SOUNDS, ATTITUDES, AND MEANING

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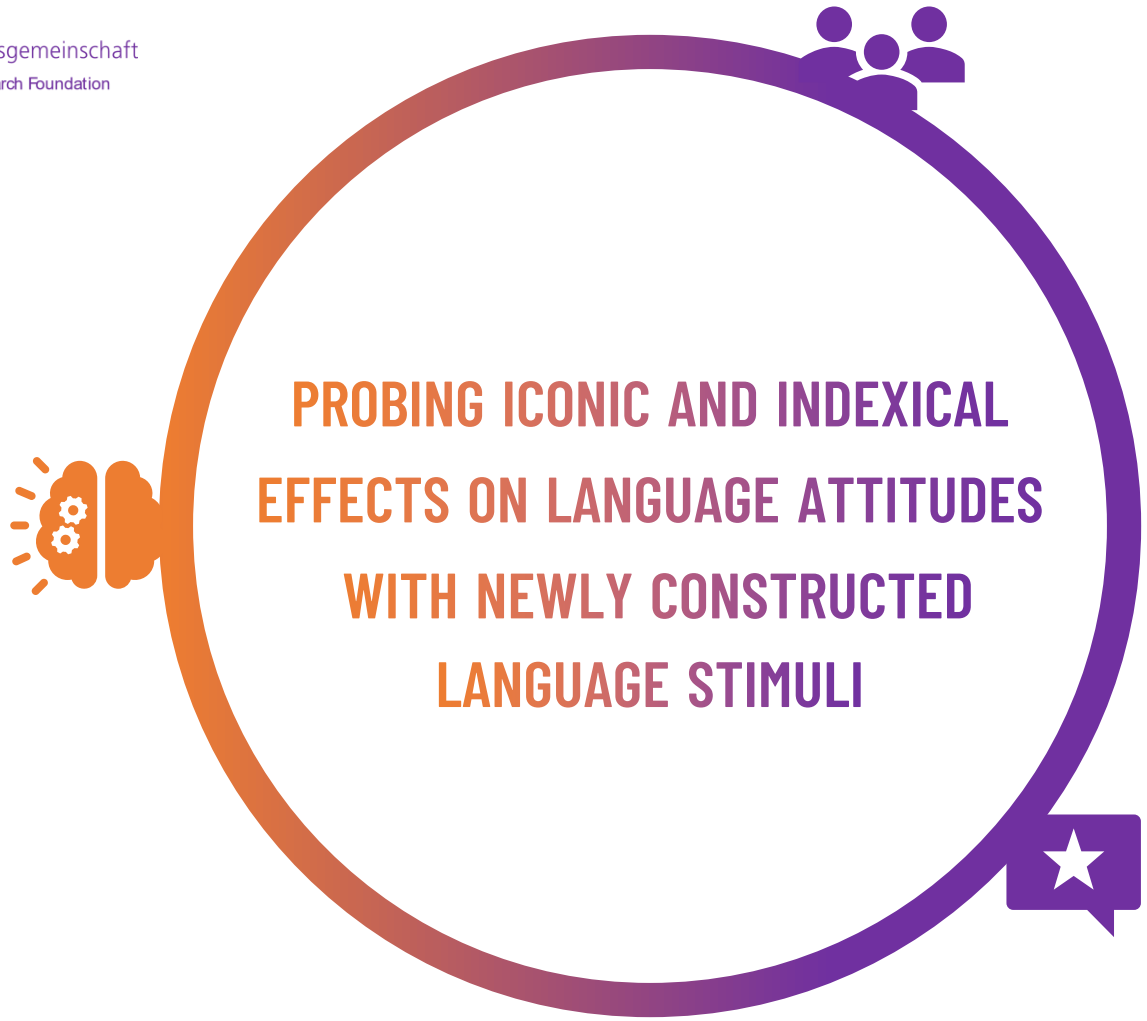

PROBING ICONIC AND INDEXICAL EFFECTS ON LANGUAGE ATTITUDES WITH NEWLY CONSTRUCTED LANGUAGE STIMULI

Berlin Workshop on Phonaesthetics

2026-08-19

Background

Language attitudes

German is ugly and harsh.

French sounds romantic.

Southern speech sounds uneducated.

If it's weird, it's Welsh.

You can almost hear Scottish people mining in a shaft when they talk.

New York English sounds rude.

examples adapted from Stein 2023, Tamasi & Antieau 2015: 2–254, and Reiterer et al. 2020; also see Silverstein 2003; Irvine & Gal 2000

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

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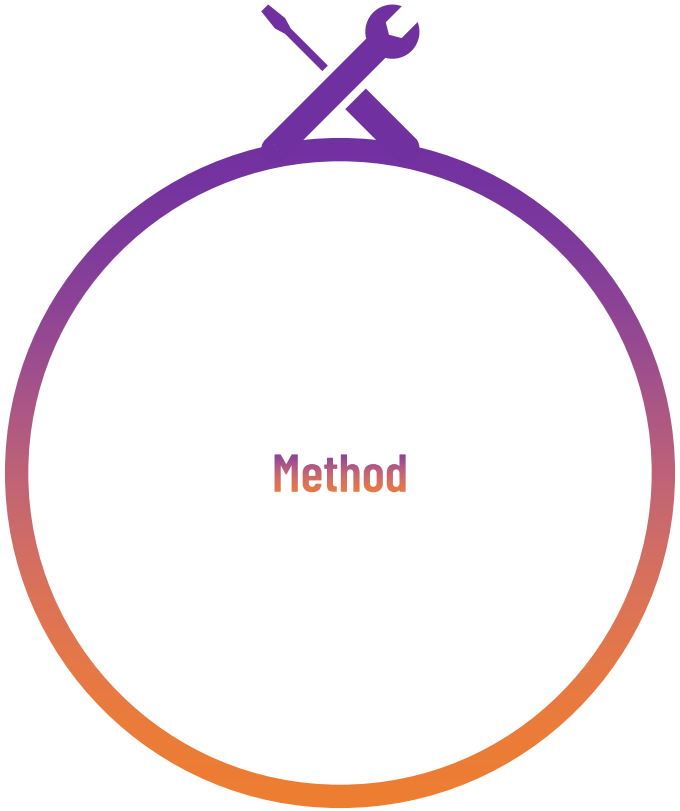
This series of studies:

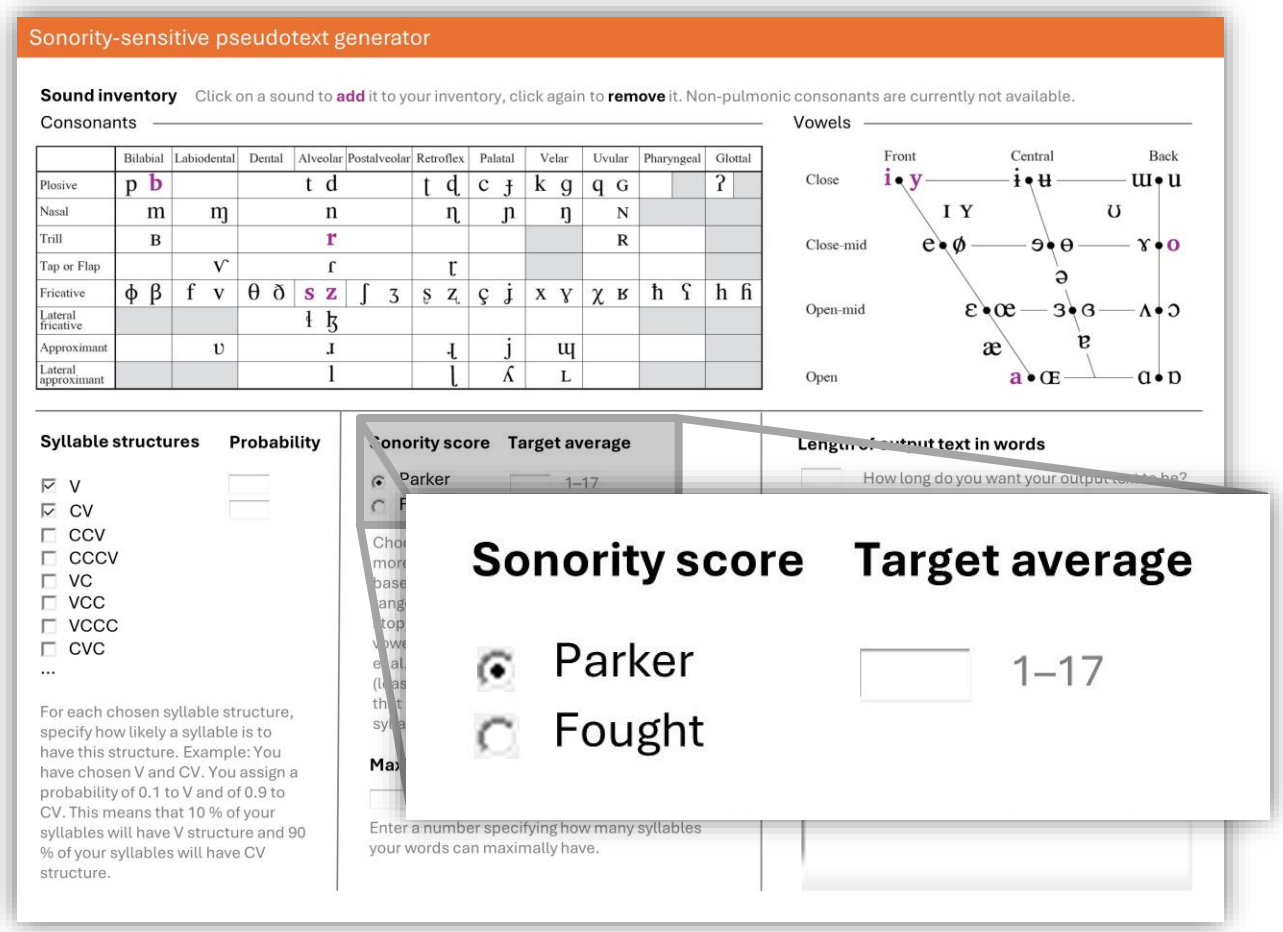
- uses languages never heard before, created from scratch.
- can play with sounds and social attributes in a targeted way.
- isolates specific, potentially iconic phonetic-phonological properties.

