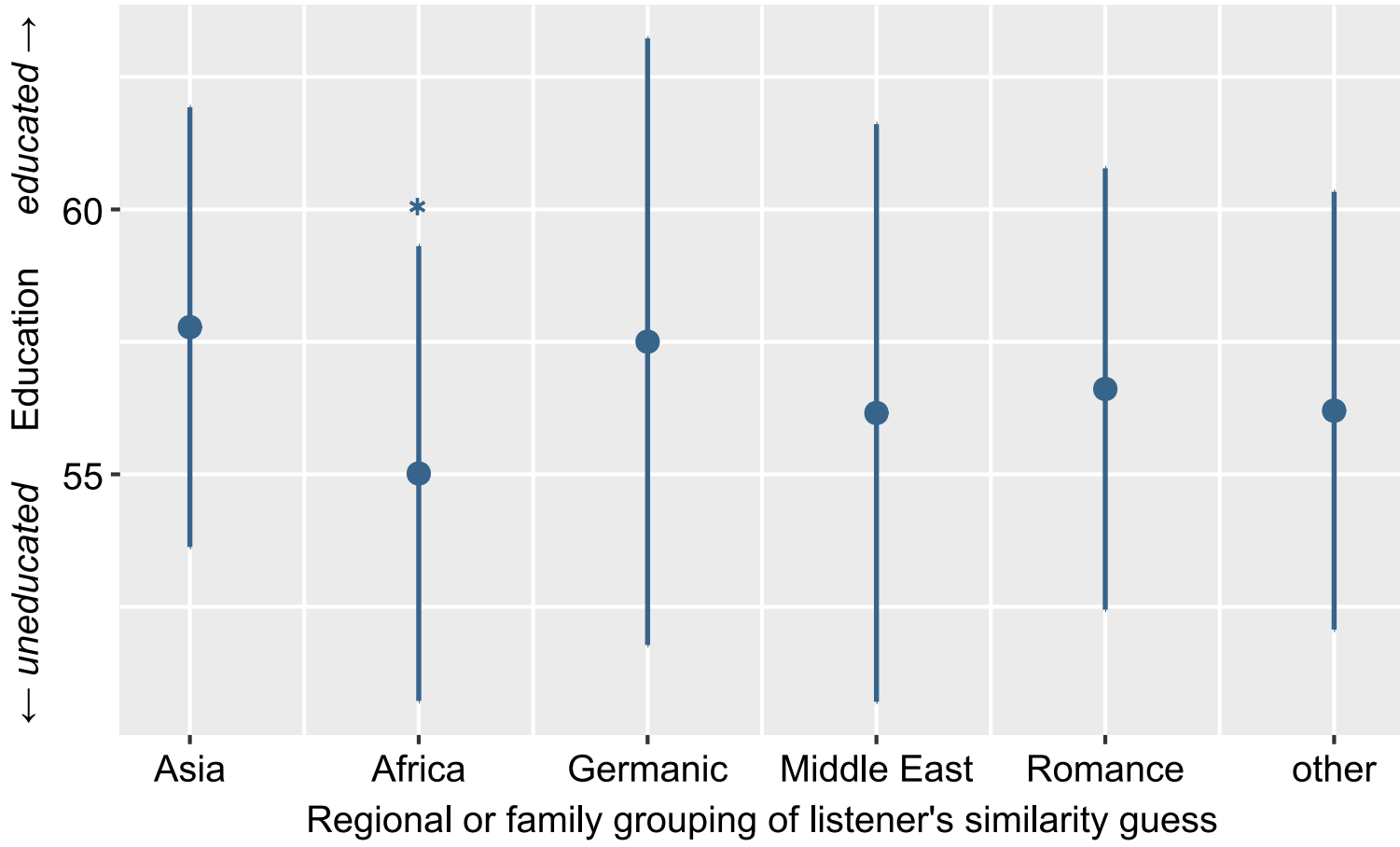
### Softness by similarity guess



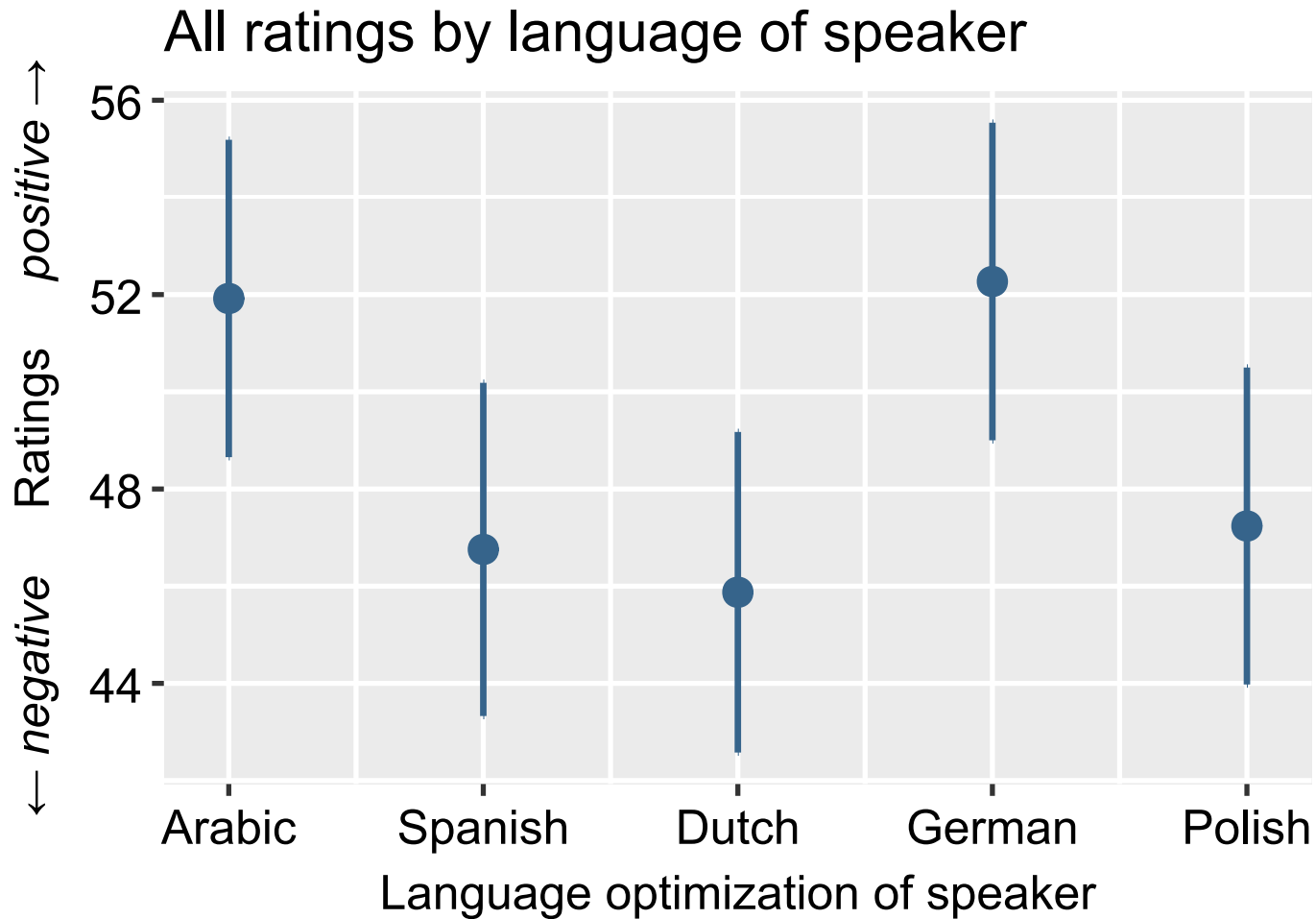
Recognition for softness model



### Education by similarity guess



Recognition for education model



Variable ▽
sonority <del>int</del>
lson <sup>H</sup> x son <sup>H</sup>
sonority <sup>H</sup> [ <sup>H</sup> ]
sonority <sup>H</sup> [ <sup>L</sup> ]
lsonority <sup>H</sup> [ <sup>H</sup> ]
lsonority <sup>H</sup> [ <sup>L</sup> ]
recognition <sup>AF</sup>
recognition <sup>GE</sup>
recognition <sup>ME</sup>
recognition <sup>RO</sup>
age
familiarity
vgender <sup>M</sup> [ <sup>IM</sup> ]
vgender <sup>M</sup> [ <sup>IF</sup> ]
lgender <sup>M</sup> [ <sup>VM</sup> ]
lgender <sup>M</sup> [ <sup>VF</sup> ]
polyglot

terms not included in this table: lsonority<sup>UN</sup> language<sup>NL, AR, DE, PL, ES</sup> linguistics musicality input... output... location...

Variable ▽	All scales	Pleasantness	Beauty	Softness	Shape	Education	Intelligence	Friendliness	Ordinariness	Goodness	Eroticism
sonority <sup>int</sup>											
lson <sup>H</sup> x son <sup>H</sup>											
sonority <sup>H</sup> [ <sup>H</sup> ]											
sonority <sup>H</sup> [ <sup>L</sup> ]											
lsonority <sup>H</sup> [ <sup>H</sup> ]											
lsonority <sup>H</sup> [ <sup>L</sup> ]											
recognition <sup>AF</sup>											
recognition <sup>GE</sup>											
recognition <sup>ME</sup>											
recognition <sup>RO</sup>											
age											
familiarity											
vgender <sup>M</sup> [ <sup>IM</sup> ]											
vgender <sup>M</sup> [ <sup>IF</sup> ]											
lgender <sup>M</sup> [ <sup>VM</sup> ]											
lgender <sup>M</sup> [ <sup>VF</sup> ]											
polyglot											

terms not included in this table: lsonority<sup>UN</sup> language<sup>NL, AR, DE, PL, ES</sup> linguistics musicality input... output... location...

Variable ▽	All scales	Pleasantness	Beauty	Softness	Shape	Education	Intelligence	Friendliness	Ordinariness	Goodness	Eroticism
sonority <sup>int</sup>	***	**	***	***	***	**	***	***	***	**	***
Ison <sup>H</sup> x son <sup>H</sup>	*							.			
sonority <sup>H</sup> [H]	***	*	**	***	***		**	***	**	**	***
sonority <sup>H</sup> [L]	***	*	**	***	***	**	***	**	***	*	***
Isonority <sup>H</sup> [H]	*	.	*		*	*		.			.
Isonority <sup>H</sup> [L]						*					.
recognition <sup>AF</sup>											
recognition <sup>GE</sup>											
recognition <sup>ME</sup>											
recognition <sup>RO</sup>											
age											
familiarity											
vgender <sup>M</sup> [IM]											
vgender <sup>M</sup> [IF]											
lgender <sup>M</sup> [VM]											
lgender <sup>M</sup> [VF]											
polyglot											
terms not included in this table: Isonority <sup>UN</sup> language <sup>NL, AR, DE, PL, ES</sup> linguistics musicality input... output... location...											

Variable ▽	All scales	Pleasantness	Beauty	Softness	Shape	Education	Intelligence	Friendliness	Ordinariness	Goodness	Eroticism
sonority <sup>int</sup>											
Ison <sup>H</sup> x son <sup>H</sup>											
sonority <sup>H</sup> [ <sup>H</sup> ]											
sonority <sup>H</sup> [ <sup>L</sup> ]											
Isonority <sup>H</sup> [ <sup>H</sup> ]											
Isonority <sup>H</sup> [ <sup>L</sup> ]											
recognition <sup>AF</sup>	***			.		*	.		.		
recognition <sup>GE</sup>											
recognition <sup>ME</sup>	*			*				*		.	
recognition <sup>RO</sup>	**			.				*		.	
age											
familiarity											
vgender <sup>M</sup> [ <sup>IM</sup> ]											
vgender <sup>M</sup> [ <sup>IF</sup> ]											
lgender <sup>M</sup> [ <sup>VM</sup> ]											
lgender <sup>M</sup> [ <sup>VF</sup> ]											
polyglot											
terms not included in this table: Isonority <sup>UN</sup> language <sup>NL, AR, DE, PL, ES</sup> linguistics musicality input... output... location...											

Variable ▽	All scales	Pleasantness	Beauty	Softness	Shape	Education	Intelligence	Friendliness	Ordinariness	Goodness	Eroticism
sonority <sup>int</sup>											
lson <sup>H</sup> x son <sup>H</sup>											
sonority <sup>H</sup> [ <sup>H</sup> ]											
sonority <sup>H</sup> [ <sup>L</sup> ]											
lsonority <sup>H</sup> [ <sup>H</sup> ]											
lsonority <sup>H</sup> [ <sup>L</sup> ]											
recognition <sup>AF</sup>											
recognition <sup>GE</sup>											
recognition <sup>ME</sup>											
recognition <sup>RO</sup>											
age	***	***	***	***	***	***	***	**	***	*	*
familiarity	***	***	***	***	***	***	***	***	***	***	***
vgender <sup>M</sup> [ <sup>IM</sup> ]											
vgender <sup>M</sup> [ <sup>IF</sup> ]											
lgender <sup>M</sup> [ <sup>VM</sup> ]											
lgender <sup>M</sup> [ <sup>VF</sup> ]											
polyglot											
terms not included in this table: lsonority <sup>UN</sup> language <sup>NL, AR, DE, PL, ES</sup> linguistics musicality input... output... location...											

Variable ▽	All scales	Pleasantness	Beauty	Softness	Shape	Education	Intelligence	Friendliness	Ordinariness	Goodness	Eroticism
sonority <sup>int</sup>											
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sonority <sup>H</sup> [ <sup>H</sup> ]											
sonority <sup>H</sup> [ <sup>L</sup> ]											
lsonority <sup>H</sup> [ <sup>H</sup> ]											
lsonority <sup>H</sup> [ <sup>L</sup> ]											
recognition <sup>AF</sup>											
recognition <sup>GE</sup>											
recognition <sup>ME</sup>											
recognition <sup>RO</sup>											
age											
familiarity											
vgender <sup>M</sup> [ <sup>IM</sup> ]	***	**	***	***		*		***		**	***
vgender <sup>M</sup> [ <sup>IF</sup> ]	***	.	*	*				**		.	***
lgender <sup>M</sup> [ <sup>VM</sup> ]	**	*	***	*			.		**	.	
lgender <sup>M</sup> [ <sup>VF</sup> ]		.				*	*		*		*
polyglot											

terms not included in this table: lsonority<sup>UN</sup> language<sup>NL, AR, DE, PL, ES</sup> linguistics musicality input... output... location...

Variable ▽	All scales	Pleasantness	Beauty	Softness	Shape	Education	Intelligence	Friendliness	Ordinariness	Goodness	Eroticism
sonority <sup>int</sup>	***	**	***	***	***	**	***	***	***	**	***
Ison <sup>H</sup> x son <sup>H</sup>	*							.			
sonority <sup>H</sup> [H]	***	*	**	***	***		**	***	**	**	***
sonority <sup>H</sup> [L]	***	*	**	***	***	**	***	**	***	*	***
Isonority <sup>H</sup> [H]	*	.	*		*	*		.			.
Isonority <sup>H</sup> [L]						*					.
recognition <sup>AF</sup>	***					*	.		.		
recognition <sup>GE</sup>											
recognition <sup>ME</sup>	*			*				*		.	
recognition <sup>RO</sup>	**			.				*		.	
age	***	***	***	***	***	***	***	**	***	*	*
familiarity	***	***	***	***	***	***	***	***	***	***	***
vgender <sup>M</sup> [IM]	***	**	***	***		*		***		**	***
vgender <sup>M</sup> [IF]	***	.	*	*				**		.	***
lgender <sup>M</sup> [VM]	**	*	***	*			.		**	.	
lgender <sup>M</sup> [VF]		.				*	*		*		*
polyglot											
terms not included in this table: Isonority <sup>UN</sup> language <sup>NL, AR, DE, PL, ES</sup> linguistics musicality input... output... location...											



## Indexicality versus iconicity

**Iconicity can be overridden by indexicality.**

- ▶ **e.g., dominance in frequency code vs. creaky voice**

Ohala 2010;  
Winter et al. 2021;  
Fuchs & Ćwiek 2022

**What we label “iconicity” is not necessarily non-arbitrary**

- ▶ **e.g., onomatopoeia is also partly conventionalized**

Kwon 2016; Anderson 1998;  
Occhino et al. 2017;  
Barker & Bozic 2024;  
Nielsen & Dingemanse 2021;  
Körtvélyessy & Štekauer 2024

**Listeners evaluate the same linguistic properties differently**

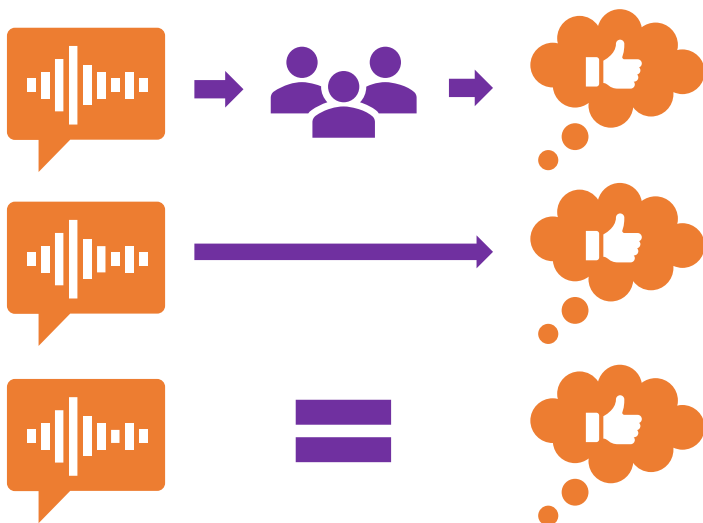
- ▶ **e.g., due to categorization and ‘social pluripotentiality’**

Dragojevic & Goatley-Soan 2022  
McLean & Motamedi 2022  
Winter et al. 2019



# Indexicality versus iconicity

## 1 iconization, indexical iconicity



Irvine & Gal 2000, Silverstein 2003

## 2 systematicity



cf., e.g., Haslett & Cai 2023

## 3 arbitrariness

Barker & Bozic, 2024; Kwon, 2016; Occhino et al., 2017; Nielsen & Dingemans, 2021



## The ontology of the rating scales

Is everything underlyingly simply **positive** or **negative**?

Maybe **not**:

- ▶ e.g., trustworthiness **independent** from attractiveness for pitch
- ▶ e.g., participants **distinguish** between moral descriptors

O'Connor & Barclay 2017

Kjeldgaard-Christiansen et al. 2025

Maybe **yes**:

- ▶ **round** is positive, **spiky** is negative
- ▶ **soft, smooth, sweet** are positive, **hard, rough, bitter** is negative
- ▶ here: **all scales** correlate with the basic scale pleasantness

Domizi 2024

Winter et al. 2019

the present study



## Limitations

- ▶ **social salience** – do we need it, after all?
- ▶ the ancient enemy: the **social desirability** bias
- ▶ there is no “**language-neutral**” realization of phoneme strings
- ▶ the variable **recognition** is notoriously hard to code
- ▶ some **scales** could actually drive each other

Li & Roberts 2023

Domizi 2024



## What's next?

SPECIFIC  
PHONEMES

/x/

SONORITY

SYLLABLE  
STRUCTURE

...