SONORITY	SPECIFIC PHONEMES	SYLLABLE STRUCTURE	...

e.g., Jacobs 2017


Method

SSPG Sonority-sensitive pseudotext generator



In development.
GUI is a draft concept.

SSPG Sonority-sensitive pseudotext generator

Low vowels	17
Mid peripheral vowels (not ə)	16
High peripheral vowels (not ɨ)	15
Mid interior vowels (ə)	14
High interior vowels (ɨ)	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

Control stimuli

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

	Control stimuli			Target stimuli		
Speaker	1	2	3	1	2	3
Mean sonority 1–17	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 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	same	same	same	same	same	same

SSPG Sonority-sensitive pseudotext generator

Example for control condition

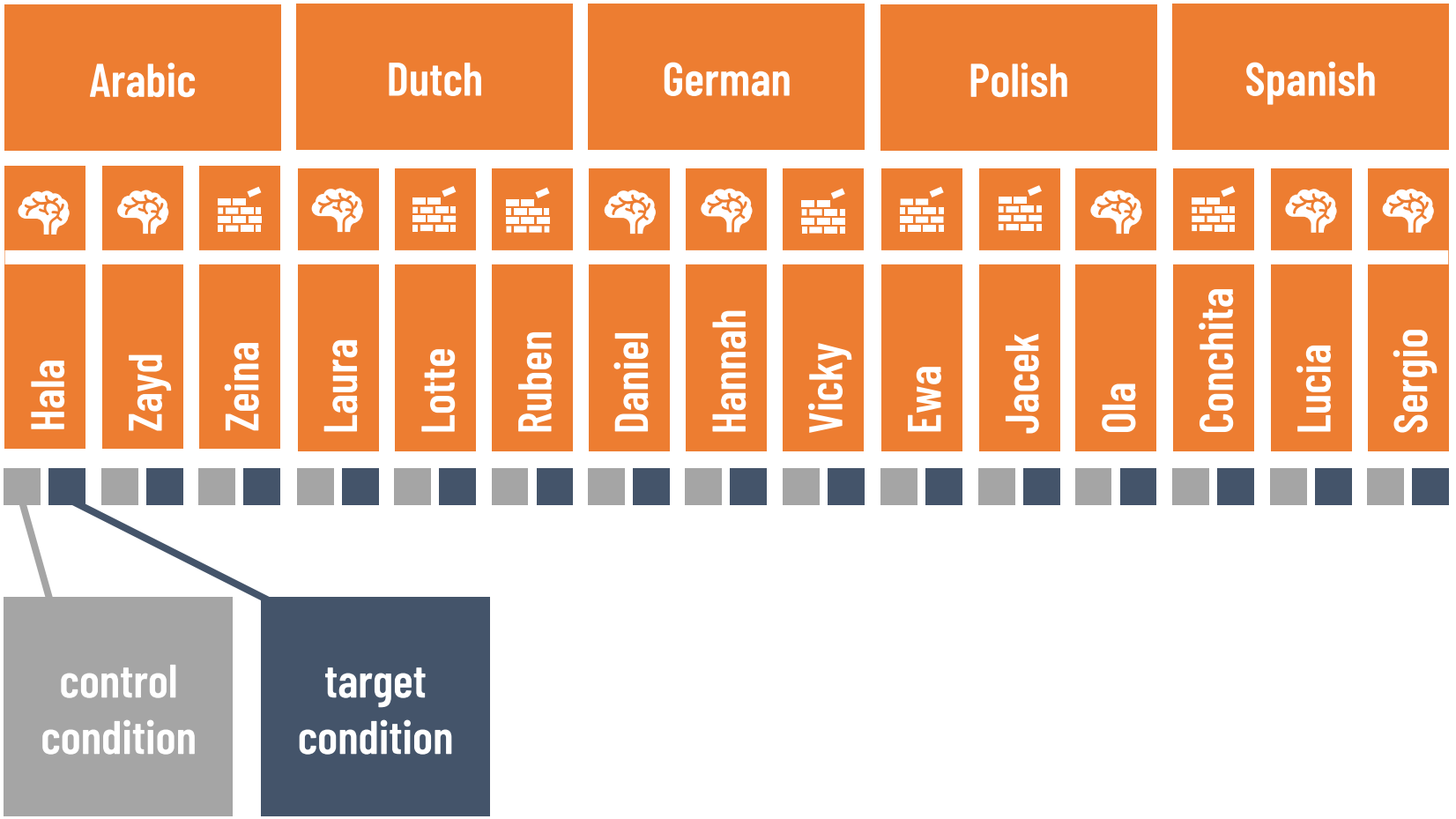
Kemeti sou ko pipomisi no epi enekomi. Te kepikiki esobe i sa kabu pusa kio si pousu libooo sepaputa pilo. Topeke nimeki kupuuki weo kopekupe tukitu ka tutemu ne paku mi tetu. Pu komutuso pipuji te tue kiki kuwupiba tuto kunate sota tokokui tukotuti pupikaa kopake kepobeo ti tapa tako pipotite kusi. Pu woe ketu sipekoo pe isetu okibase take pekotobu pe popibami putoi ute ba peteti. Posa pike pewoki tiki kekikeko tetu. Topo jaketi poke. 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	

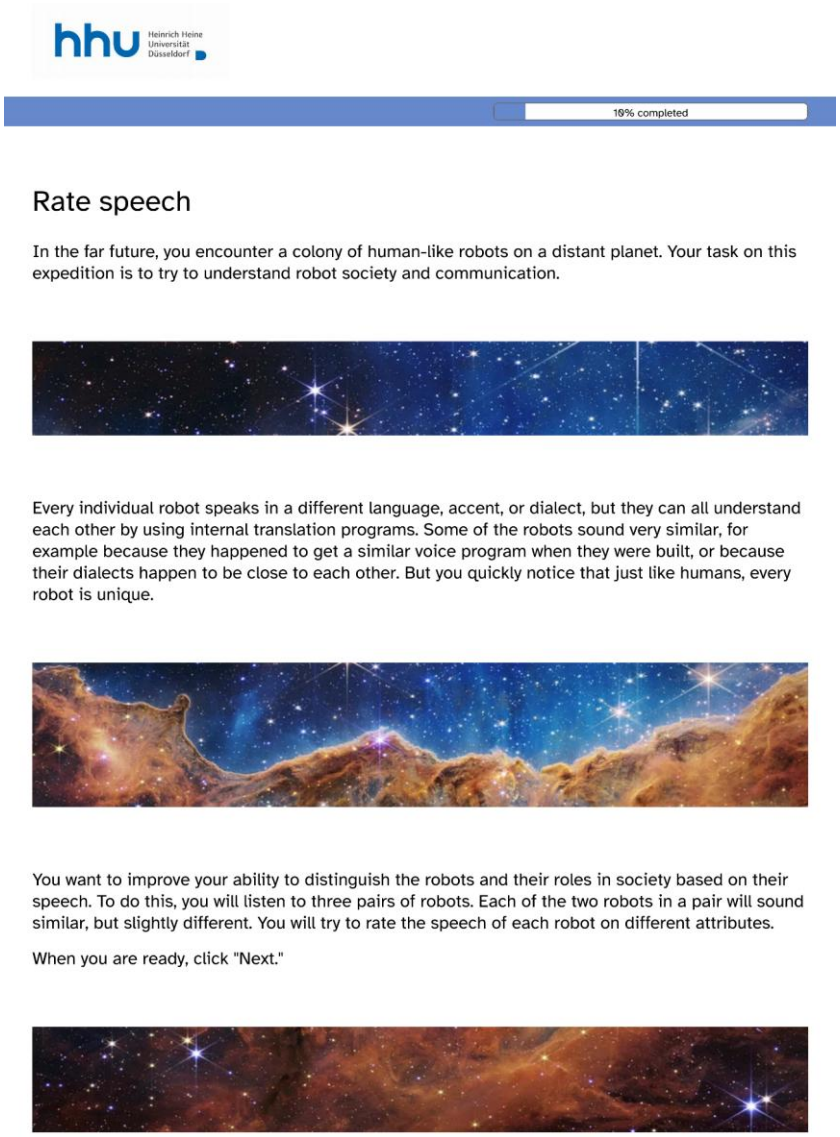
high sonority

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



Questionnaire

Rate speech

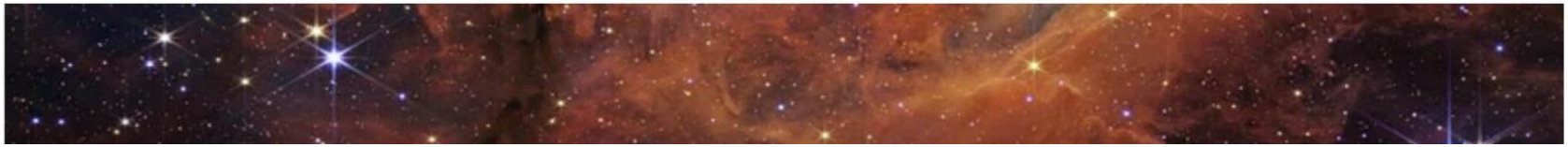
In the far future, you encounter a colony of human-like robots on a distant planet. Your task on this expedition is to try to understand robot society and communication.