**Bonus:** /X/



## /X/ SSPG Sonority-sensitive pseudotext generator

### Control stimuli

Consonants = ['m', 'k', 'j', 'p', 'w', 'n', 't', 'l', 's', 'b']

Vowels = ['i', 'u', 'a', 'e', 'o']

Sounds['SonorityWeight'] = 1

MaxSyllableNumber = 4

SyllableStructures = ['V', 'CV']

SyllableWeights = [1, 9]

TextLength = 100

SenLength = max(1, int(random.gauss(12, 5)))

### Target stimuli

Consonants = ['m', 'k', 'j', 'p', 'w', 'n', 't', 's', 'X']

Vowels = ['i', 'u', 'a', 'e', 'o']

Sounds['SonorityWeight'] = 1

MaxSyllableNumber = 4

SyllableStructures = ['V', 'CV']

SyllableWeights = [1, 9]

TextLength = 100

SenLength = max(1, int(random.gauss(12, 5)))



cf. Gordon 2016, Maddieson 2013, Moran et al. 2019, Goodall 2020



## /X/ SSPG Sonority-sensitive pseudotext generator

	Control			Stimulus		
Speaker	1	2	3	1	2	3
Mean sonority 1-17	10.91	10.94	10.92	10.94	10.95	10.92
Consonants %	47.62	46.9	47.26	47.33	47.44	47.13
Obstruents %	25.32	23.97	23.73	24.52	26.07	26.43
Vowels %	52.4	53.1	52.7	52.7	52.6	52.9
Voicing %	79.44	80.37	79.51	79.53	78.21	78.28
Syllable structure	CV, V	CV, V	CV, V	CV, V	CV, V	CV, V
Syllable weights 0-1	0.9, 0.1	0.9, 0.1	0.9, 0.1	0.9, 0.1	0.9, 0.1	0.9, 0.1
Number of words in text	100	100	100	100	100	100
Max number of syllables	4	4	4	4	4	4
Sound inventory	base	base	base	base, x	base, x	base, x



## /X/ SSPG Sonority-sensitive pseudotext generator

### Example for control condition

Mo mutu kima le napo soteoi lubita bisi mabumopi tapesi satiu sue sobabise si painu nopu wupeto je sipawi bu nake muba no pa. Pe ne jako u po munilawi o jetuwi nu mo kuloa wiwiji somawejo. Nosobape juji pu kopopobo waka toajonu mi takeka jabakeja tisu tuelu kepe jewo luwo jesoja wejoniwe kasajo jujianu. Wulusa sa ma mieto ta tojimu motutasa lo we no pika. Nomewiju sau ta seili ni puwoja nase ju lelemi wawamonu bo pukebopo. Wa bakolimu kuuali jiku ke sobi tosisabo kikitebi nitiwusu jupike lipu enibu mopobewa ti iwibaja kinotu wa busu bibuase kuine kosumewe. Toinu.



## /X/ SSPG Sonority-sensitive pseudotext generator

### Example for target condition

Sauxi nuopo pu xo boxiliwa limuwua muneu tasasupe banepoku bano jumabise kuta wi pu pa tixu meja tupi tobimo boma. Ku jewia mujaxito li ta. Teloju ana epoo xitexi xotiwo no pexu kuwuto epa muwubu isiju. Wipoxai nubunipe niopawa xane joluxoka xo buipu owilu no pu mile sitokame mupaje. Xine nekosu. Mapejo ja xunujiwi esi si epa naji nuxu to. Ma naemexe beame jesobu betetumu bajotu mioxi lalo. Pibila bi wuneomo nonamito wo pelejiwe xo pa jo. Wokiwabi jopu xia ta masa ne jubuja sunasato ataxibu josakuto buxuwuxu telouna mele ku. Misa monapo ta miwi jeu so jumu enilepe lolami.



## /X/ SSPG Sonority-sensitive pseudotext generator

### Example for target condition

Sauxi nuopo pu xo boxiliwa limuwua muneu tasasupe banepoku bano jumabise kuta wi pu pa tixu meja tupi tobimo boma. Ku jewia mujaxito li ta. Teloju ana epoo xitexi xotiwo no pexu kuwuto epa muwubu isiju. Wipoxai nubunipe niopawa xane joluxoka xo buipu owilu no pu mile sitokame mupaje. Xine nekosu. Mapejo ja xunujiwi esi si epa naji nuxu to. Ma naemxe beame jesobu betetumu bajotu mioxi lalo. Pibila bi wuneomo nonamito wo pelejiwe xo pa jo. Wokiwabi jopu xia ta masa ne jubuja sunasato ataxibu josakuto buxuwuxu telouna mele ku. Misa monapo ta miwi jeu so jumu enilepe lolami.



## **/X/** SSPG **Sonority-sensitive pseudotext generator**

### **Example for control condition**

```
<speak> <phoneme alphabet="ipa" ph="mo mutu kima le napo soteoi lubita bisi mabumopi
tapesi satiu sue sobabise si painu nopu wupeto je sipawi bu nake muba no
pa"></phoneme> <break strength="strong"/> <phoneme alphabet="ipa" ph=" pe ne jako u
po munilawi o jetuwi nu mo kuloa wiwiji somawejo"></phoneme> <break
strength="strong"/> <phoneme alphabet="ipa" ph=" nosobape juji pu kopopobo waka
toajonu mi takeka jabakeja tisu tuelu kepe jewo luwo jesoja wejoniwe kasajo
jujianu"></phoneme> <break strength="strong"/> <phoneme alphabet="ipa" ph=" wulusa
sa ma mieto ta tojimu motutasa lo we no pika"></phoneme> <break strength="strong"/>
<phoneme alphabet="ipa" ph=" nomewiju sau ta seili ni puwoja nase ju lelemi wawamonu
bo pukebopo"></phoneme> <break strength="strong"/> <phoneme alphabet="ipa" ph=" wa
bakolimu kuuali jiku ke sobi tosisabo kikitebi nitiwusu jupike lipu enibu mopobewa ti
iwibaja kinotu wa busu bibuase kuine kosumewe"></phoneme> <break
strength="strong"/> <phoneme alphabet="ipa" ph=" toinu"></phoneme> ...
```



## /X/ SSPG Sonority-sensitive pseudotext generator

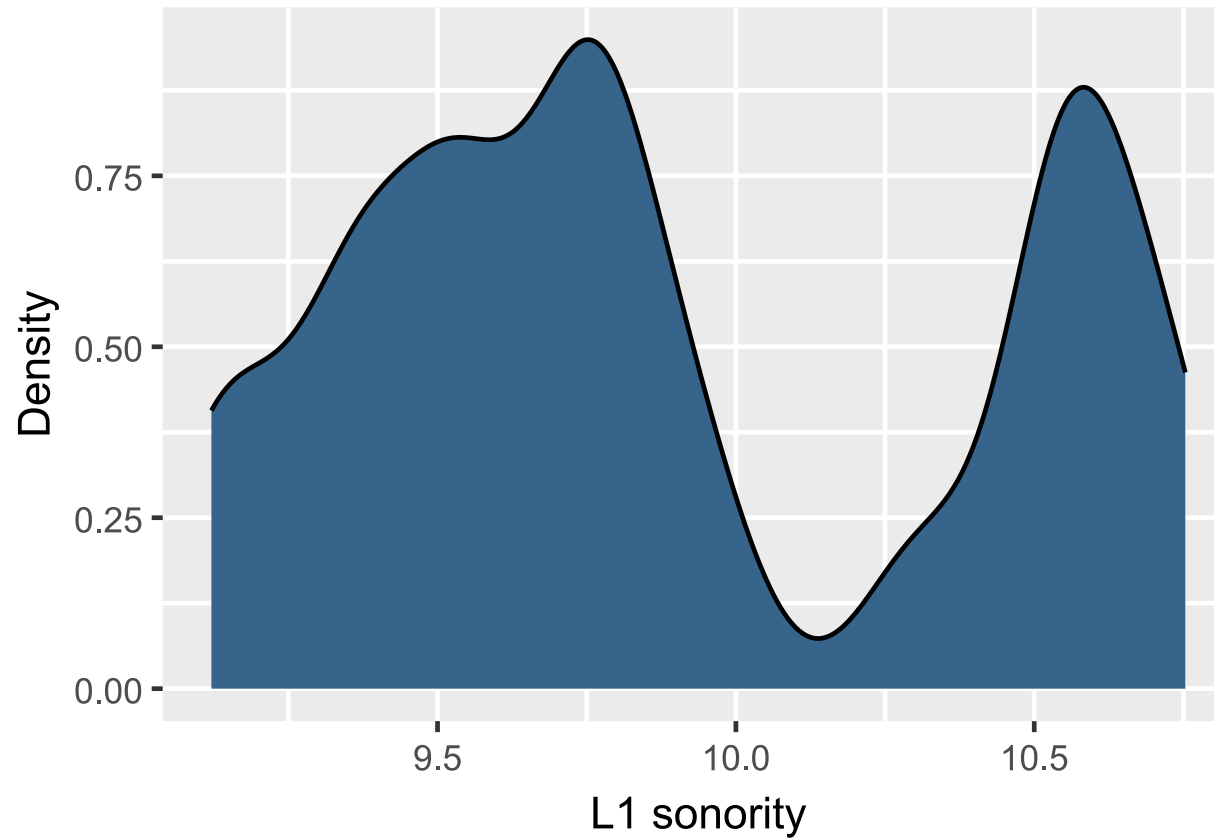
### Example for target condition

```
<speak> <phoneme alphabet="ipa" ph="sauxi nuopo pu xo boxiliwa limuwua muneu tasasupe
banepoku bano jumabise kuta wi pu pa tixu meja tupi tobimo boma"></phoneme> <break
strength="strong"/> <phoneme alphabet="ipa" ph=" ku jewia mujaxito li ta"></phoneme> <break
strength="strong"/> <phoneme alphabet="ipa" ph=" teluju ana epoo xitexi xotiwo no pexu kuwuto
epa muwubu isiju"></phoneme> <break strength="strong"/> <phoneme alphabet="ipa" ph=" wipoxai
nubunipe niopawa xane joluxoka xo buipu owilu no pu mile sitokame mupaje"></phoneme> <break
strength="strong"/> <phoneme alphabet="ipa" ph=" xine nekosu"></phoneme> <break
strength="strong"/> <phoneme alphabet="ipa" ph=" mapejo ja xunujiwi esi si epa naji nuxu
to"></phoneme> <break strength="strong"/> <phoneme alphabet="ipa" ph=" ma naemexe beame
jesobu betetumu bajotu mioxi lalo"></phoneme> <break strength="strong"/> <phoneme
alphabet="ipa" ph=" pibila bi wuneomo nonamito wo pelejiwe xo pa jo"></phoneme> <break
strength="strong"/> <phoneme alphabet="ipa" ph=" wokiwabi jopu xia ta masa ne jubuja sunasato
ataxibu josakuto buxuwuxu telouna mele ku"></phoneme> <break strength="strong"/> <phoneme
alphabet="ipa" ph=" misa monapo ta miwi jeu so jumu enilepe lolami"></phoneme> <break
strength="strong"/> <phoneme alphabet="ipa" ph=""></phoneme> </speak>
```



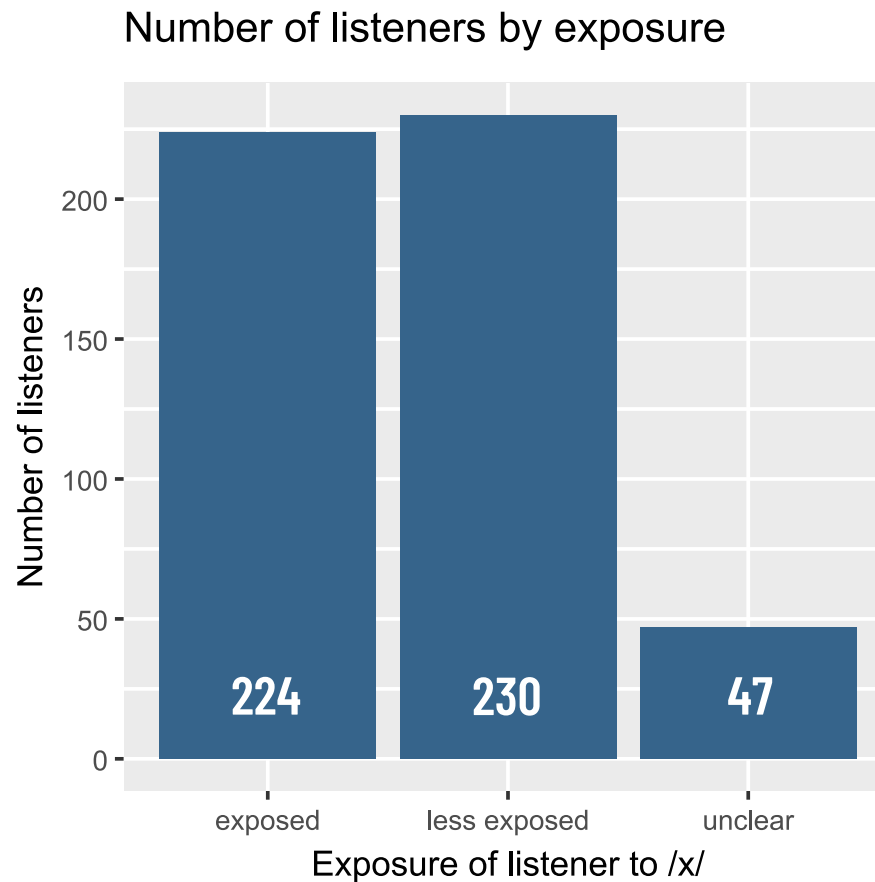
Participant quota sampling by **FIRST LANGUAGE**  Prolific

Density of L1 sonority





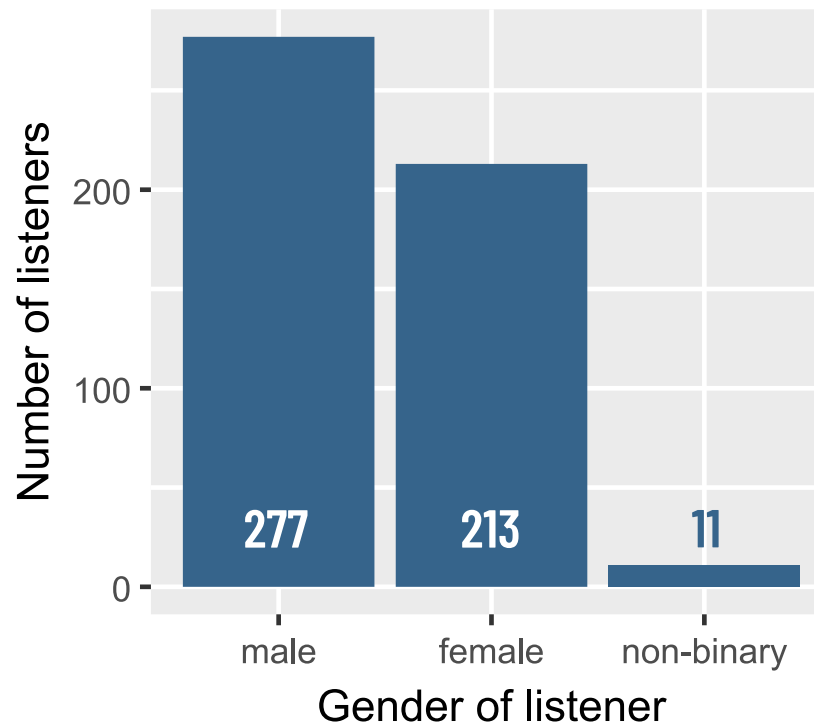
## Participant quota sampling by **FIRST LANGUAGE** Prolific





## Participant quota sampling by **FIRST LANGUAGE** Prolific

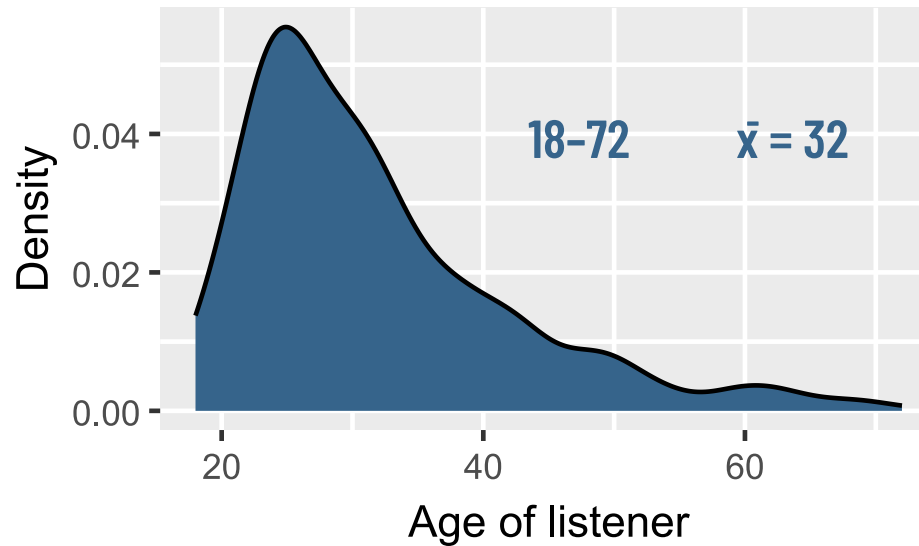
Number of listeners by gender





## Participant quota sampling by **FIRST LANGUAGE** Prolific

Density of age of listeners





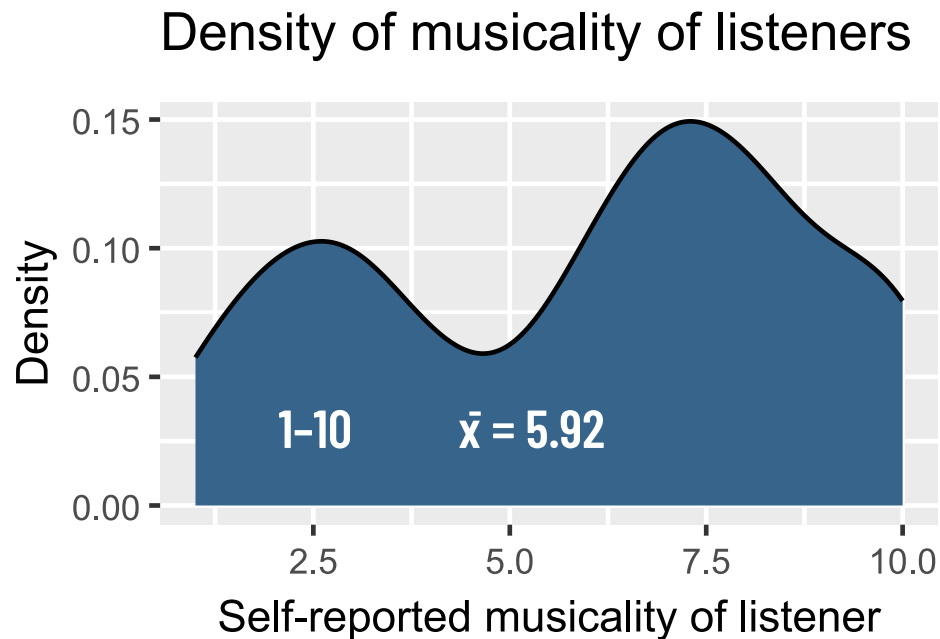
## Participant quota sampling by **FIRST LANGUAGE** Prolific