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.

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".

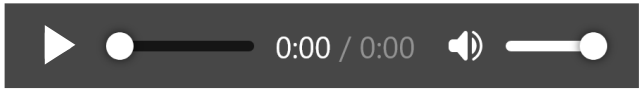
Next

Questionnaire

30% completed

Please listen to the recording of the first robot:

To listen, click the play button.



Questionnaire

How does the robot sound?

unpleasant	———	pleasant
ugly	———	beautiful
hard	———	soft
spiky	———	round
uneducated	———	educated
stupid	———	intelligent
unfriendly	———	friendly
strange	———	normal
evil	———	good
unerotic	———	erotic

Questionnaire

How familiar does this language sound to you?

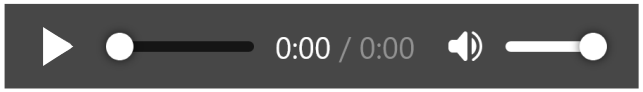
not at all familiar — very familiar

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.



Questionnaire

How does the robot sound?

unpleasant	———	pleasant
ugly	———	beautiful
hard	———	soft
spiky	———	round
uneducated	———	educated
stupid	———	intelligent
unfriendly	———	friendly
strange	———	normal
evil	———	good
unerotic	———	erotic

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

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

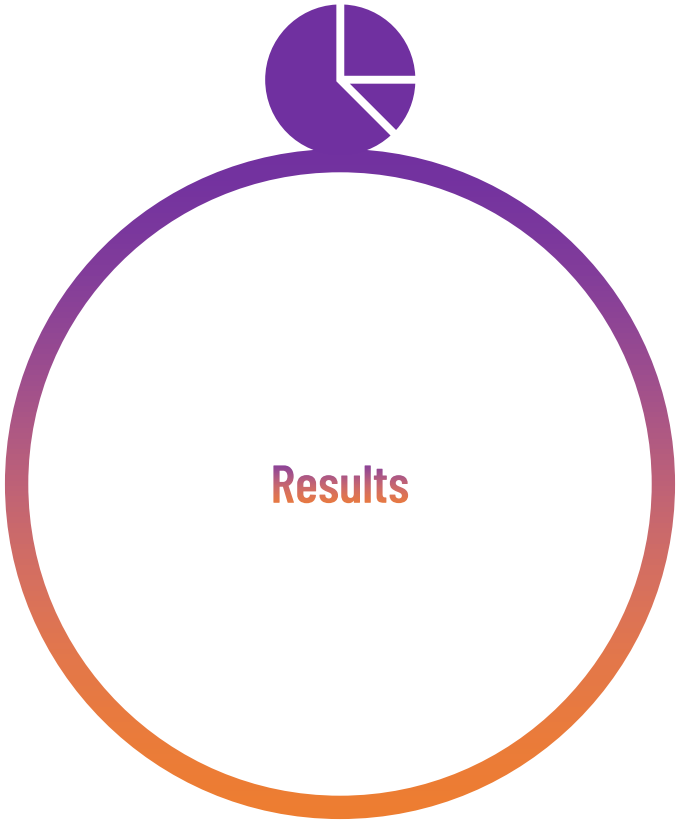
RATING ~ SONORITY * LISTENER SONORITY +
RECOGNITION +
FAMILIARITY +
LANGUAGE +
LISTENER GENDER * VOICE GENDER +
POLYGLOT +
AGE + MUSICALITY + LINGUISTICS +
INPUT + OUTPUT + LOCATION +
SCALE +
(1 | PARTICIPANT)

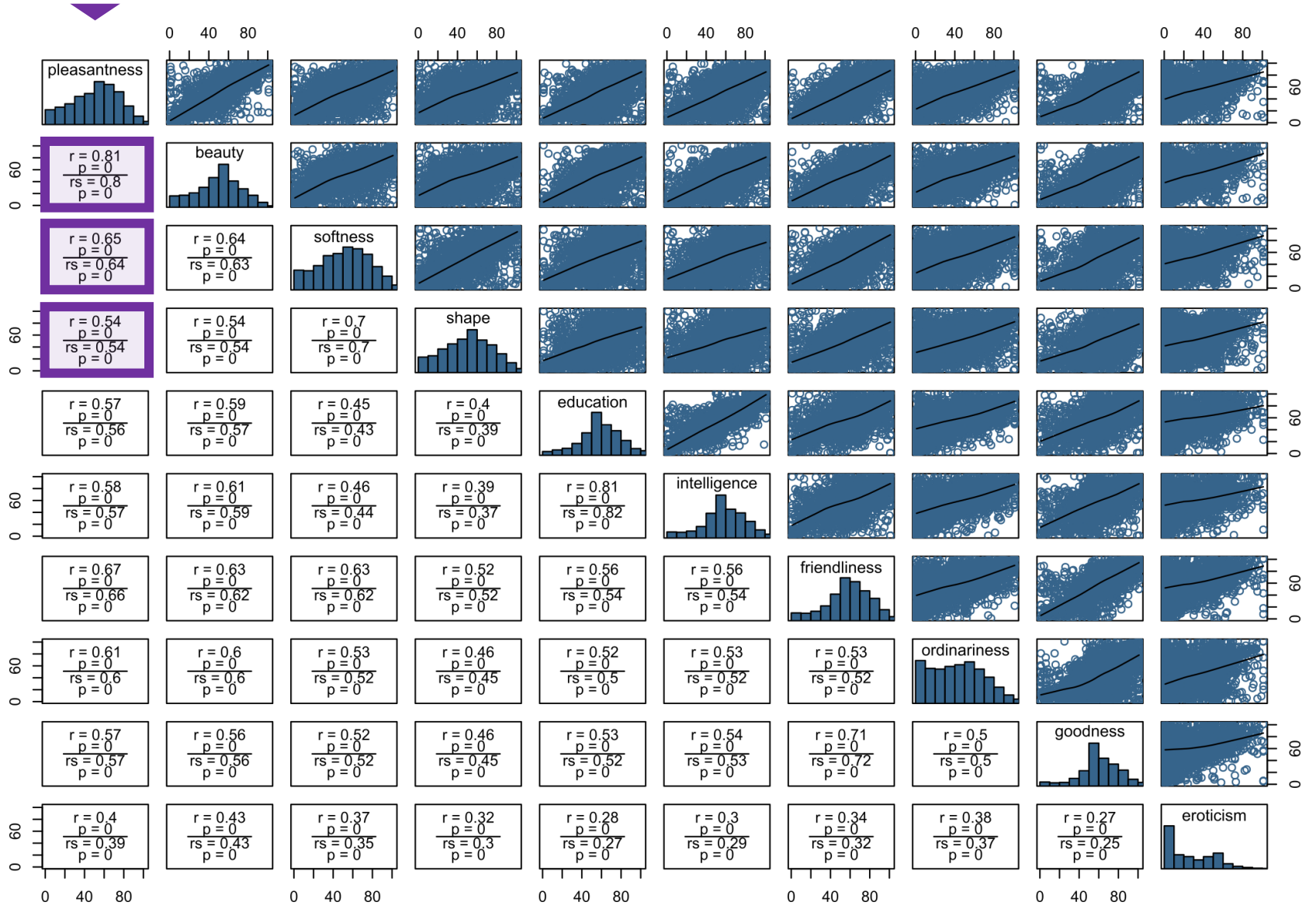
cf., e.g.,
Hilton et al. 2022
Anikin et al. 2023
Reiterer et al. 2020
Mooshammer et al. 2023

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


Results



Correlation matrix of all semantic scales

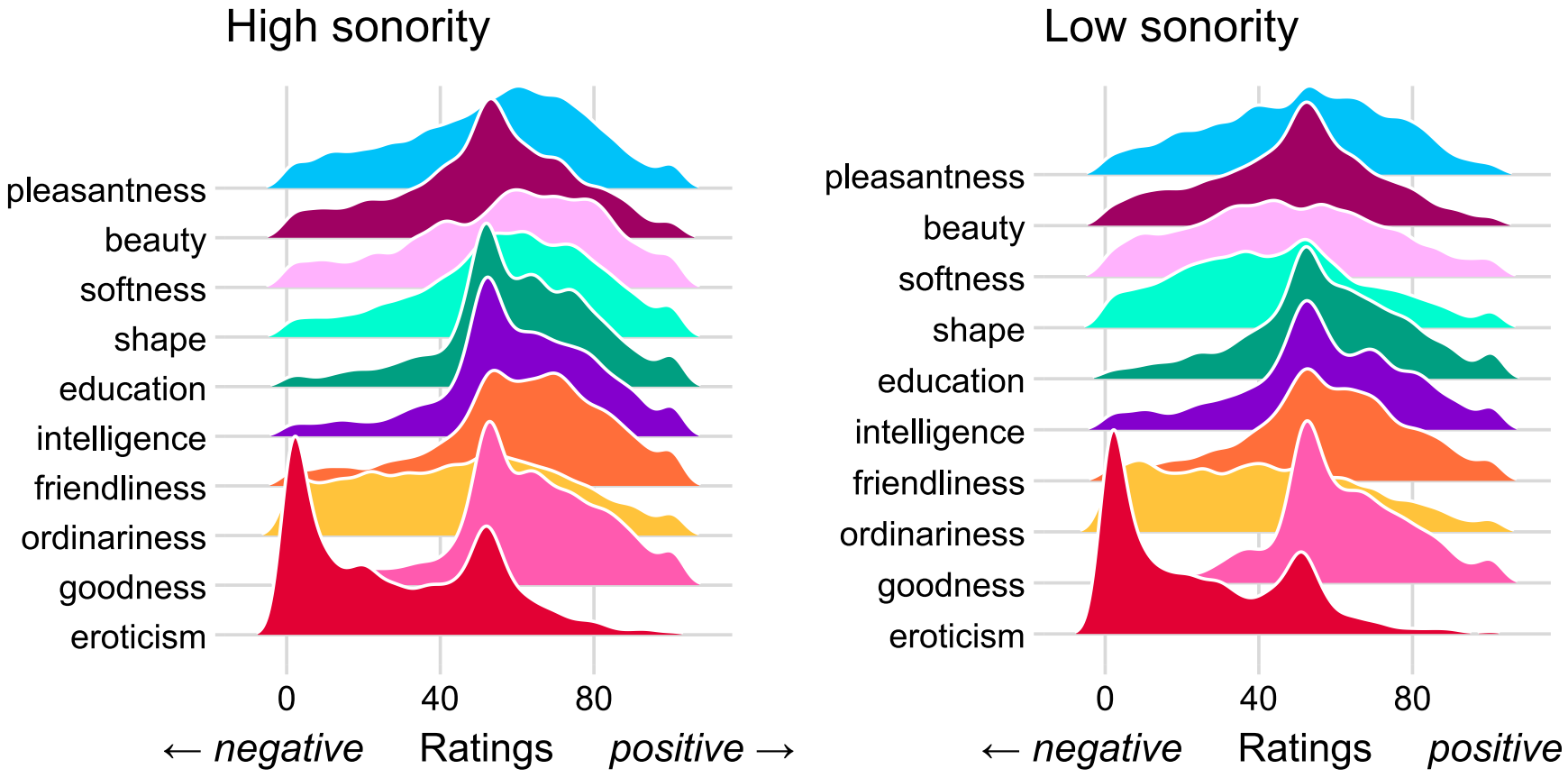
Correlation matrix of all semantic scales

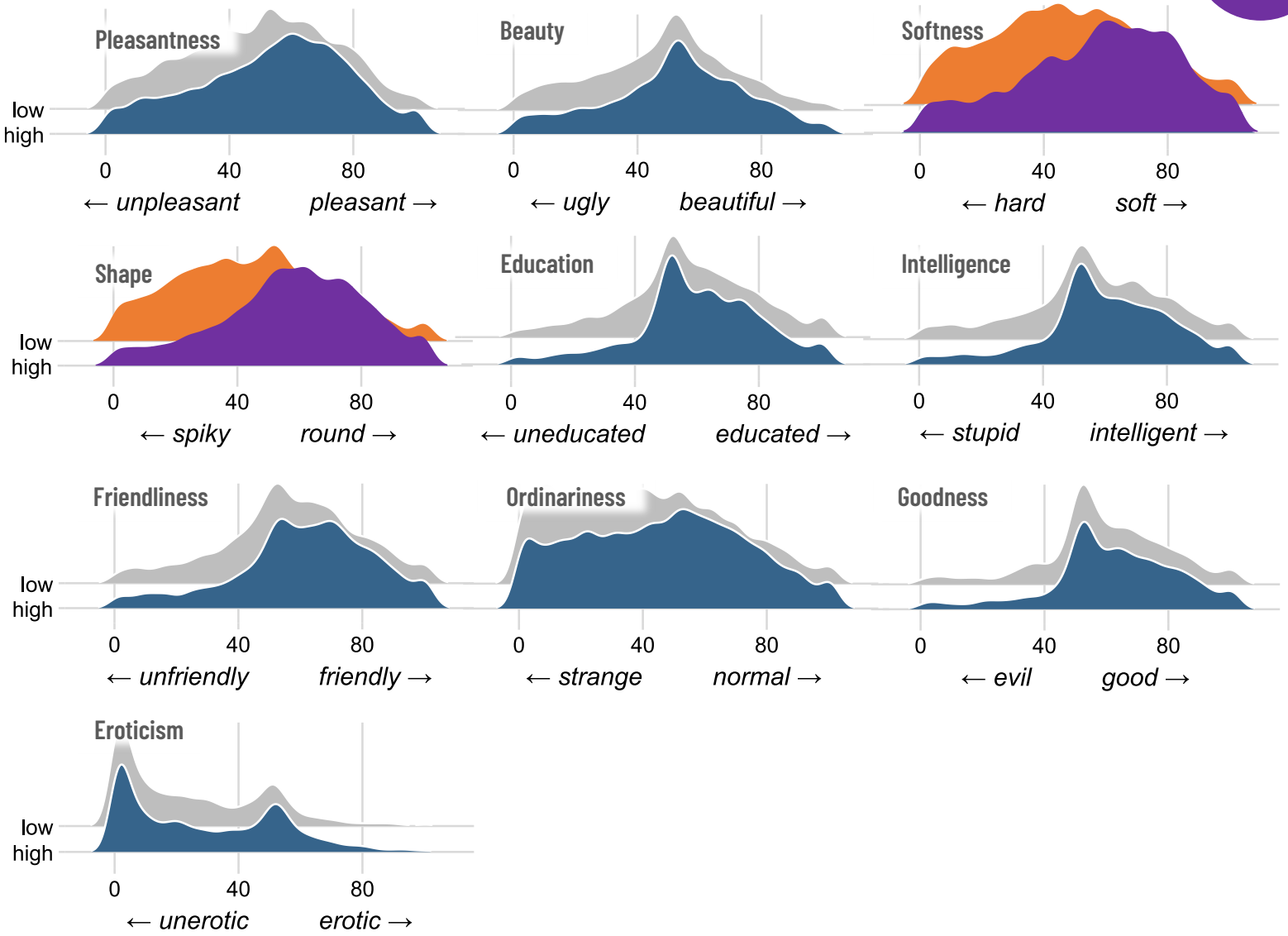
Correlation matrix of all semantic scales