Number of listeners by linguistics





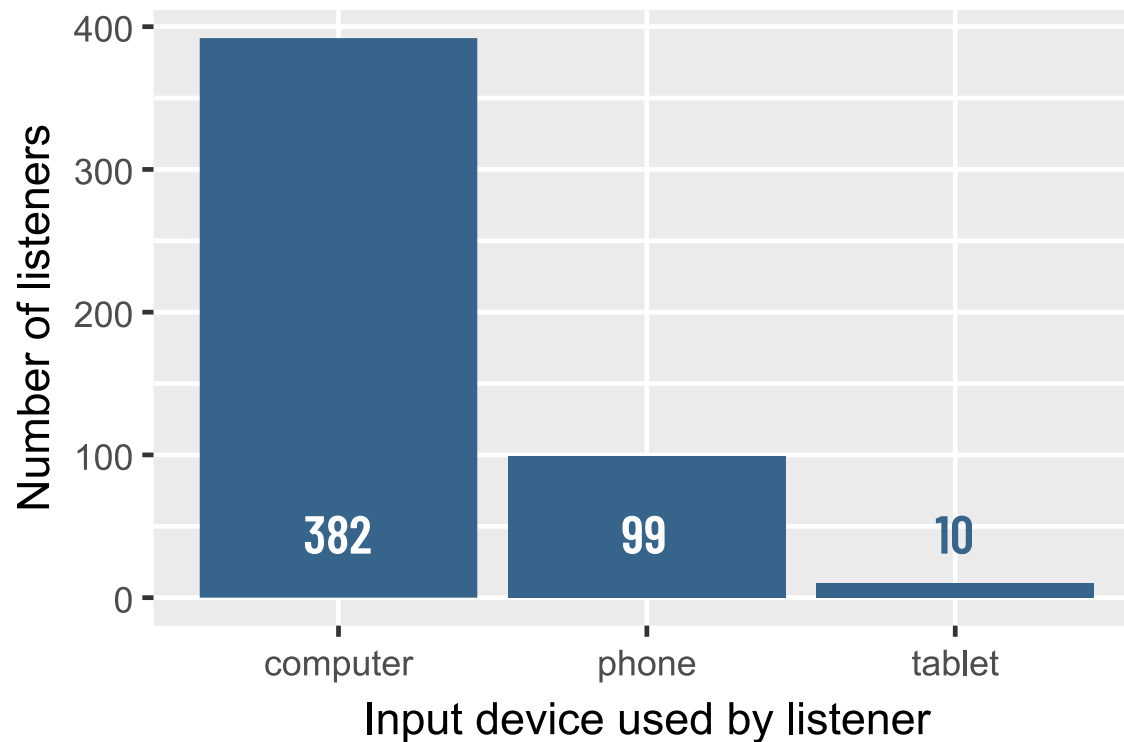
## Participant quota sampling by **FIRST LANGUAGE** Prolific





## Participant quota sampling by **FIRST LANGUAGE** Prolific

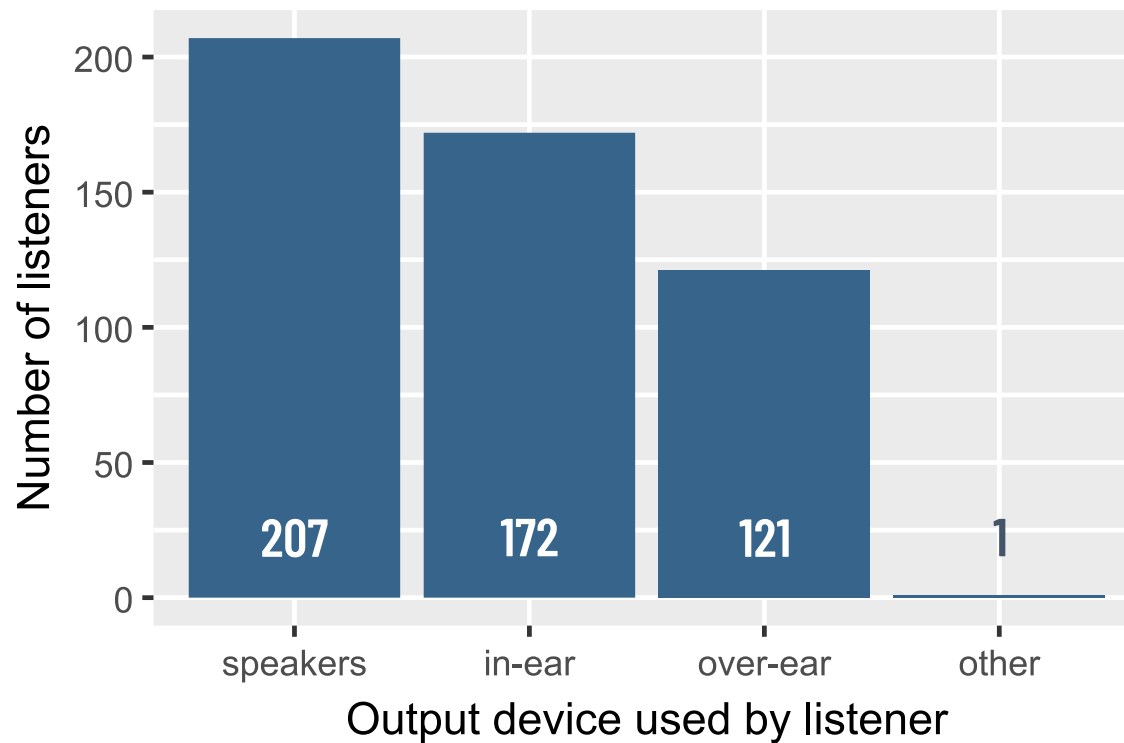
### Number of listeners by input device





## Participant quota sampling by **FIRST LANGUAGE** Prolific

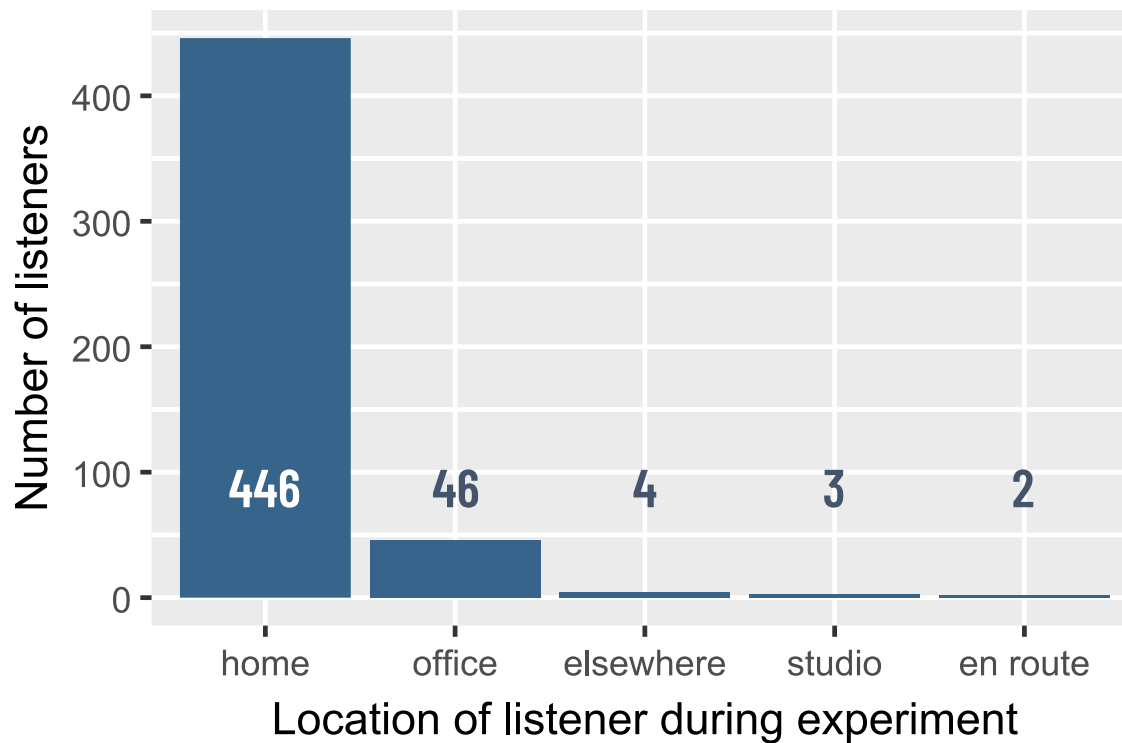
### Number of listeners by output device





## Participant quota sampling by **FIRST LANGUAGE** Prolific

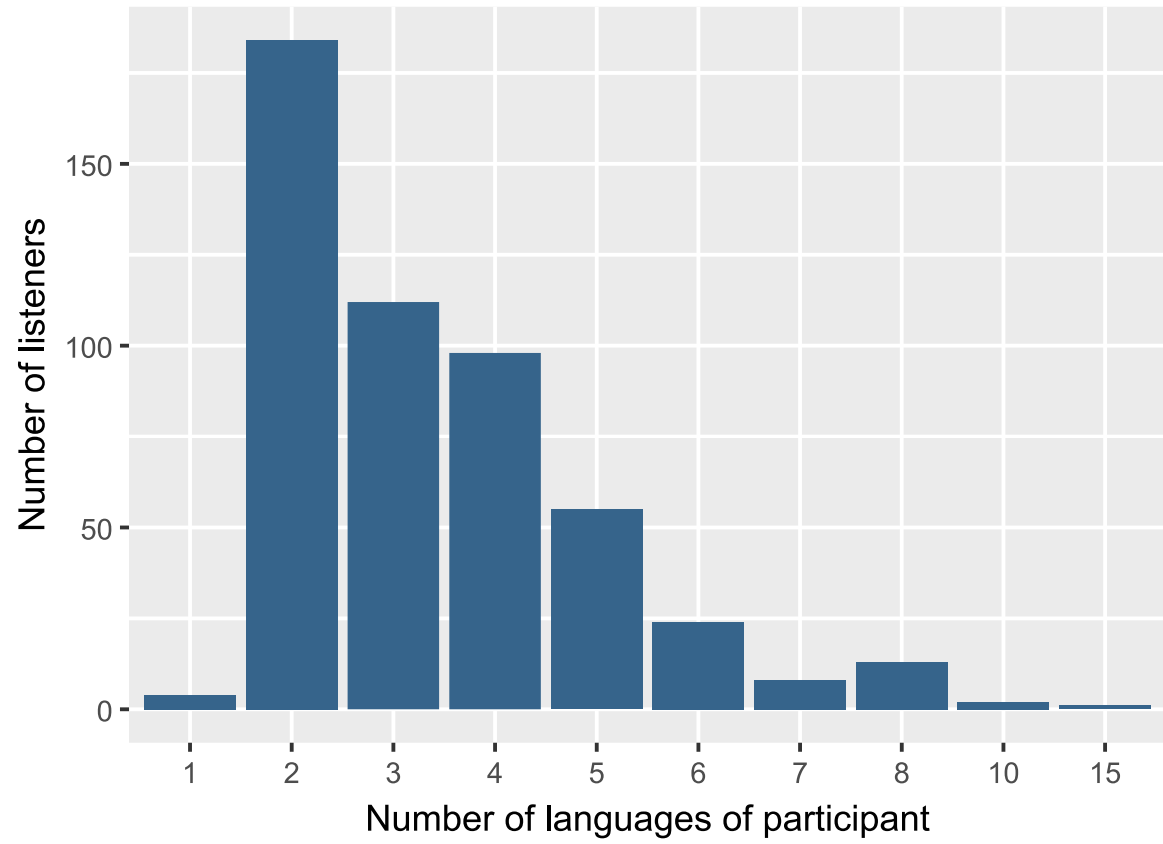
### Number of listeners by location






# Participant quota sampling by **FIRST LANGUAGE** Prolific

Number of listeners by polyglot factor





# /X/ Participant quota sampling by PRIMARY LANGUAGE

<b>exposed</b>	<b>Arabic</b>	<b>Dutch</b>	<b>German</b>	<b>Polish</b>	<b>Spanish</b>
	10 %	10 %	10 %	10 %	10 %
	50	50	50	50	50
<b>less exposed</b>	<b>English</b>	<b>Italian</b>	<b>Japanese</b>		
	17 %	17 %	16 %		
	86	85	80	= 100 % = 500	



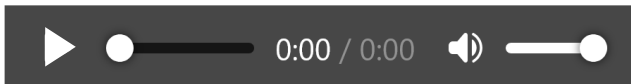
## /X/ Questionnaire



30% completed

Please listen to the recording of the first robot:

To listen, click the play button.

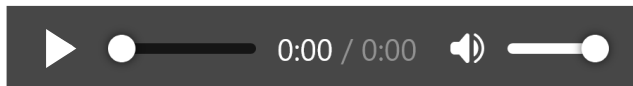




## /X/ Questionnaire

Please listen to the recording of the second robot:

To listen, click the play button.

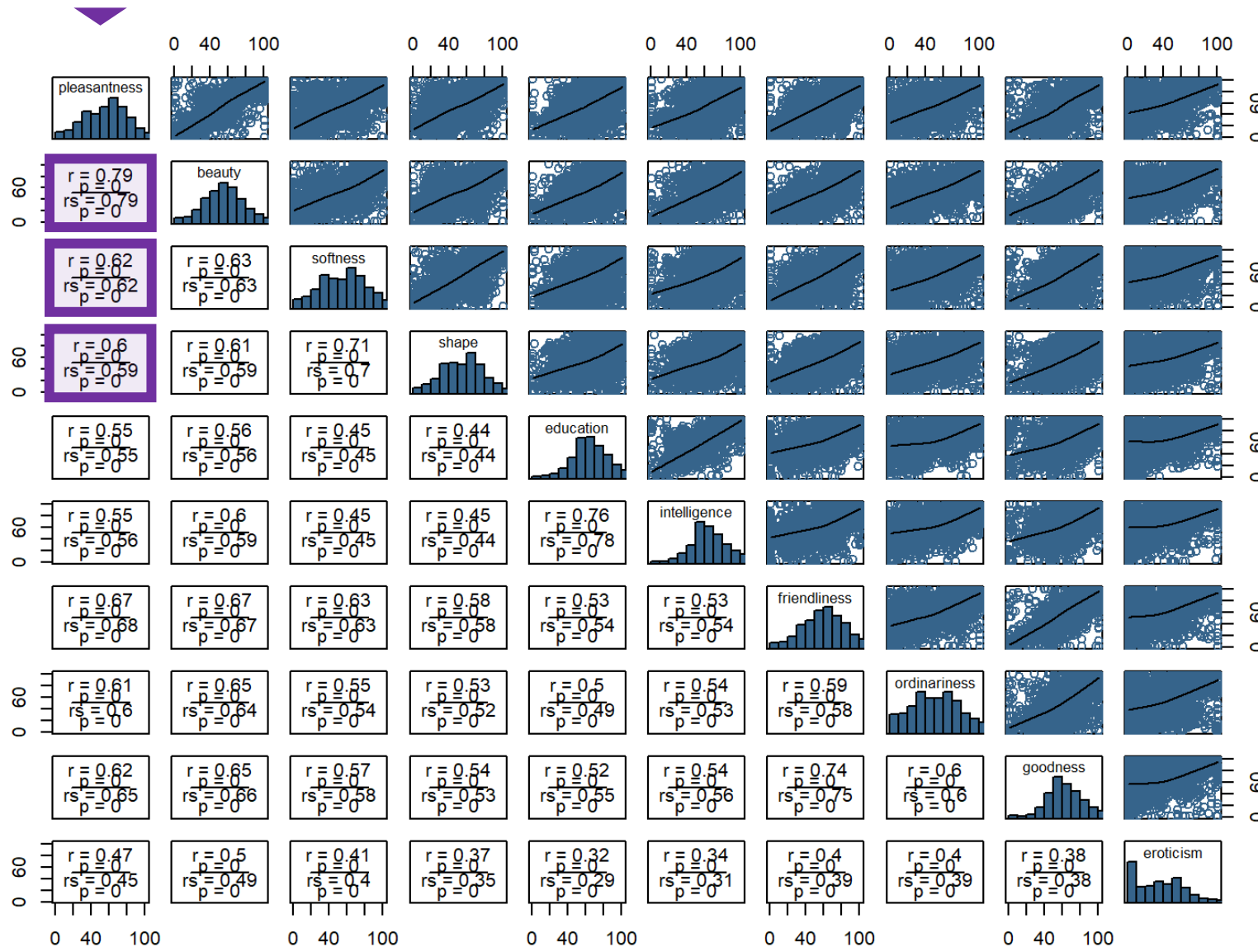




## **/X/** Modeling **One model with all scales**

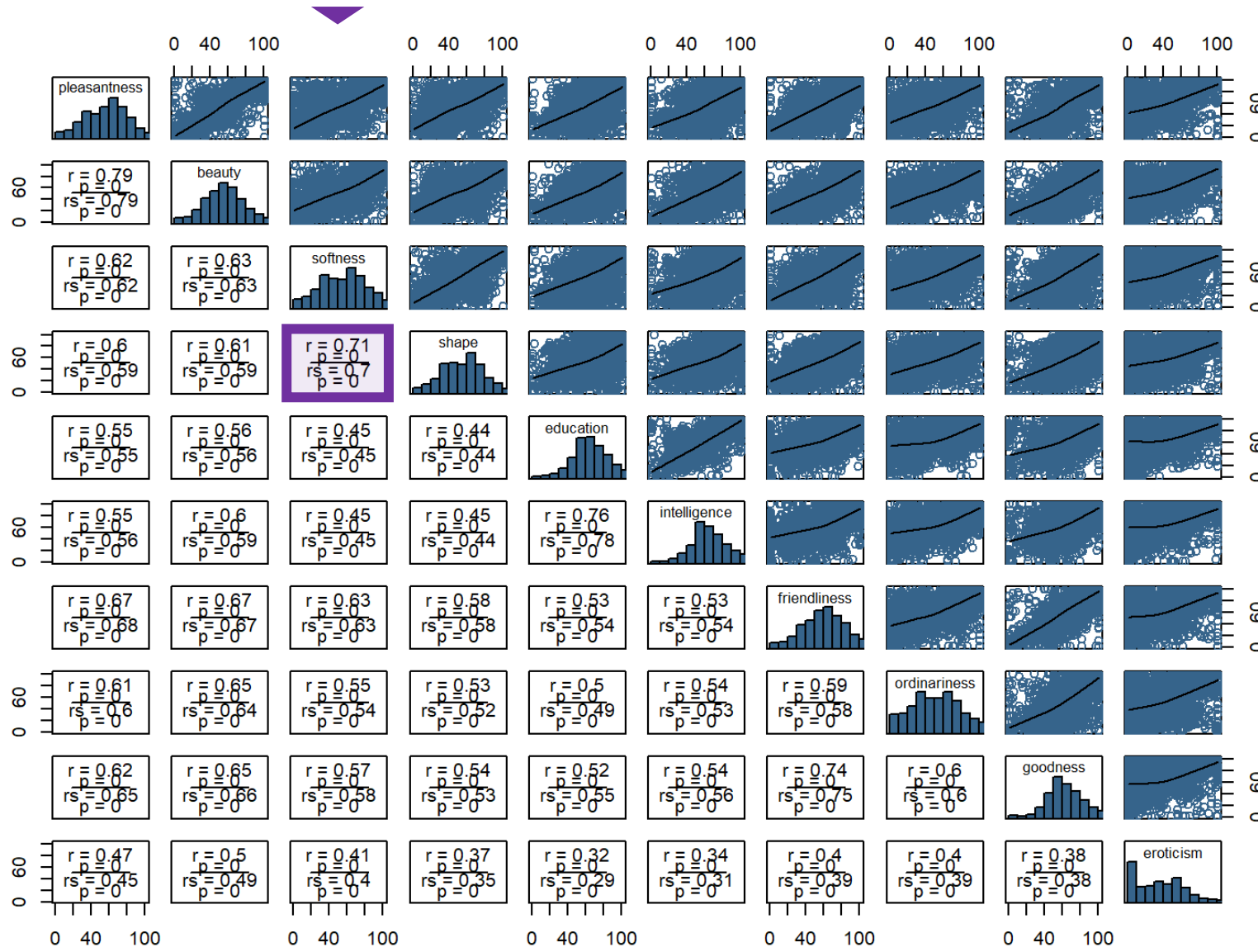
**RATING** ~ **CONDITION \* EXPOSURE +**  
**RECOGNITION +**  
**FAMILIARITY +**  
**LANGUAGE +**  
**LISTENER GENDER \* VOICE GENDER +**  
**POLYGLOT +**  
**AGE + MUSICALITY + LINGUISTICS +**  
**INPUT + OUTPUT + LOCATION +**  
**SCALE +**  
**(1 | PARTICIPANT)**