Correlation matrix of all semantic scales

Correlation matrix of all semantic scales

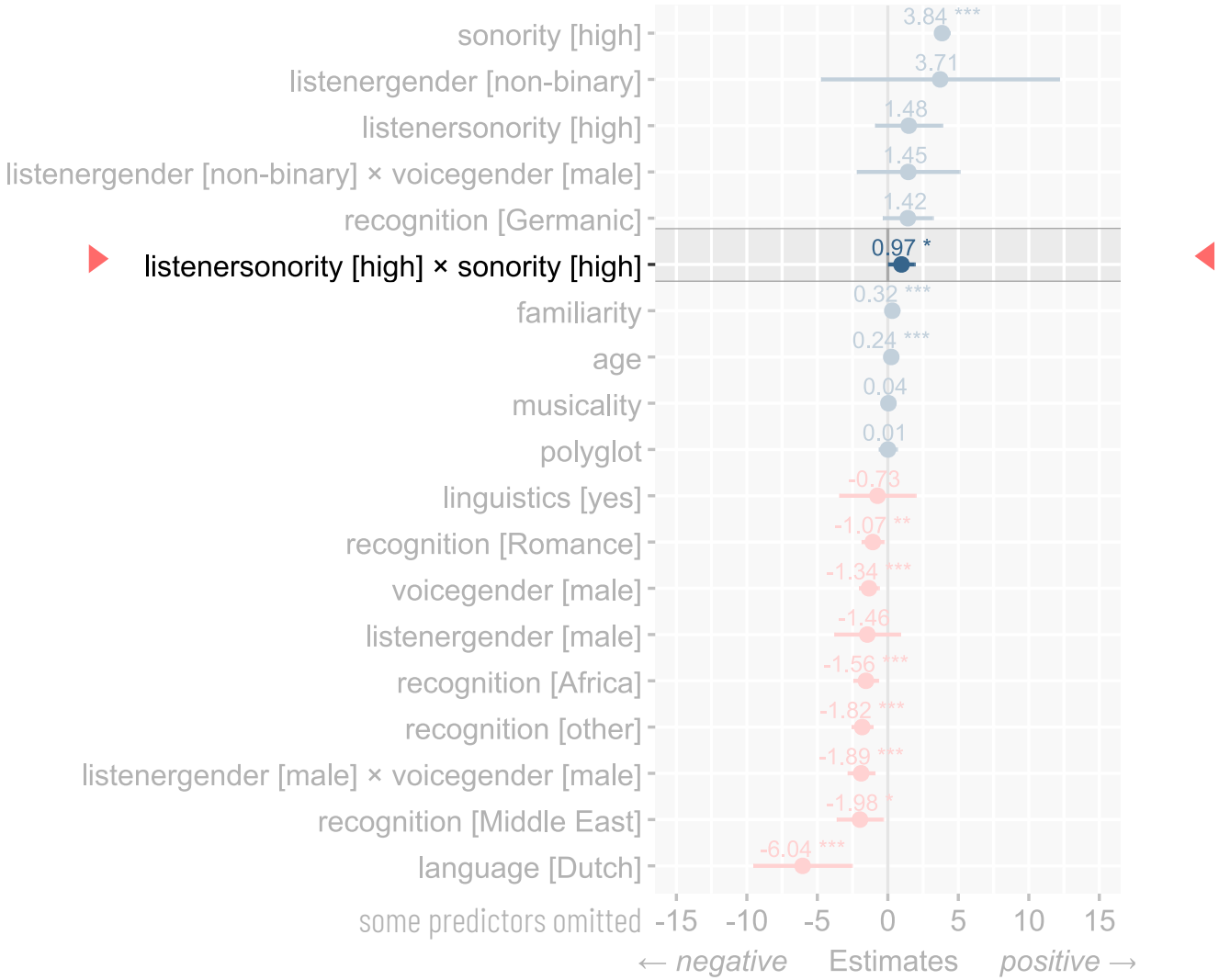
Distribution of ratings by scale for each condition



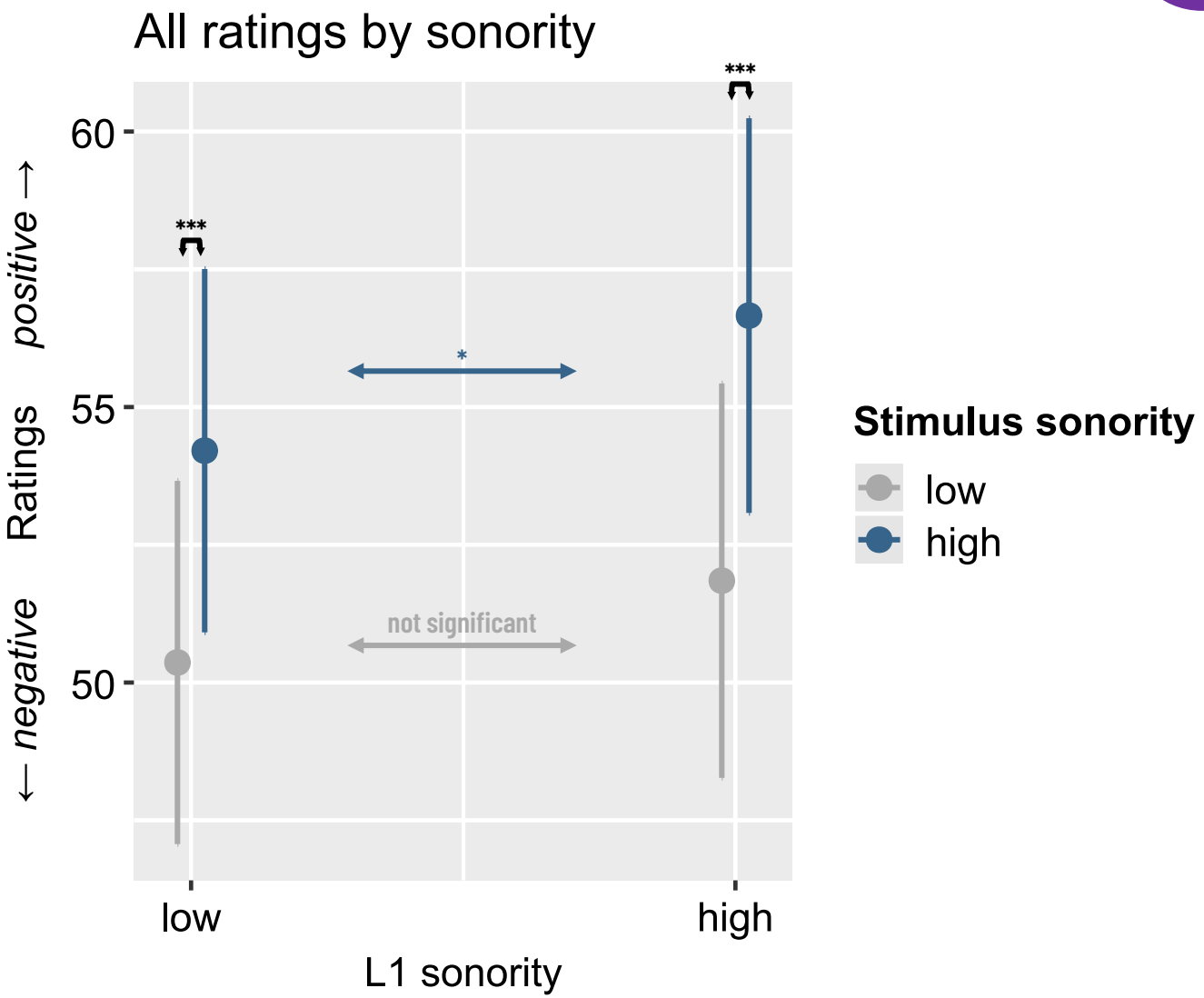


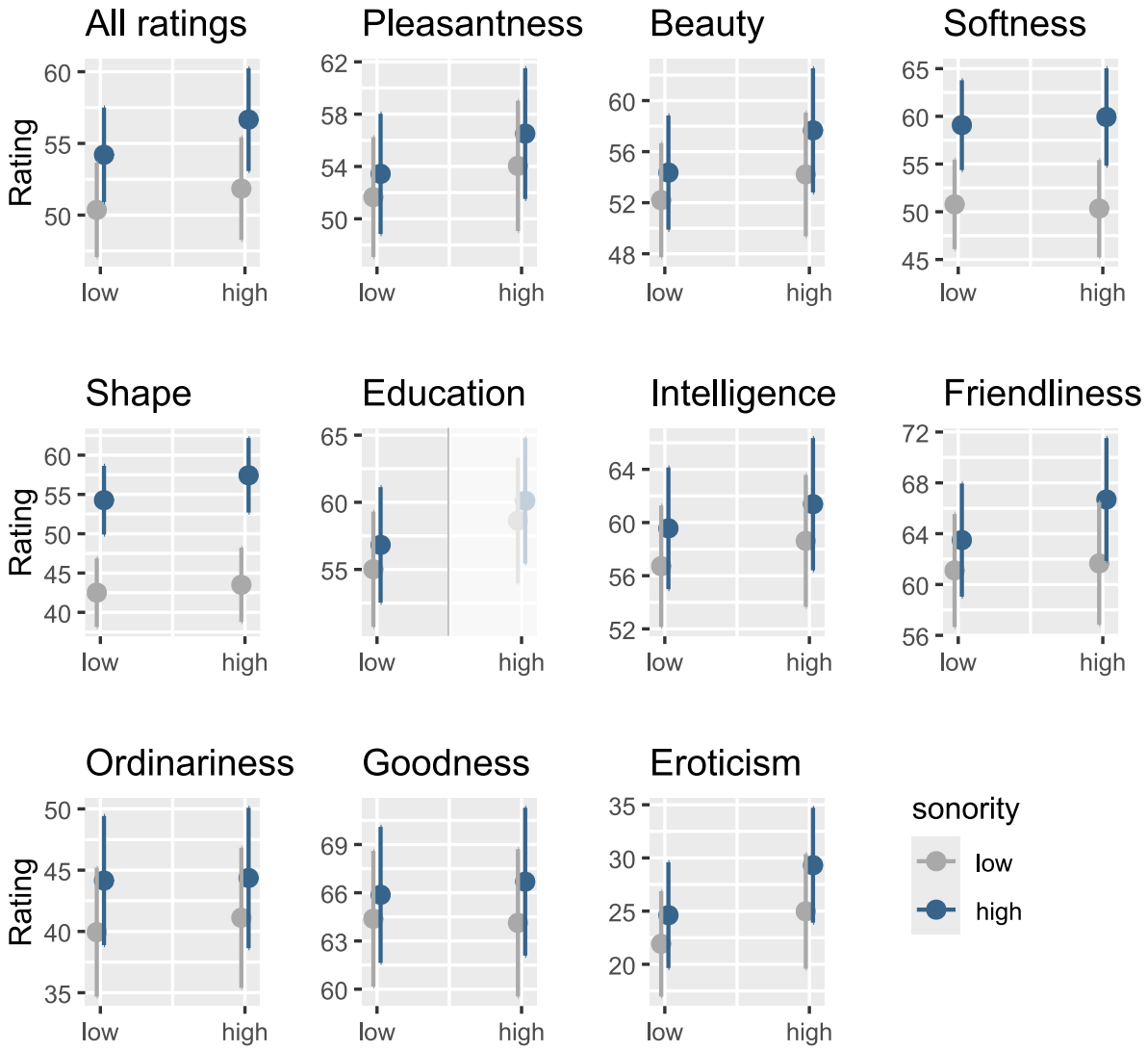
Distribution of ratings by sonority for each scale