cf., e.g.,  
 Hilton et al. 2022  
 Anikin et al. 2023  
 Reiterer et al. 2020  
 Mooshammer et al. 2023



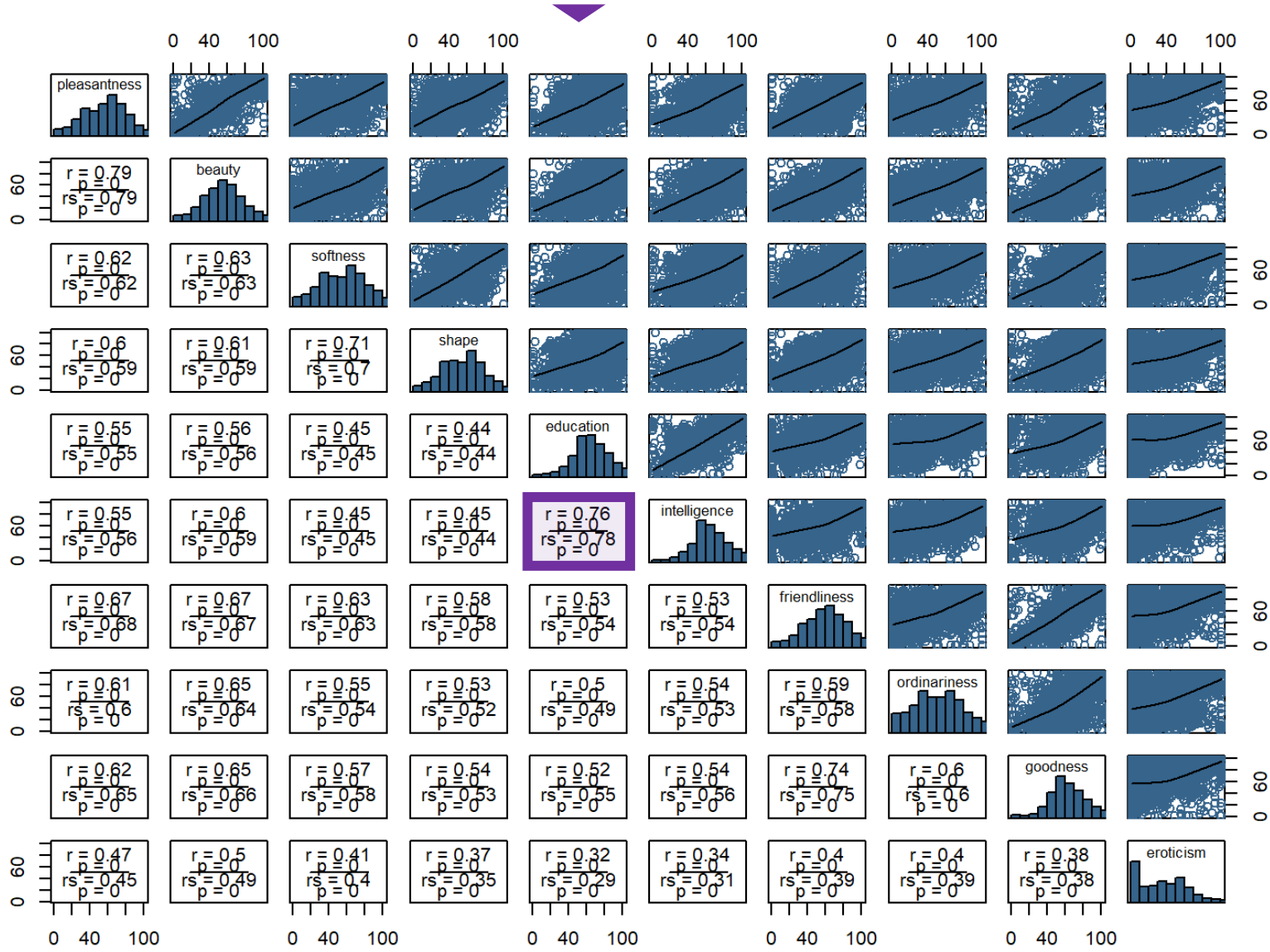
/X/

Correlation matrix of all semantic scales



/X/

Correlation matrix of all semantic scales



/X/

Correlation matrix of all semantic scales



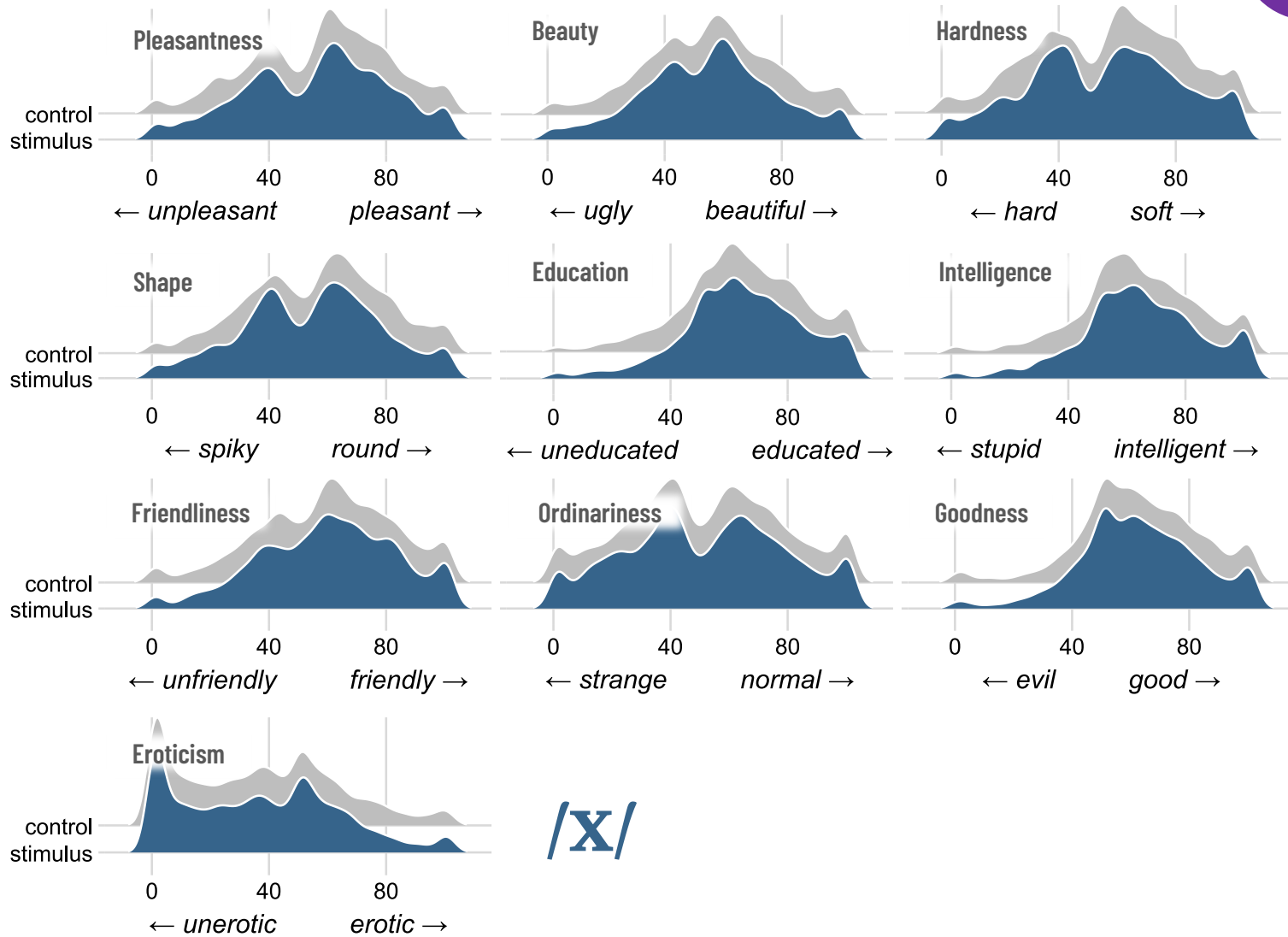
/X/

Correlation matrix of all semantic scales



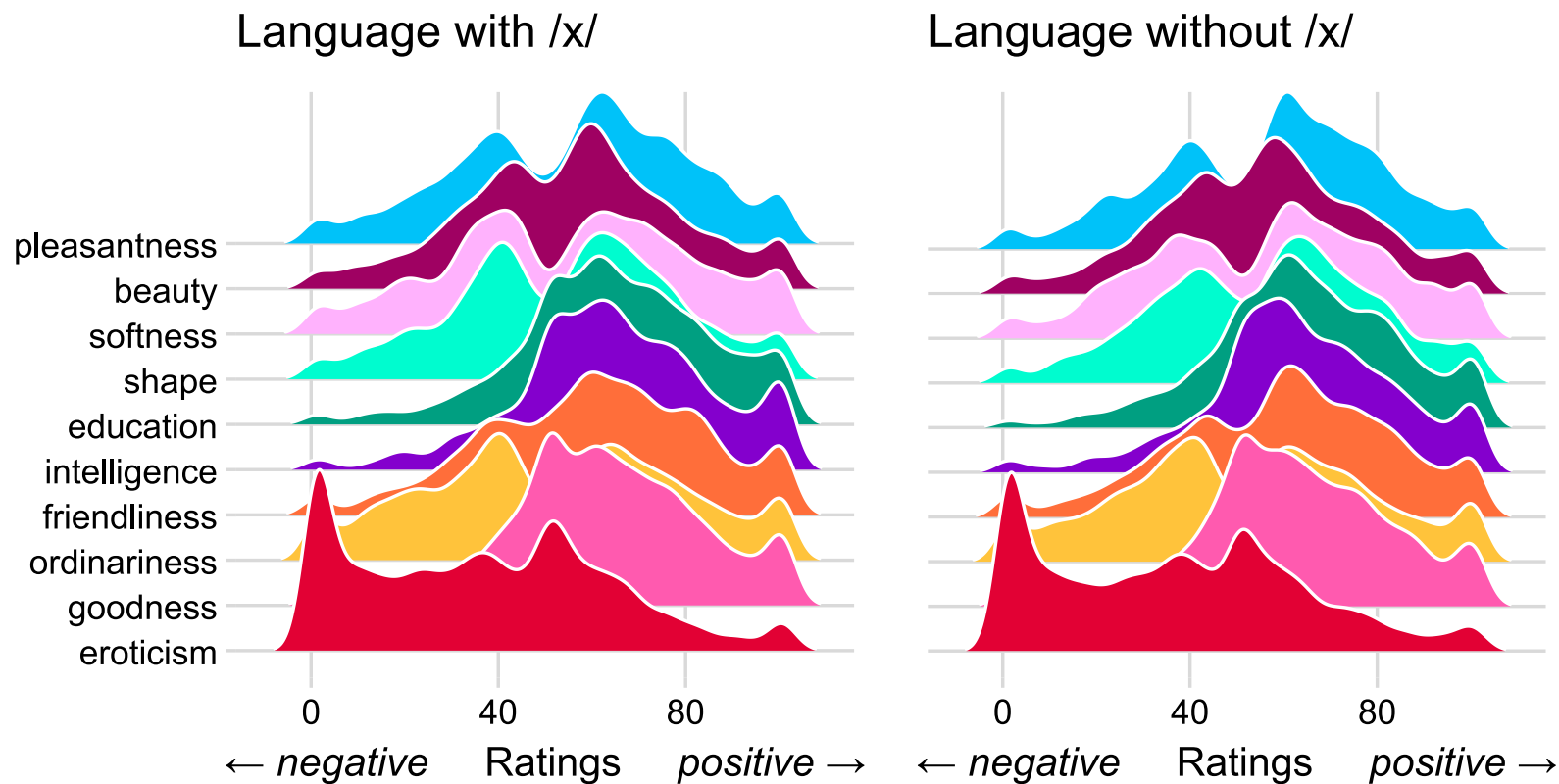
/X/

Correlation matrix of all semantic scales



Distribution of ratings by condition for each scale

**/x/** Distribution of ratings by scale for each condition



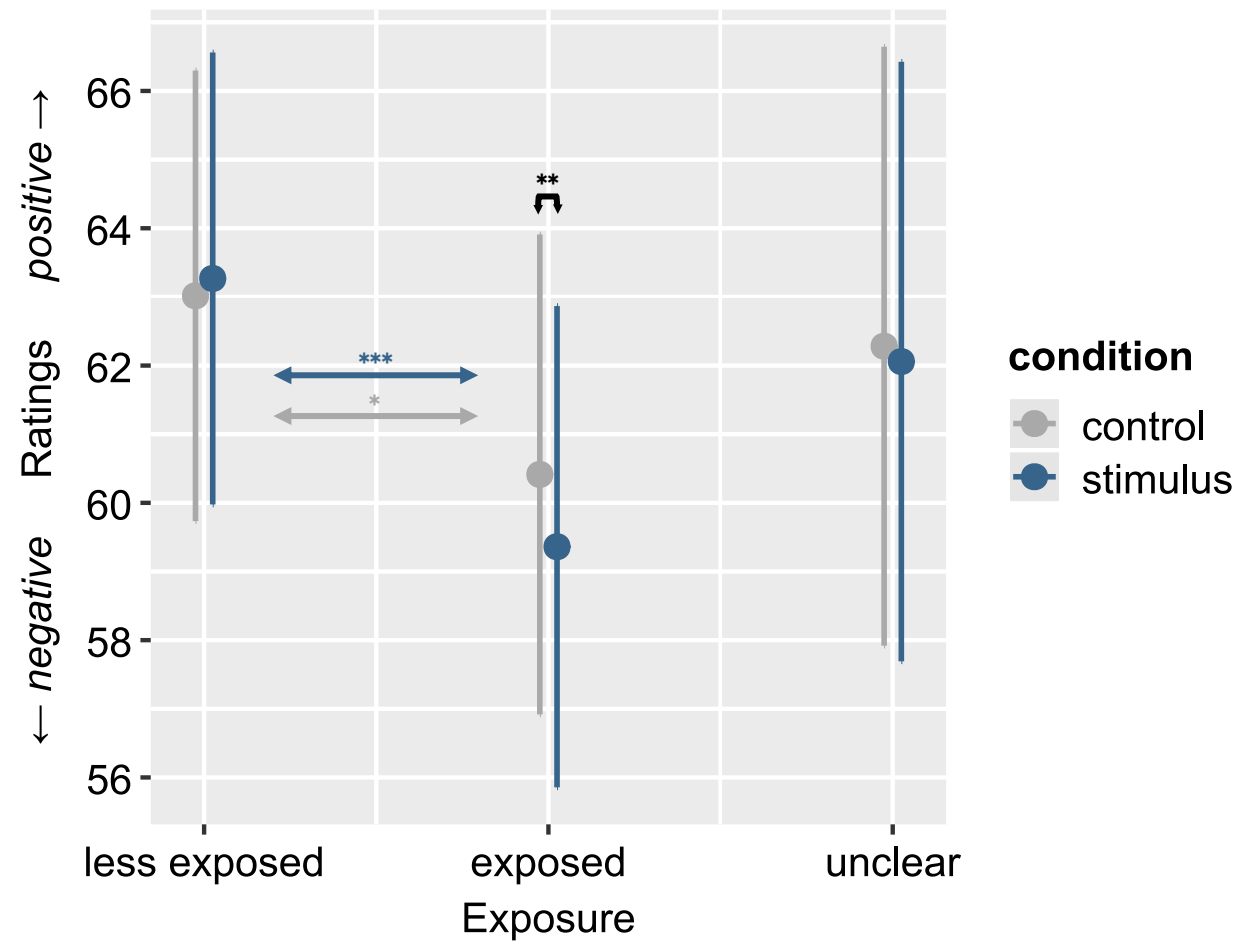
### Effects across all rating scales



/X/

Overview of model with all scales

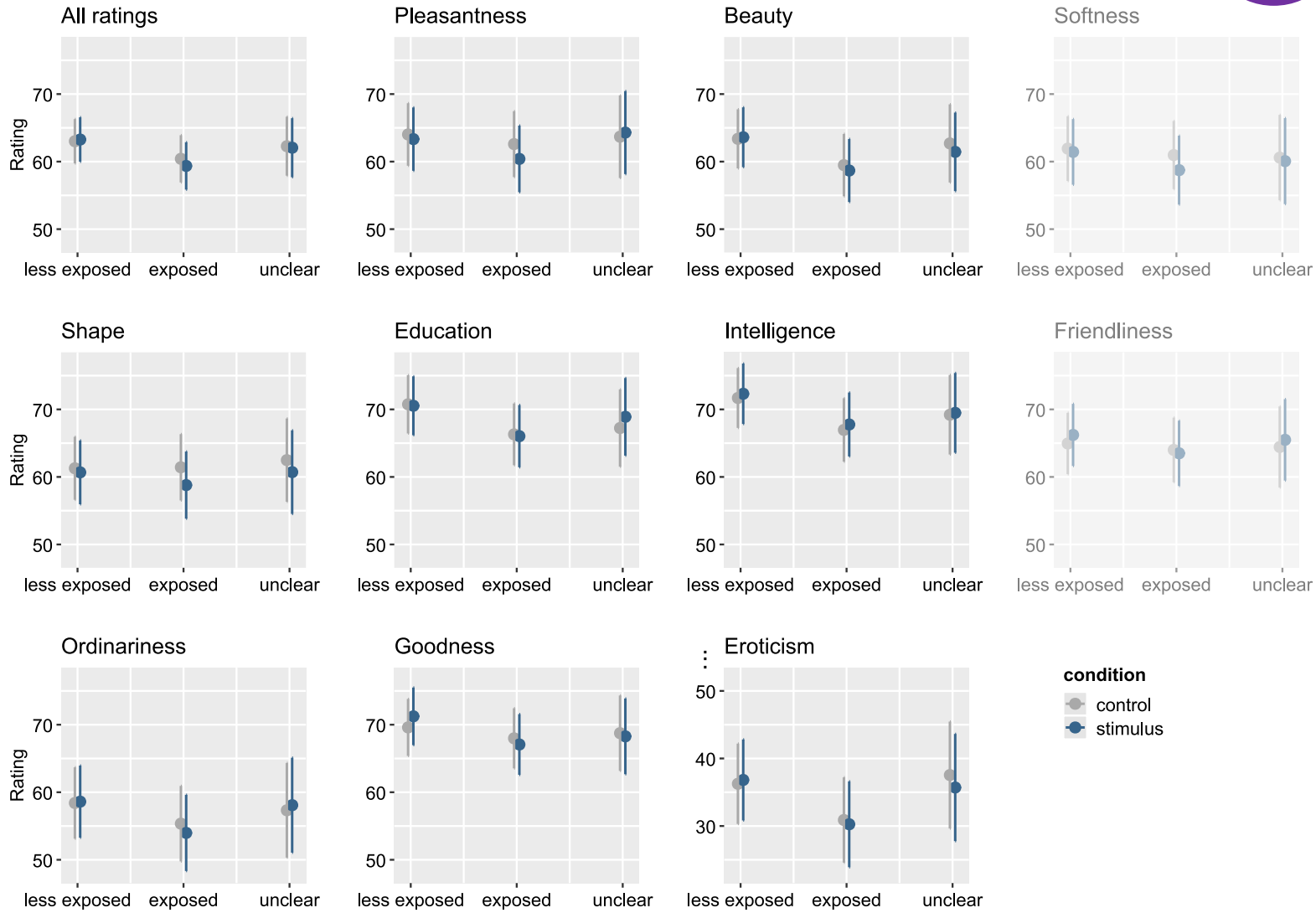
# /x/ All ratings by condition and exposure