Effects across all rating scales

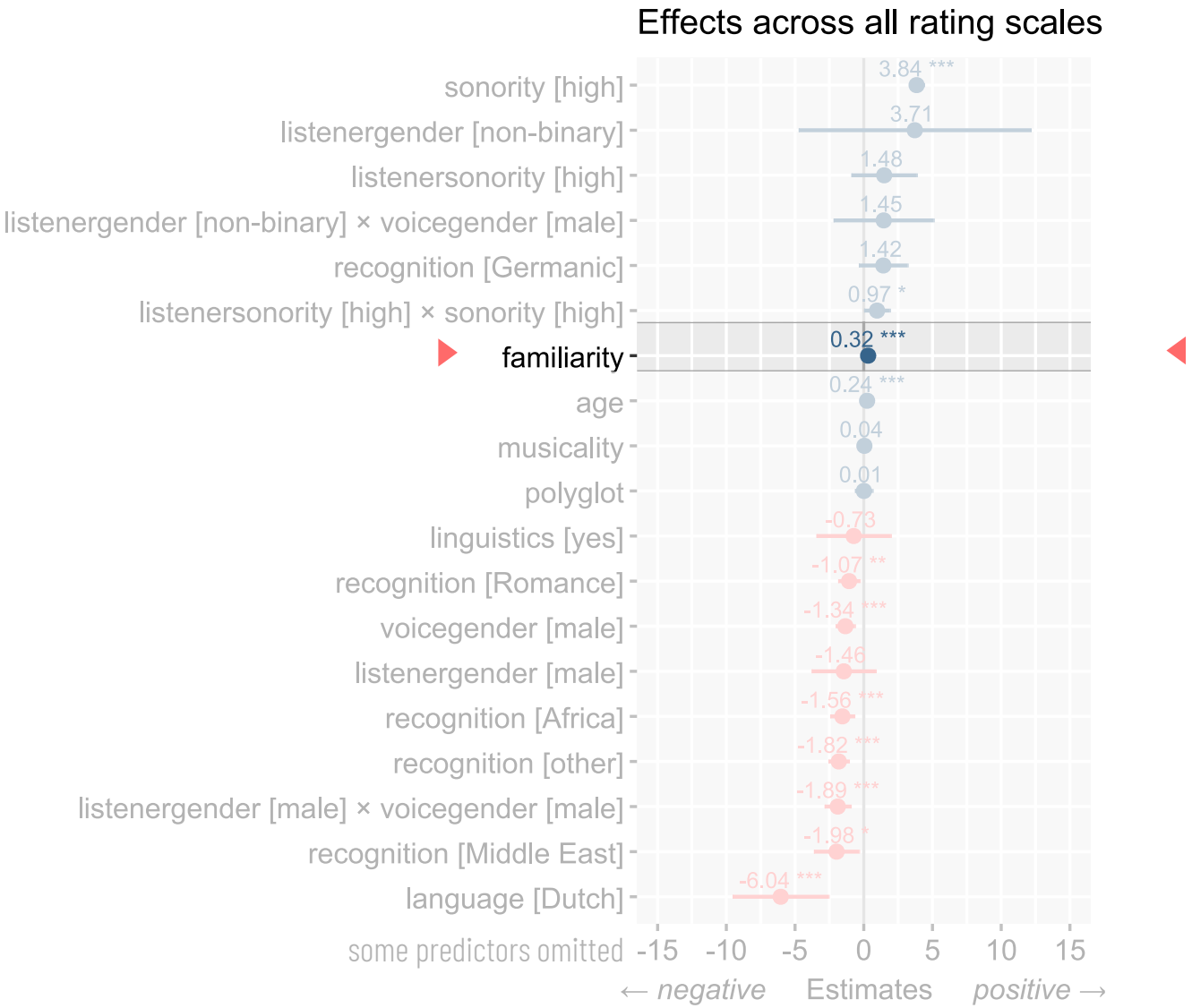


Overview of model with all scales

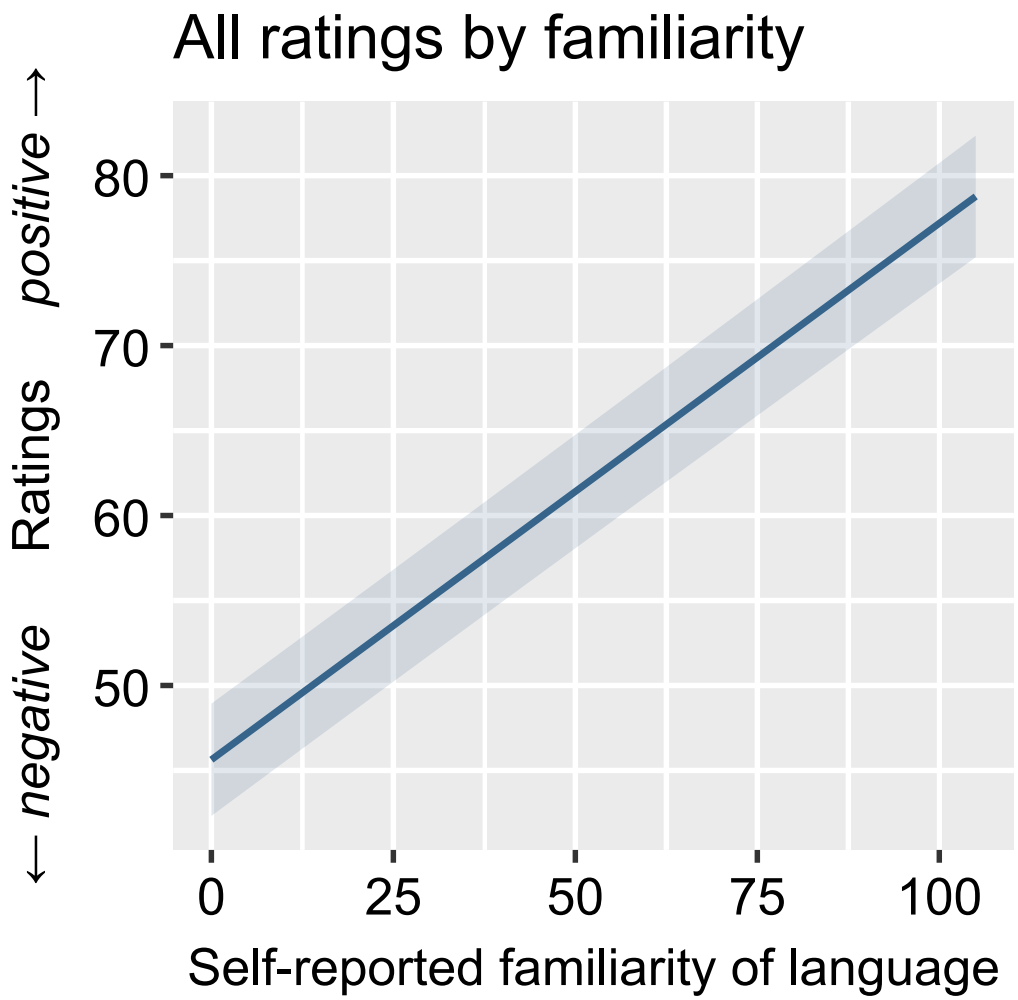

All ratings by sonority
***
***
*
not significant
60
55
50
← negative Ratings positive →
low
high
L1 sonority
Stimulus sonority
low
high
Condition by exposure for model with all scales