Condition by exposure for model with all scales

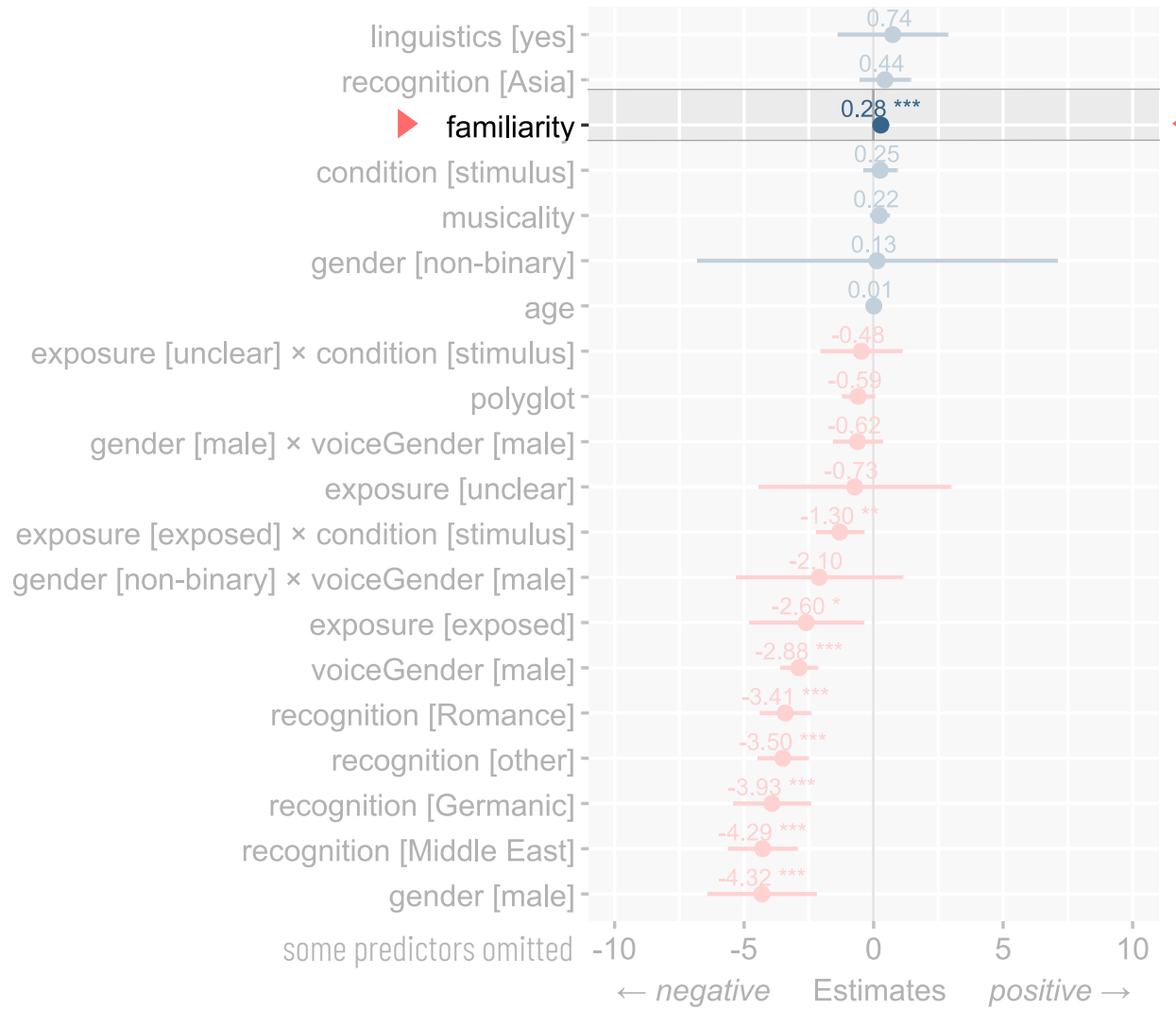


/X/



Overview of condition by exposure

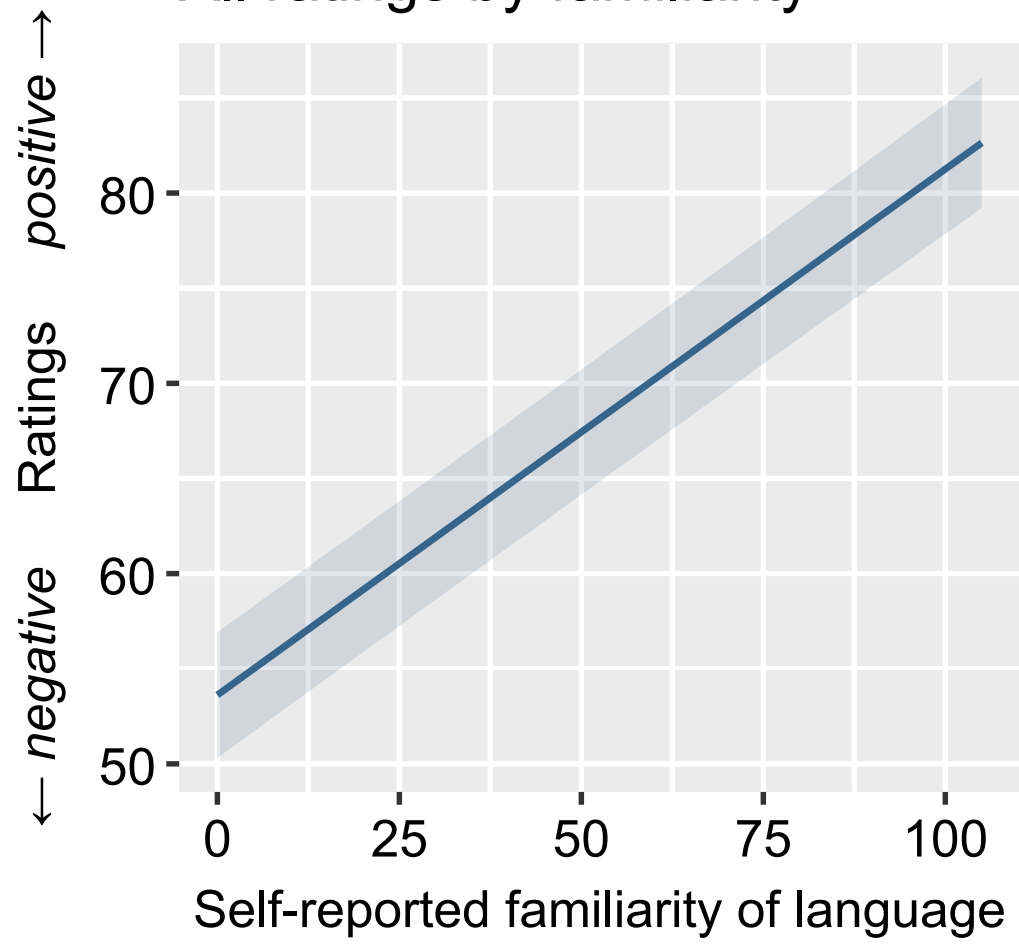
### Effects across all rating scales



/X/

Overview of model with all scales

### All ratings by familiarity

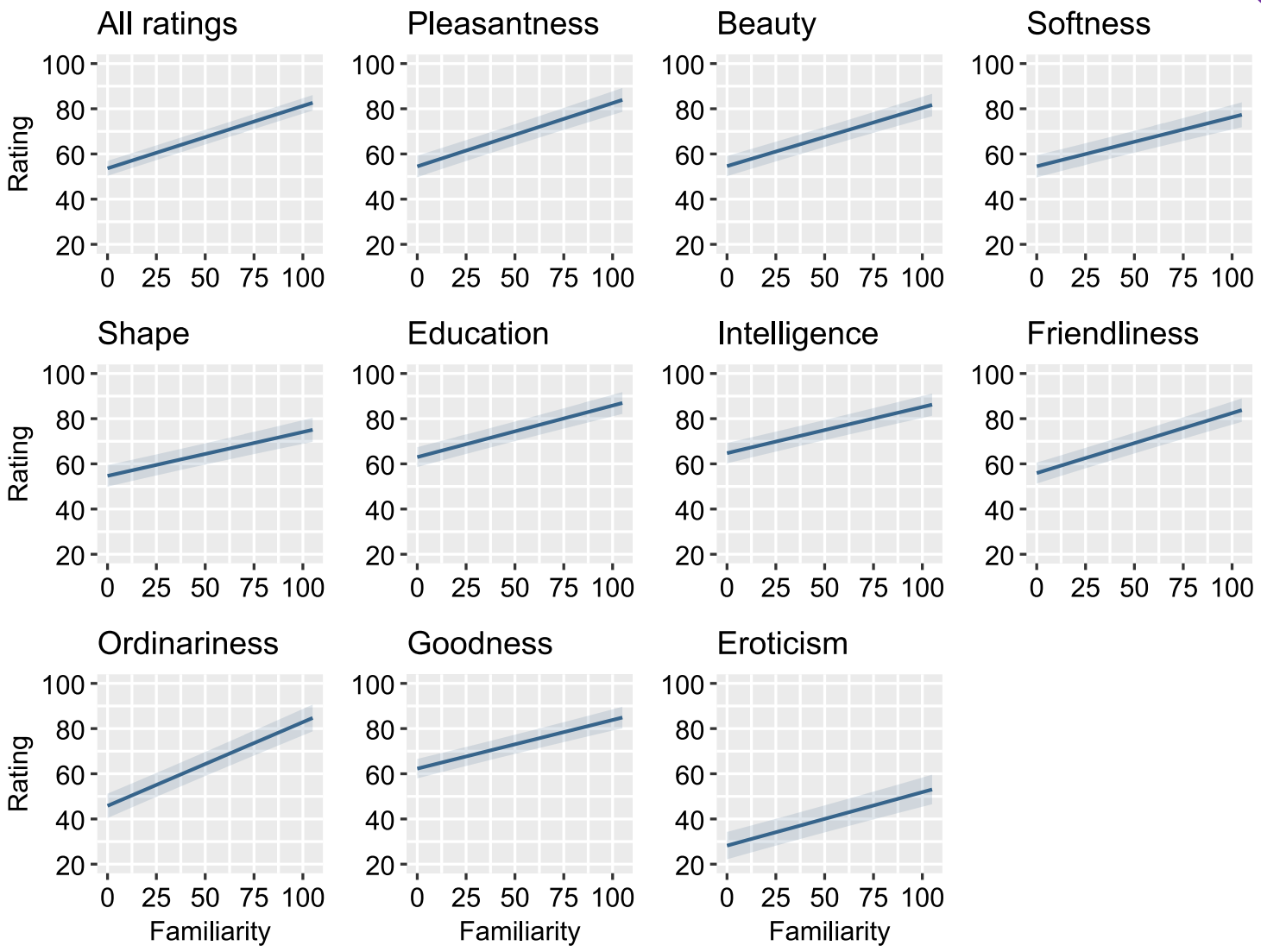


/X/

Familiarity for model with all scales

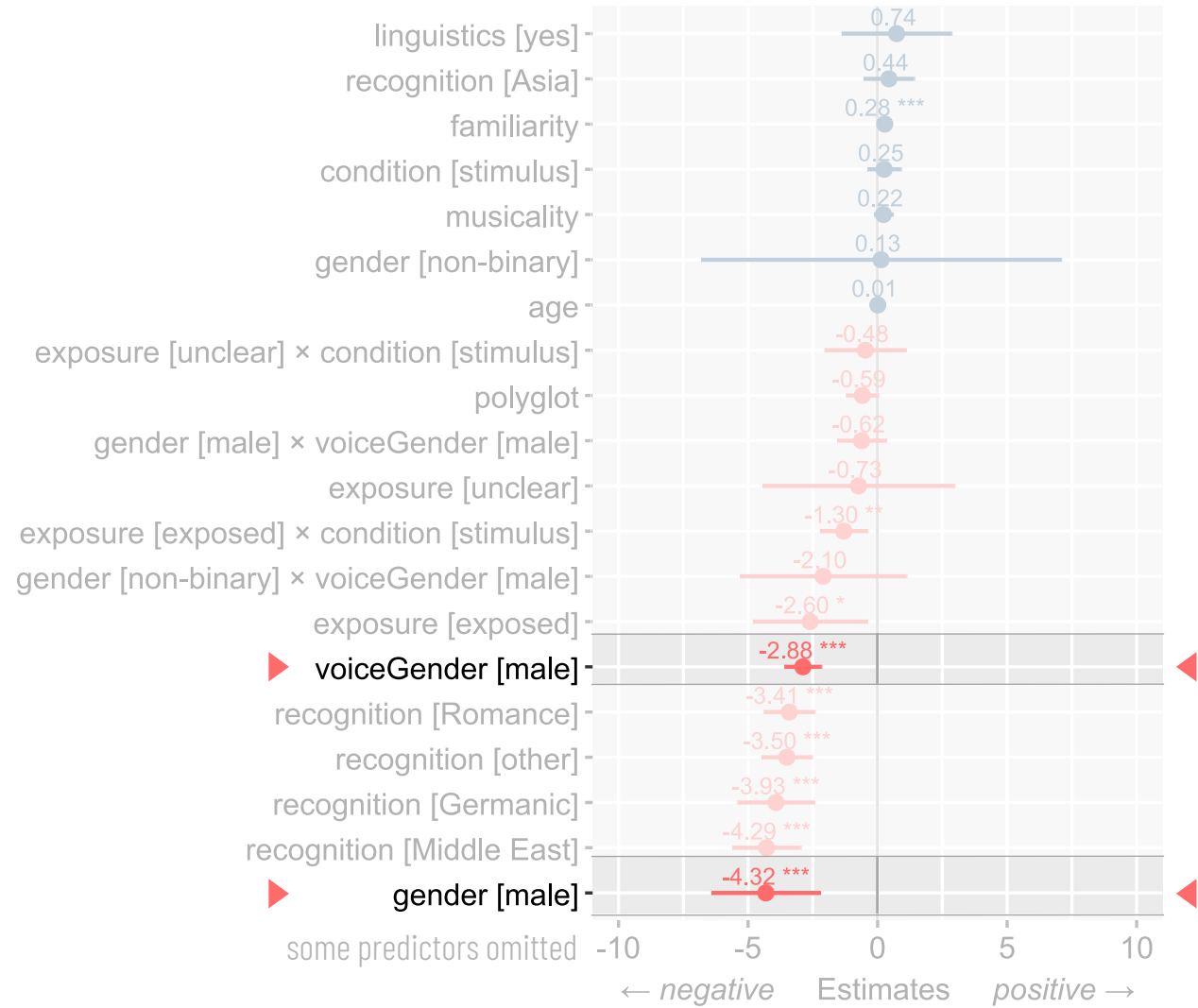


/X/



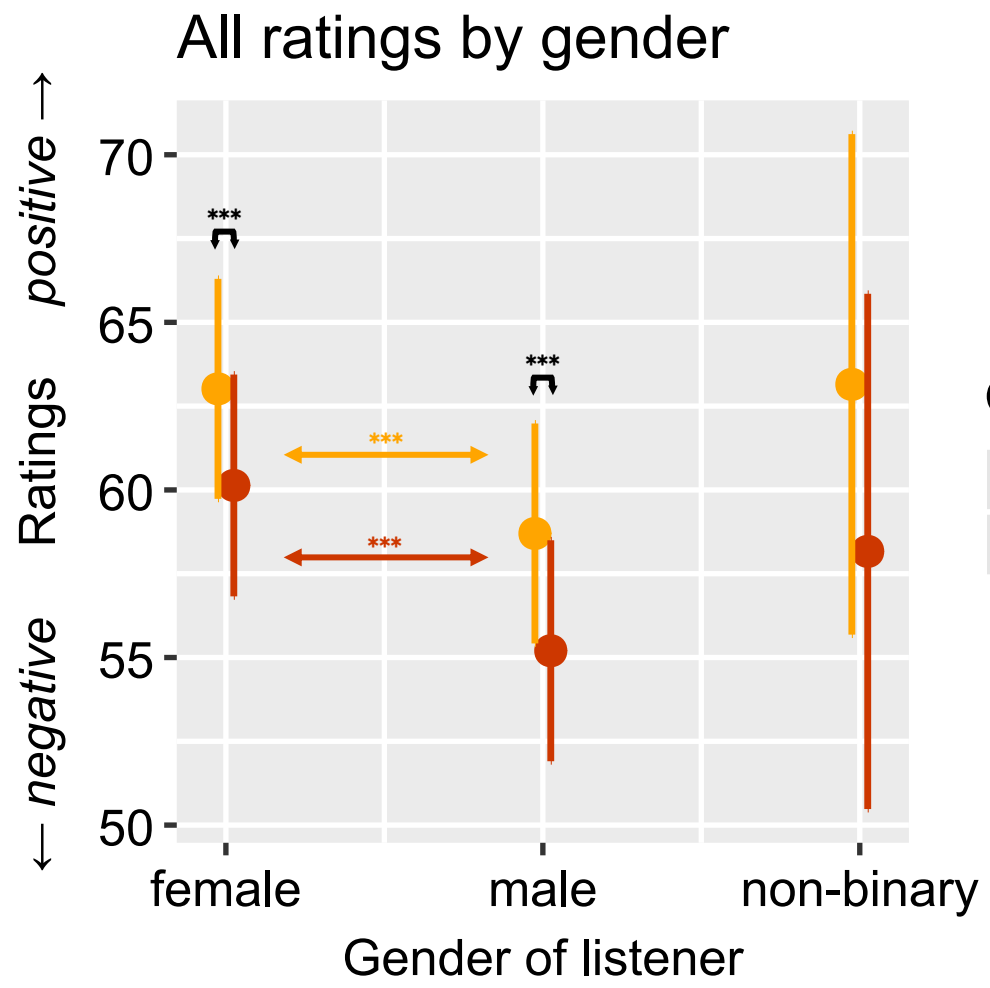
Overview of familiarity

Effects across all rating scales



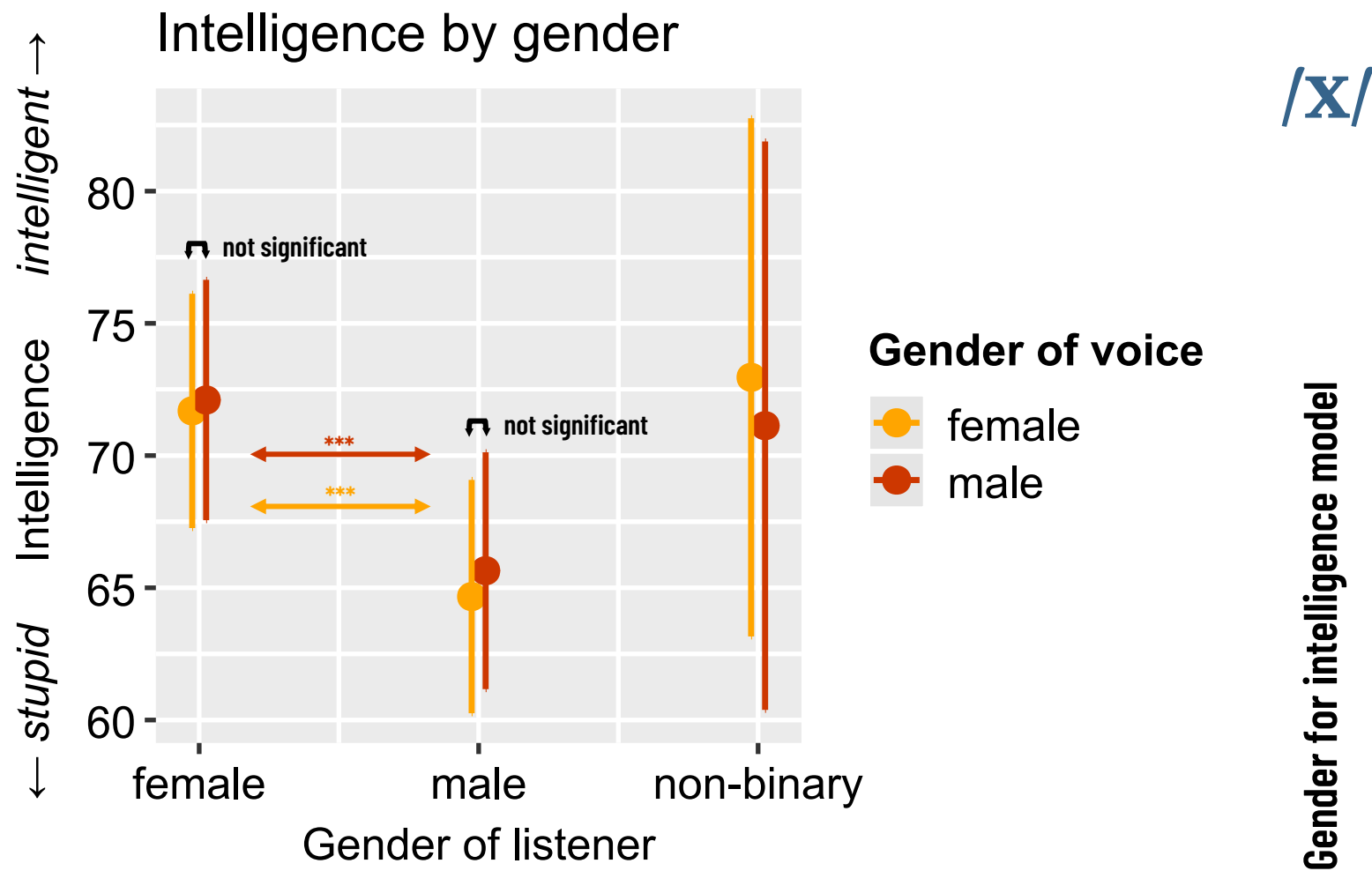
/X/

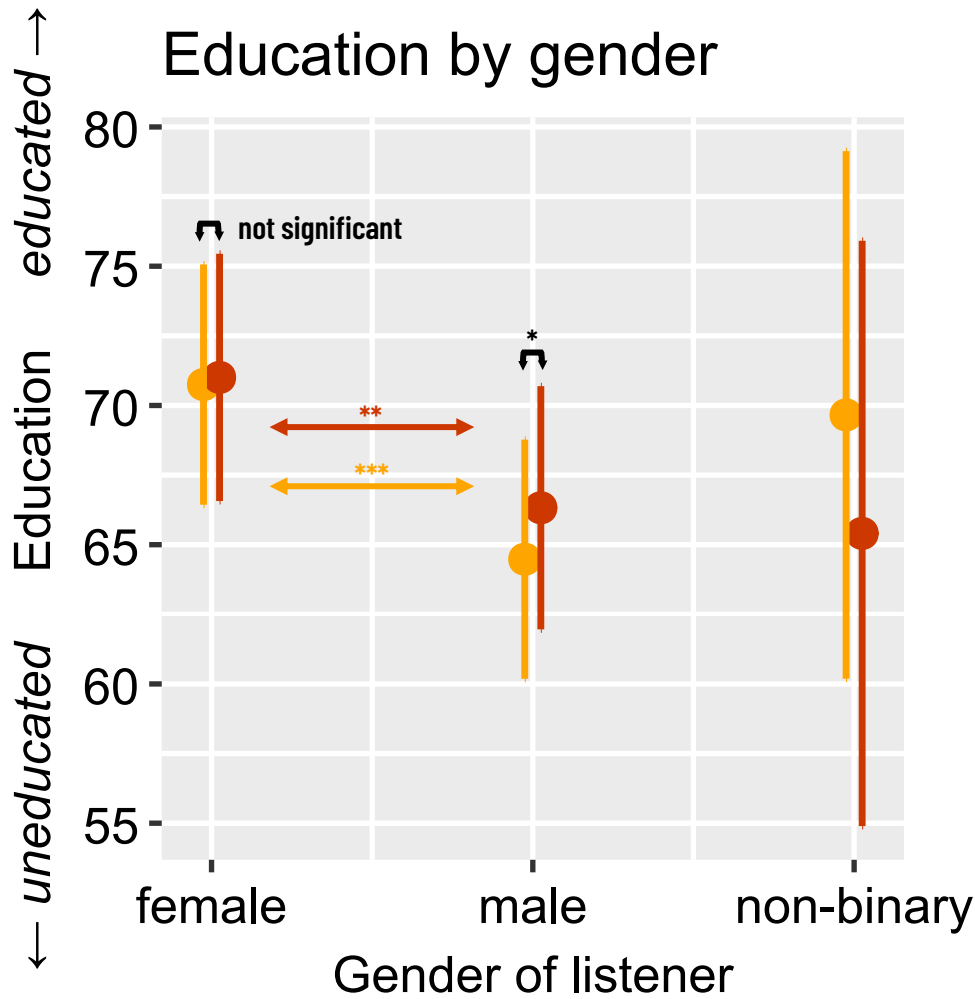
Overview of model with all scales



/x/

Gender for model with all scales





/x/

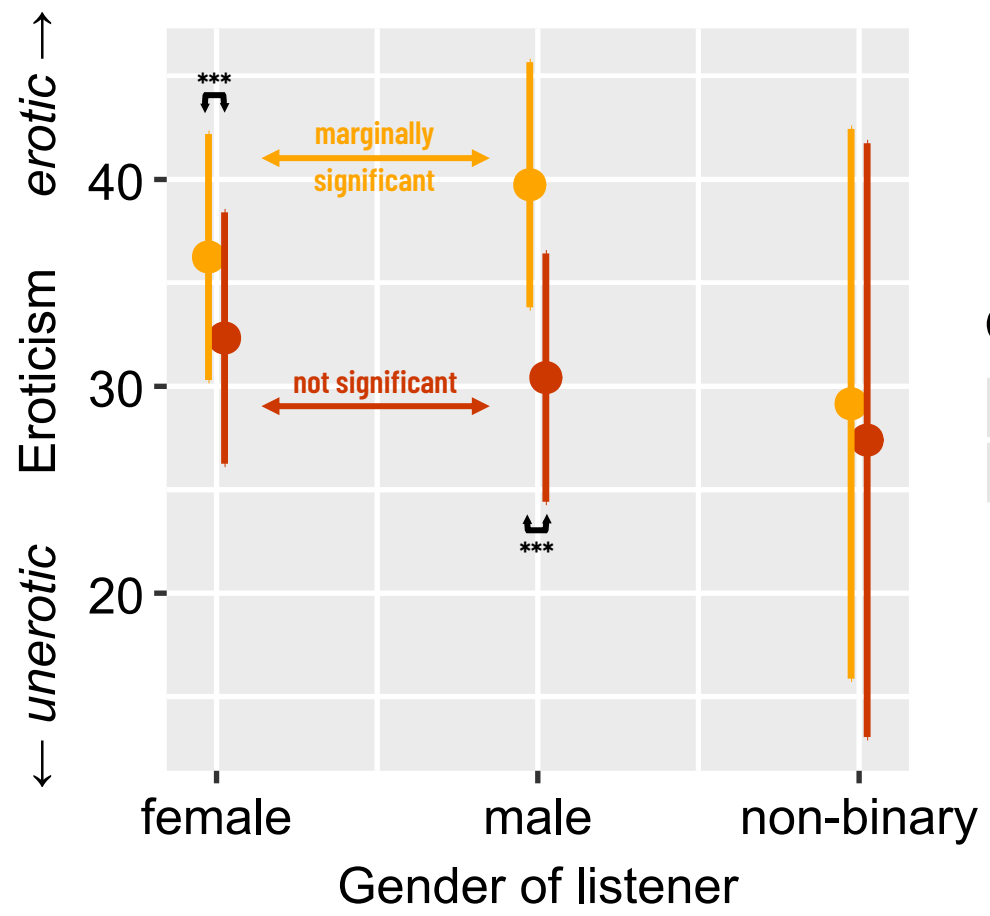
### Gender of voice

- female
- male

Gender for education model



## Eroticism by gender

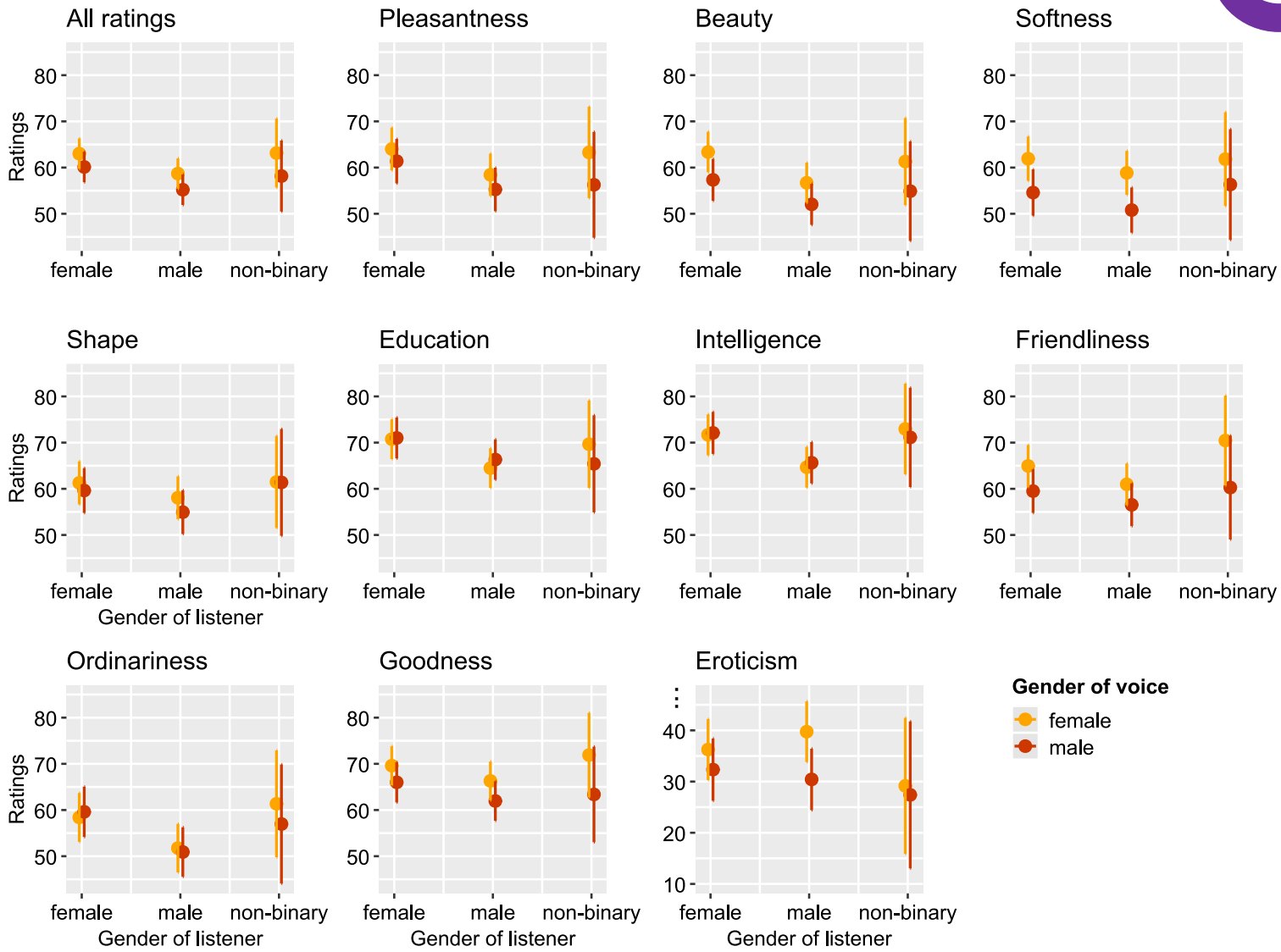


/x/

### Gender of voice

- female
- male

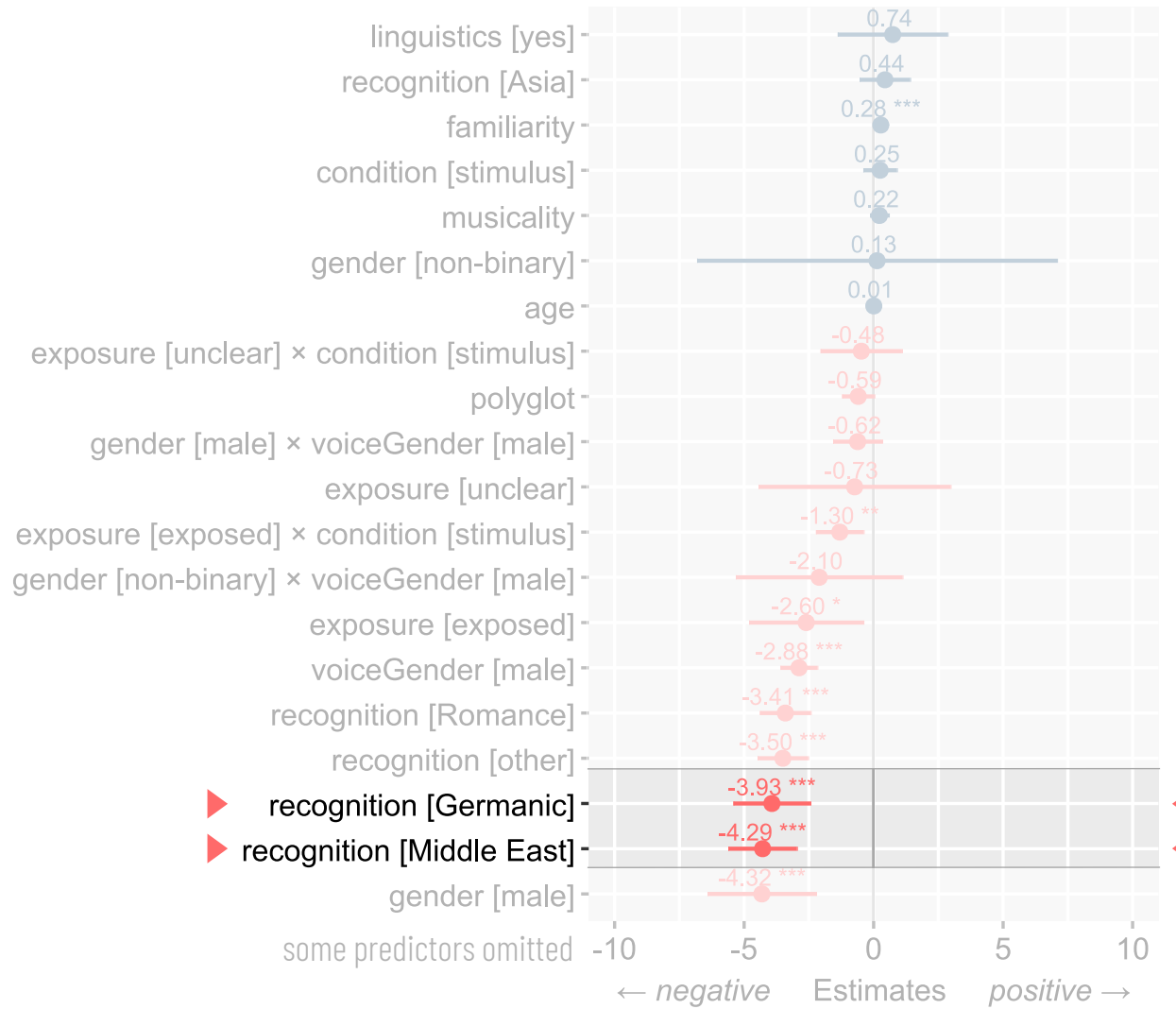
Gender for eroticism model