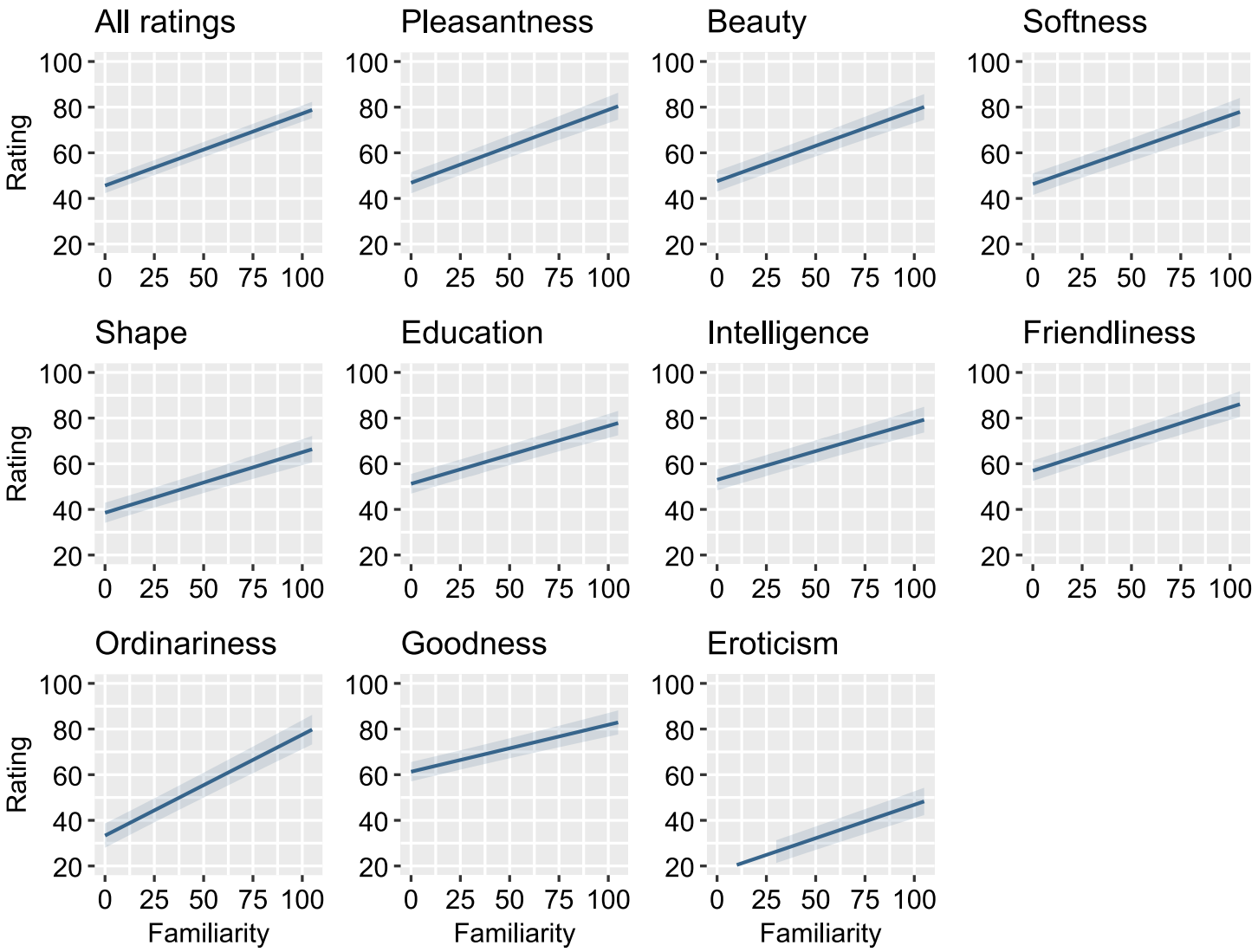
Overview of condition by exposure



Overview of model with all scales



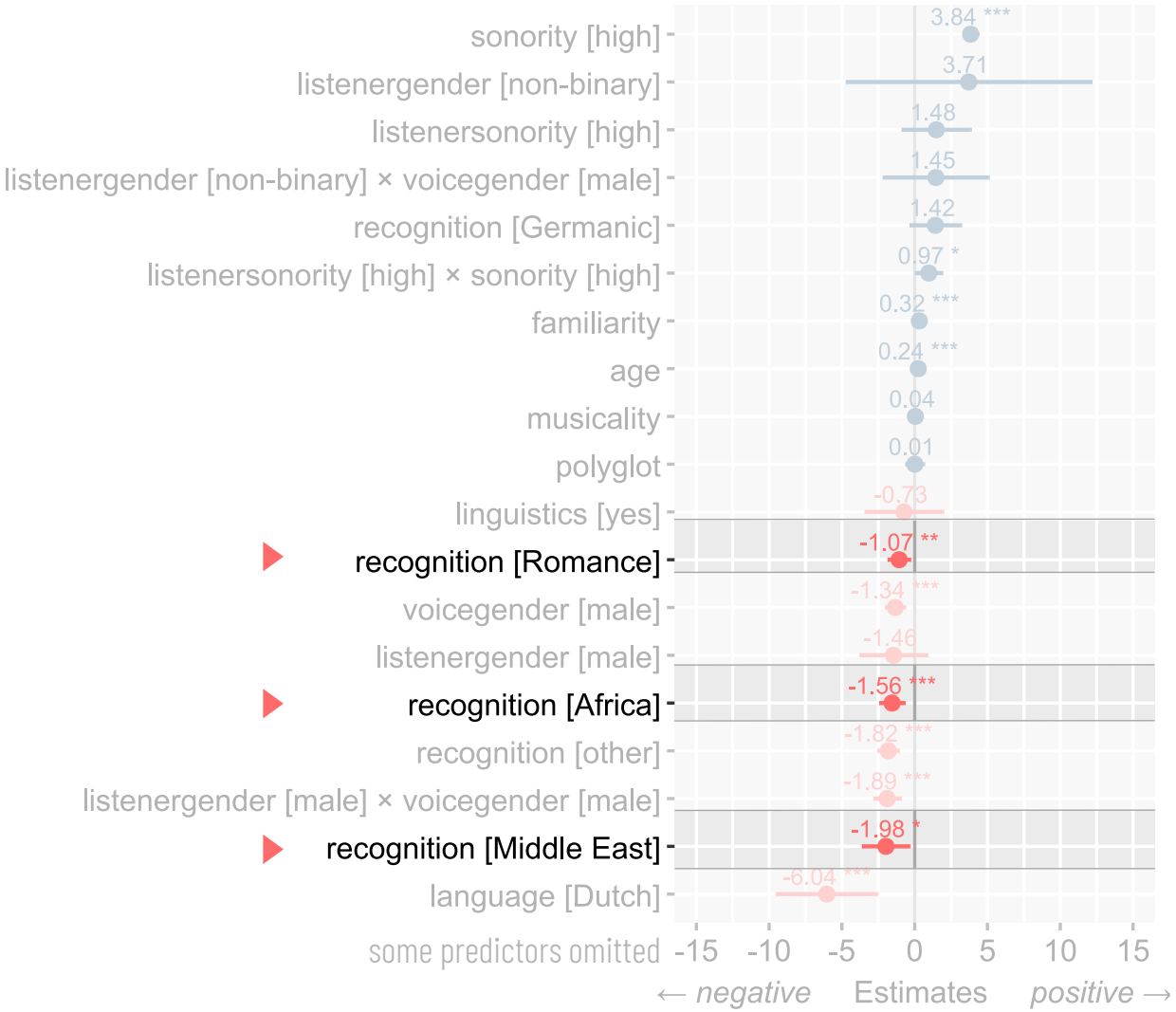
Familiarity for model with all scales