/X/

Overview of gender

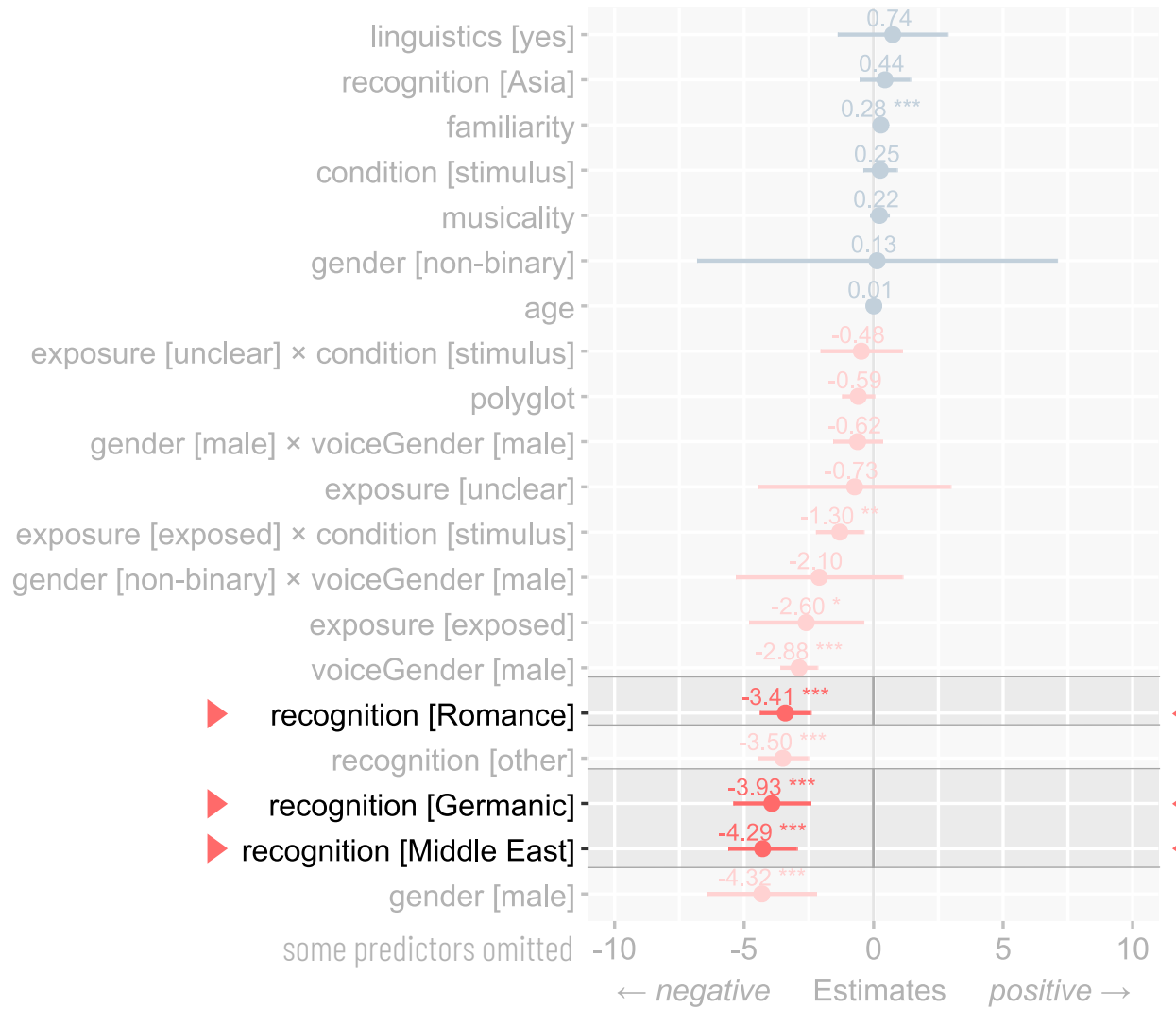
Effects across all rating scales



/X/

Overview of model with all scales

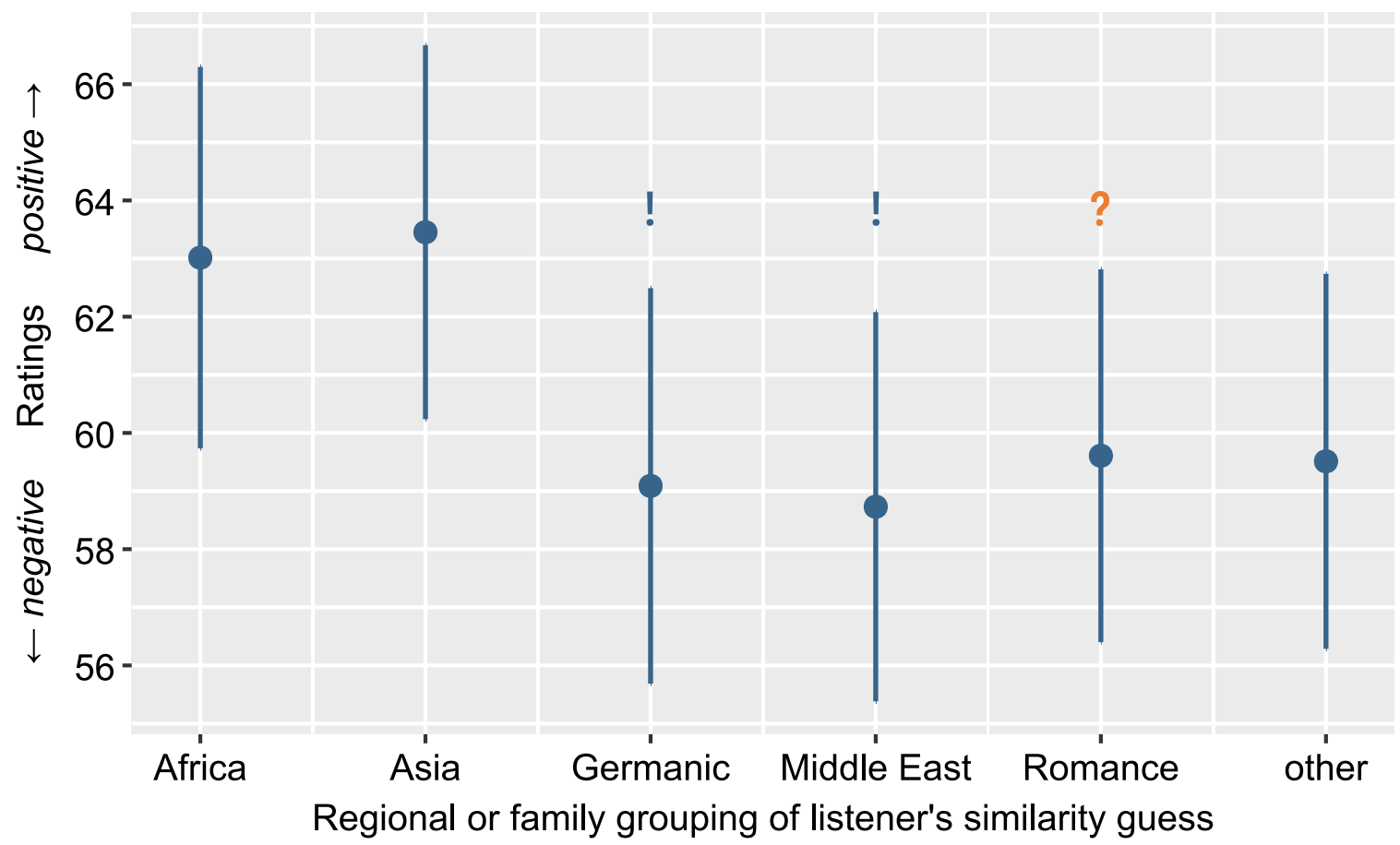
### Effects across all rating scales



/X/

Overview of model with all scales

### All ratings by similarity guess

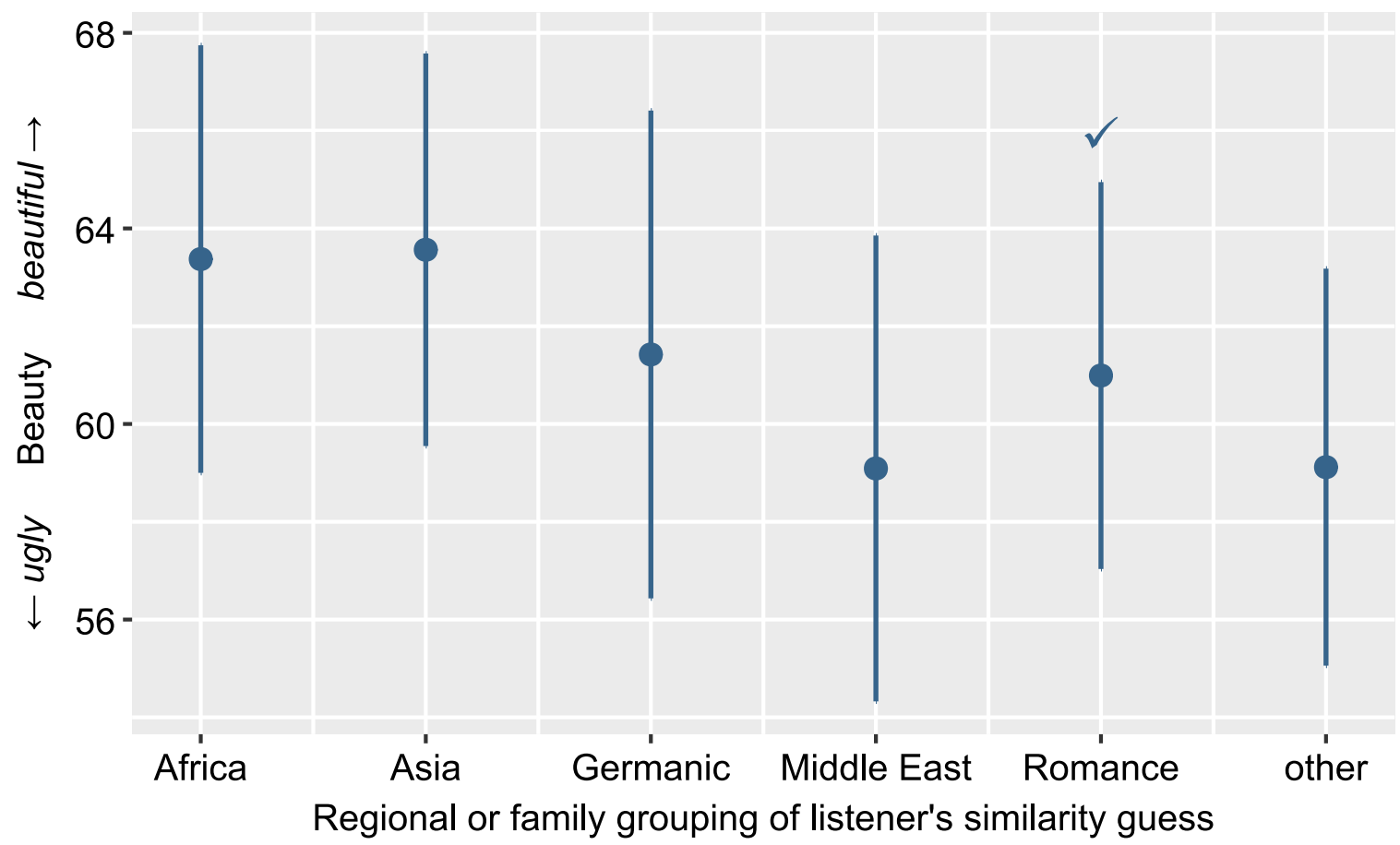


/X/

Recognition for model with all scales



### Beauty by similarity guess

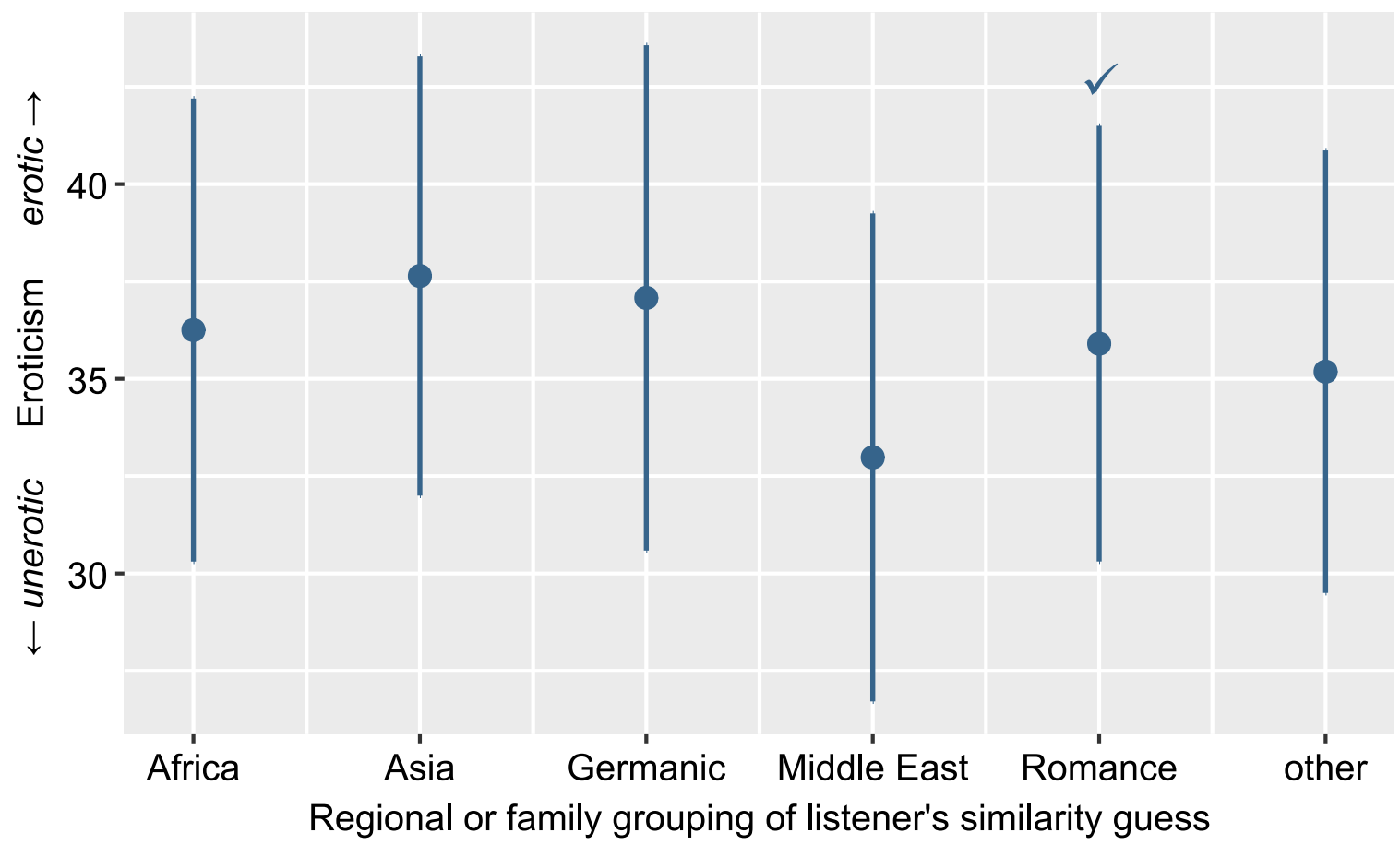


/x/

Recognition for beauty model



### Eroticism by similarity guess

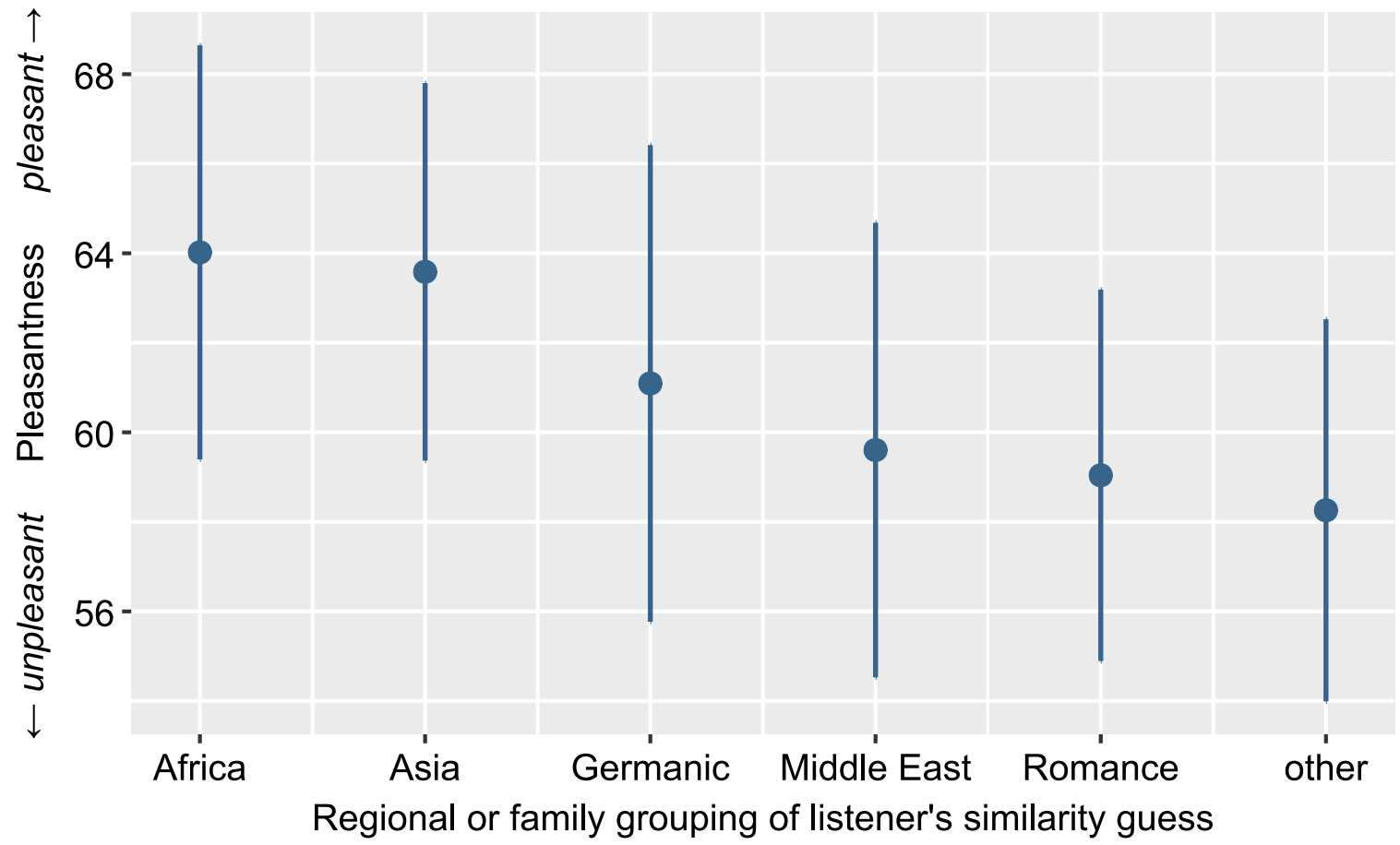


/x/

Recognition for eroticism model



### Pleasantness by similarity guess

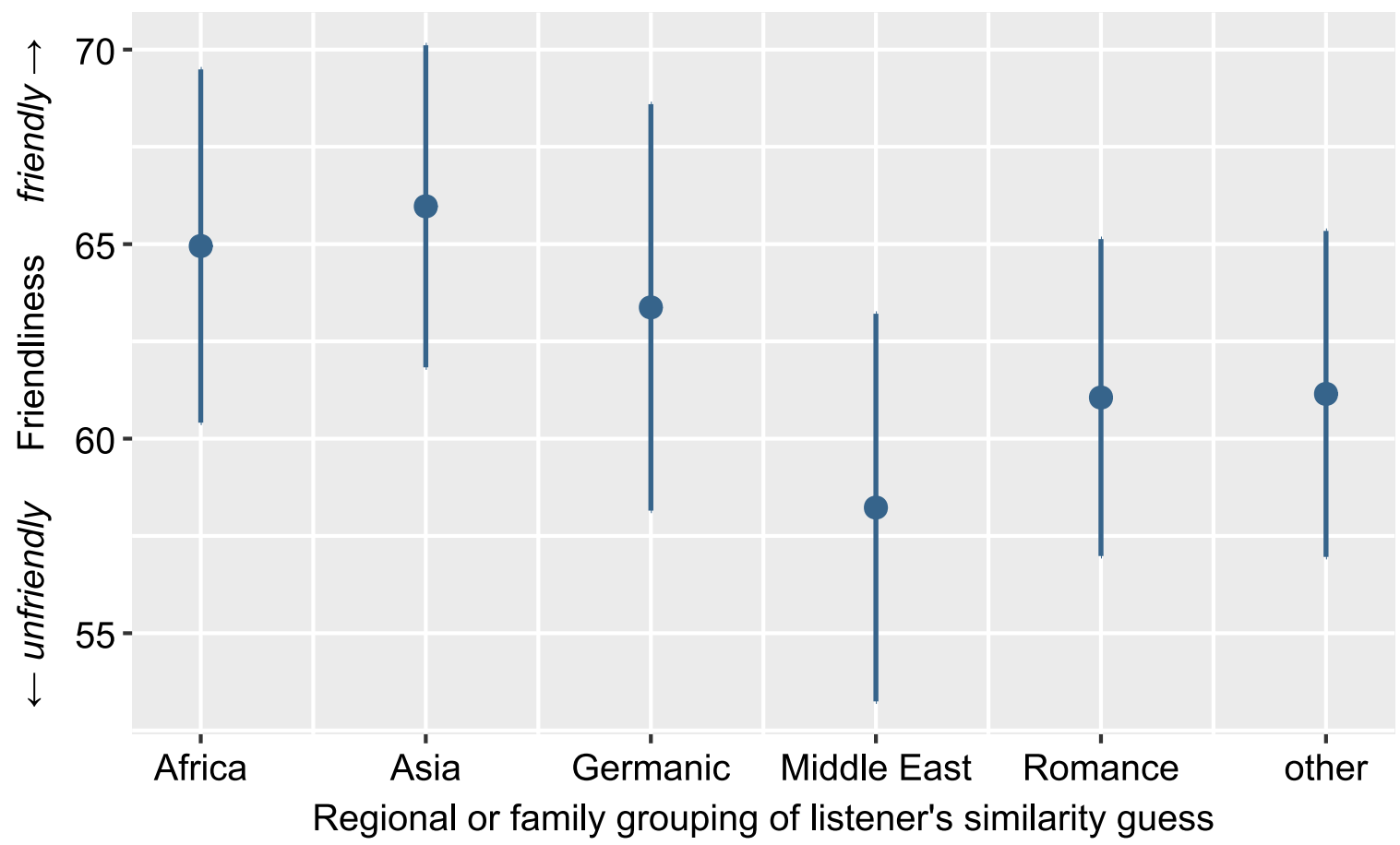


/x/

Recognition for pleasantness model



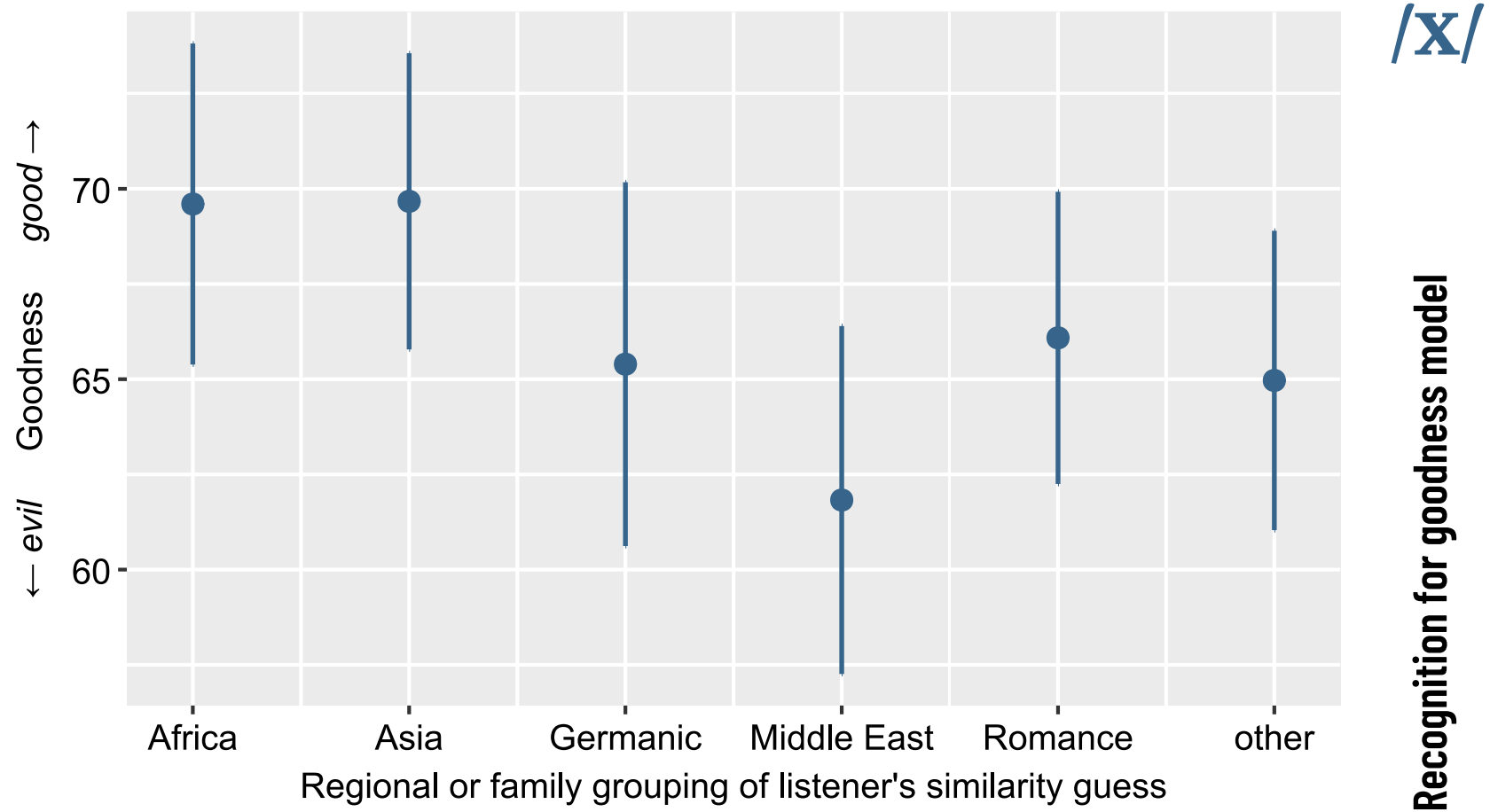
### Friendliness by similarity guess

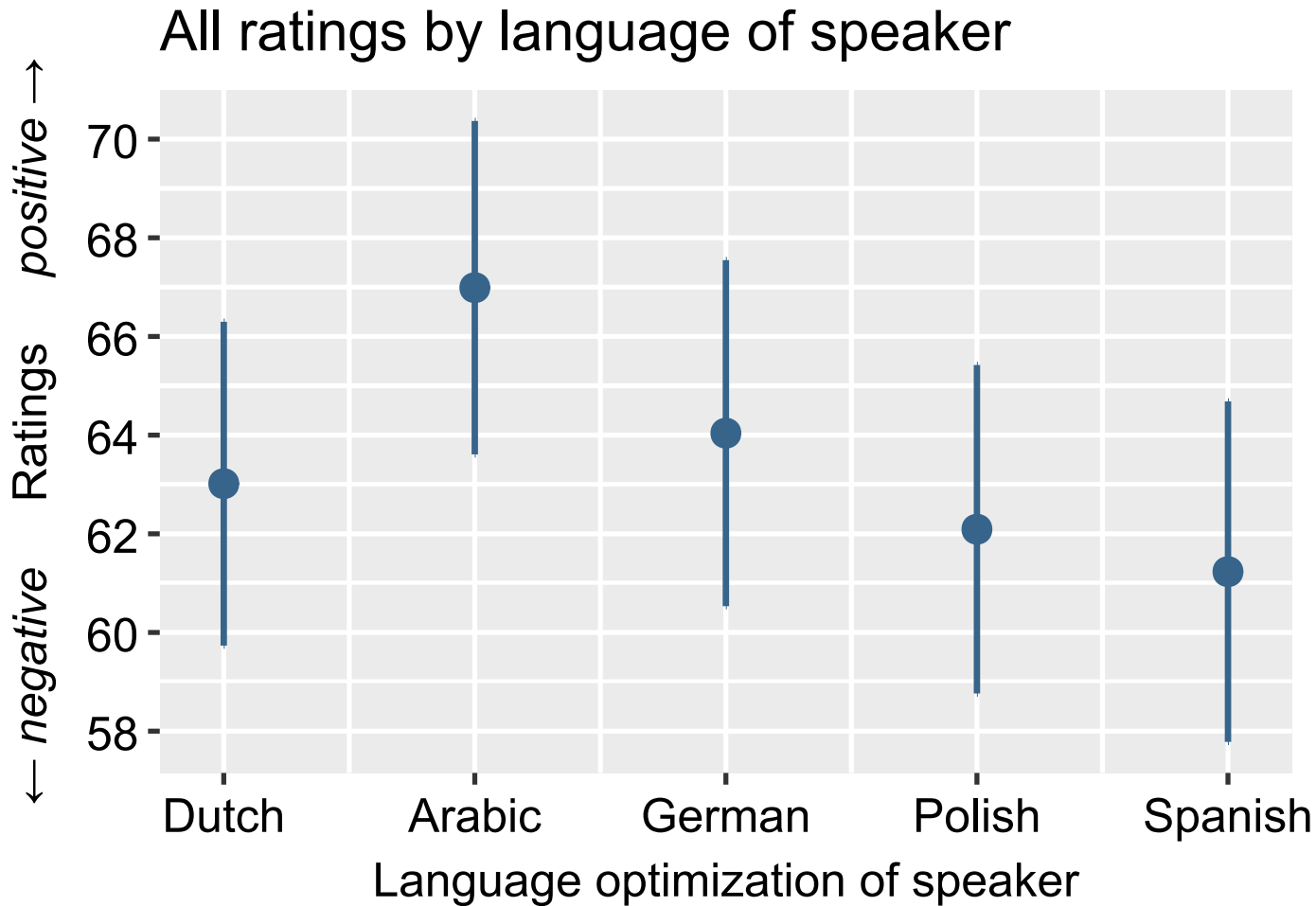


/X/

Recognition for friendliness model

### Goodness by similarity guess

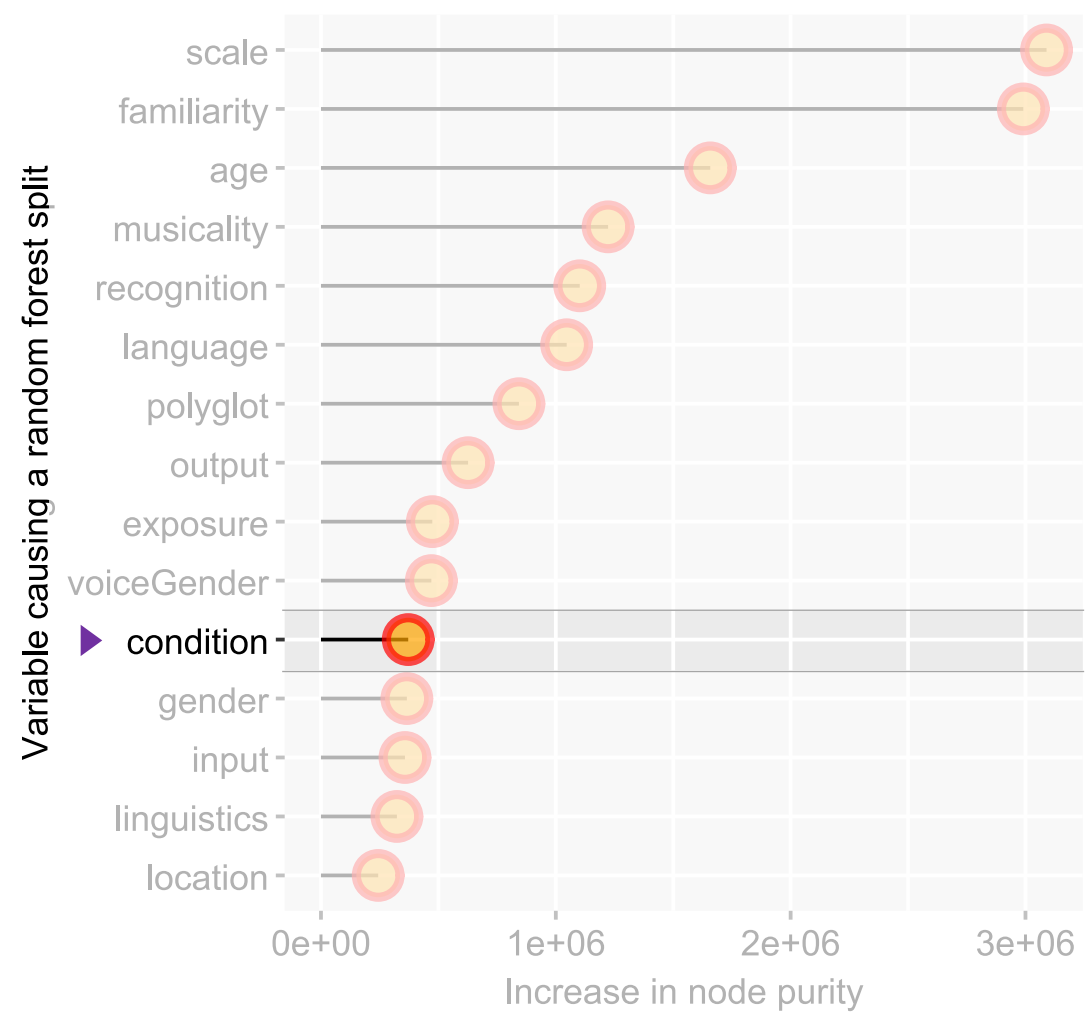




<b>/x/</b>	All scales	Pleasantness	Beauty	Softness	Shape	Education	Intelligence	Friendliness	Ordinariness	Goodness	Eroticism
condition <sup>int</sup>	.	.			*						
condition <sup>ST[EX]</sup>	**	*		.	*						
condition <sup>ST[LE]</sup>										.	
exposed <sup>EX[ST]</sup>	***	.	***	.		**	**	.	**	**	**
exposed <sup>EX[CT]</sup>	*		**			**	**		.		**
recognition <sup>AS</sup>						*					
recognition <sup>GE</sup>	***			*	**					*	
recognition <sup>ME</sup>	***	*	*	*	**			***		***	.
recognition <sup>RO</sup>	***	***	.		,		.	**		**	
recognition <sup>0</sup>	***	***	***		**			**	*	***	
familiarity	***	***	***	***	***	***	***	***	***	***	***
vGender <sup>M[GM]</sup>	***	**	***	***	**	*		***		***	***
vGender <sup>M[GF]</sup>	***	*	***	***				***		***	***
gender <sup>M[VM]</sup>	***	***	***	*	**	**	***	.	***	**	
gender <sup>M[VF]</sup>	***	***	***	*	*	***	***	**	***	*	.
polyglot	.			.		.	.			.	.
musicality		*									*

terms not included in this table: condition<sup>x</sup>exposed exposed<sup>UN</sup> language<sup>NL, AR, DE, PL, ES</sup> linguistics age input... output... location...

### Importance of variables across scales



/X/

Random forest for model with all scales



## **/x/** Indexicality seems to be stronger than iconicity

- ▶ Ratings are **not**, or only **weakly**, affected by whether /x/ is present.
- ▶ /x/ is sometimes rated worse if the listener had been more **exposed** to it.
  - ▶ Exposed listeners may be more aware of respective **stereotypes**.
  - ▶ Thus, they rate /x/ **worse** despite being more used to it.
- ▶ The strongest predictors are **sociocultural** in nature.
- ▶ Listeners rate languages **worse** on almost all scales if:
  - ▶ they are **male**.
  - ▶ they perceive the language as being **less familiar**.
  - ▶ they *felt* it resembled a language from a specific **region** or **family**.



## **/x/** The takeaway

**/x/ is not as bad as people think it is!**  
**... unless social meaning makes it sound bad.**