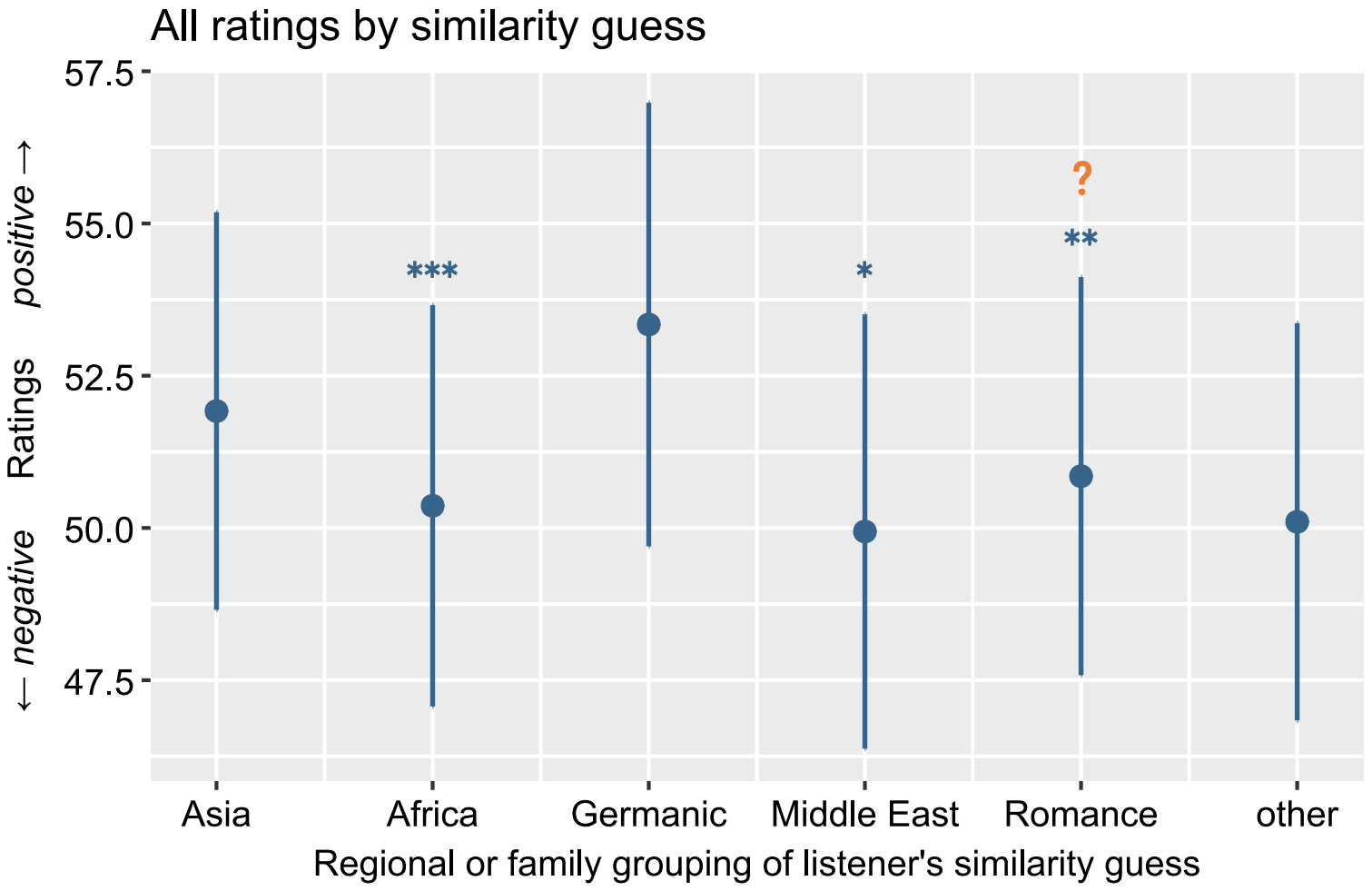
Overview of familiarity

Overview of model with all scales

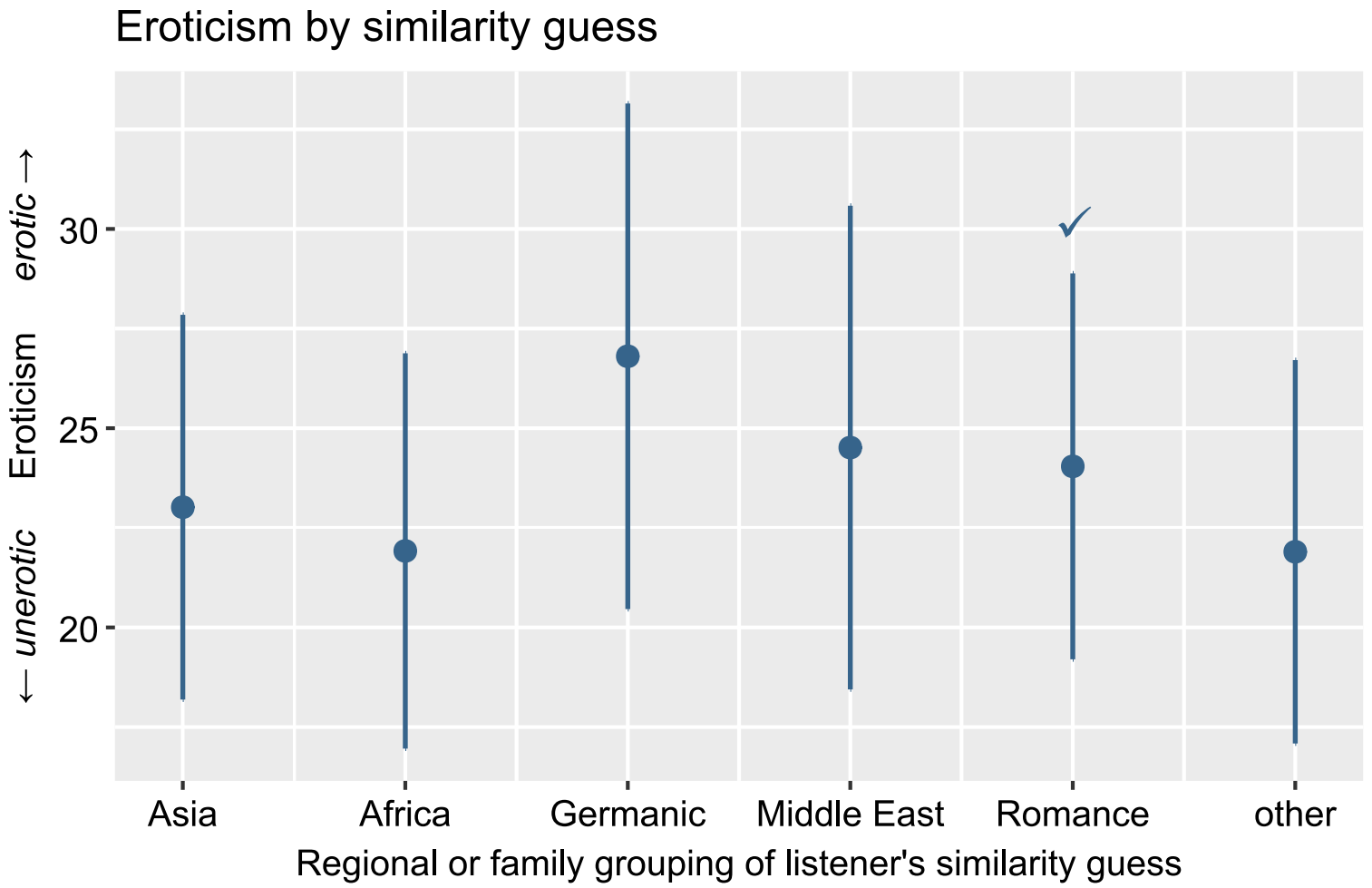
Effects across all rating scales

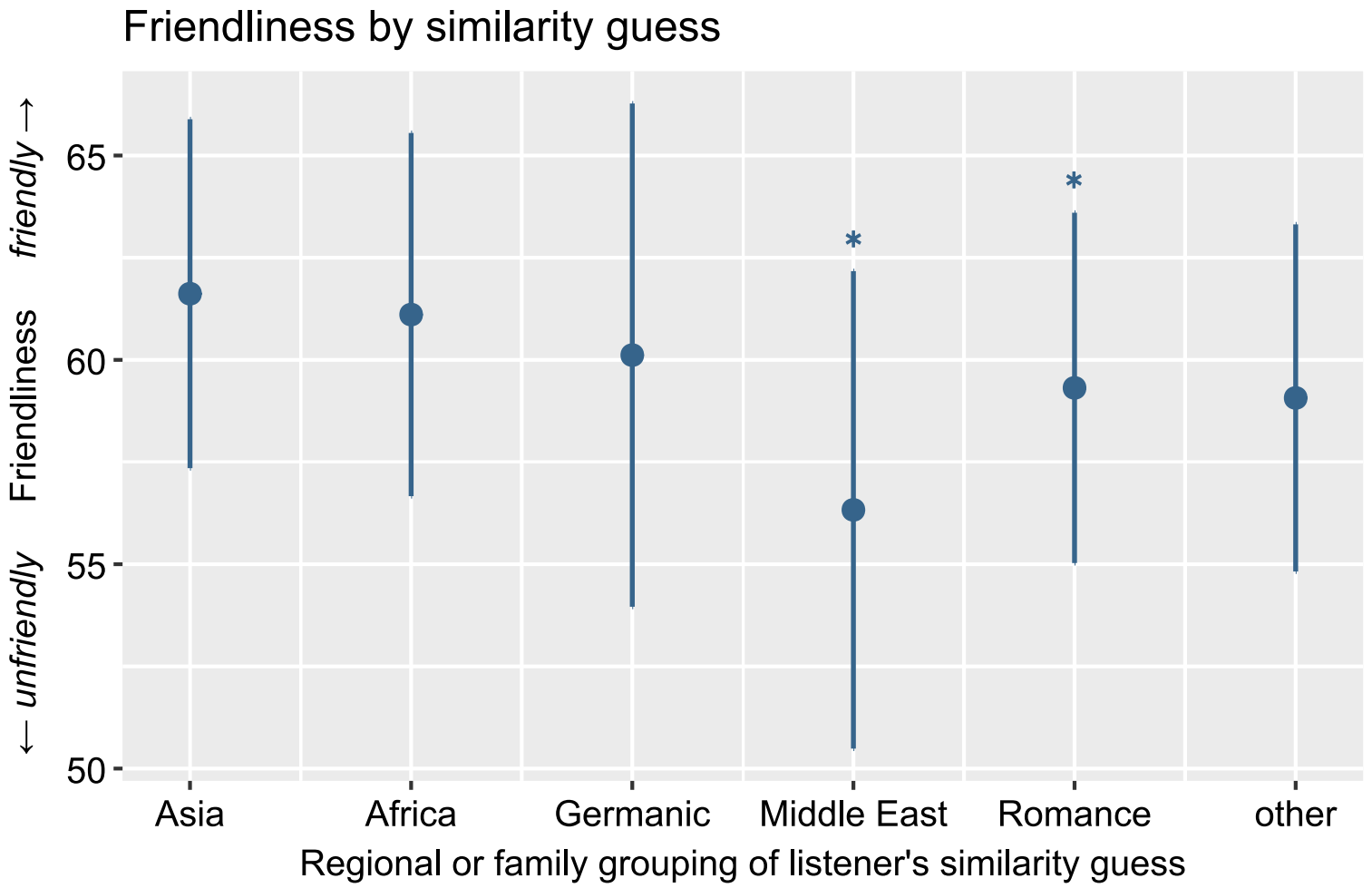


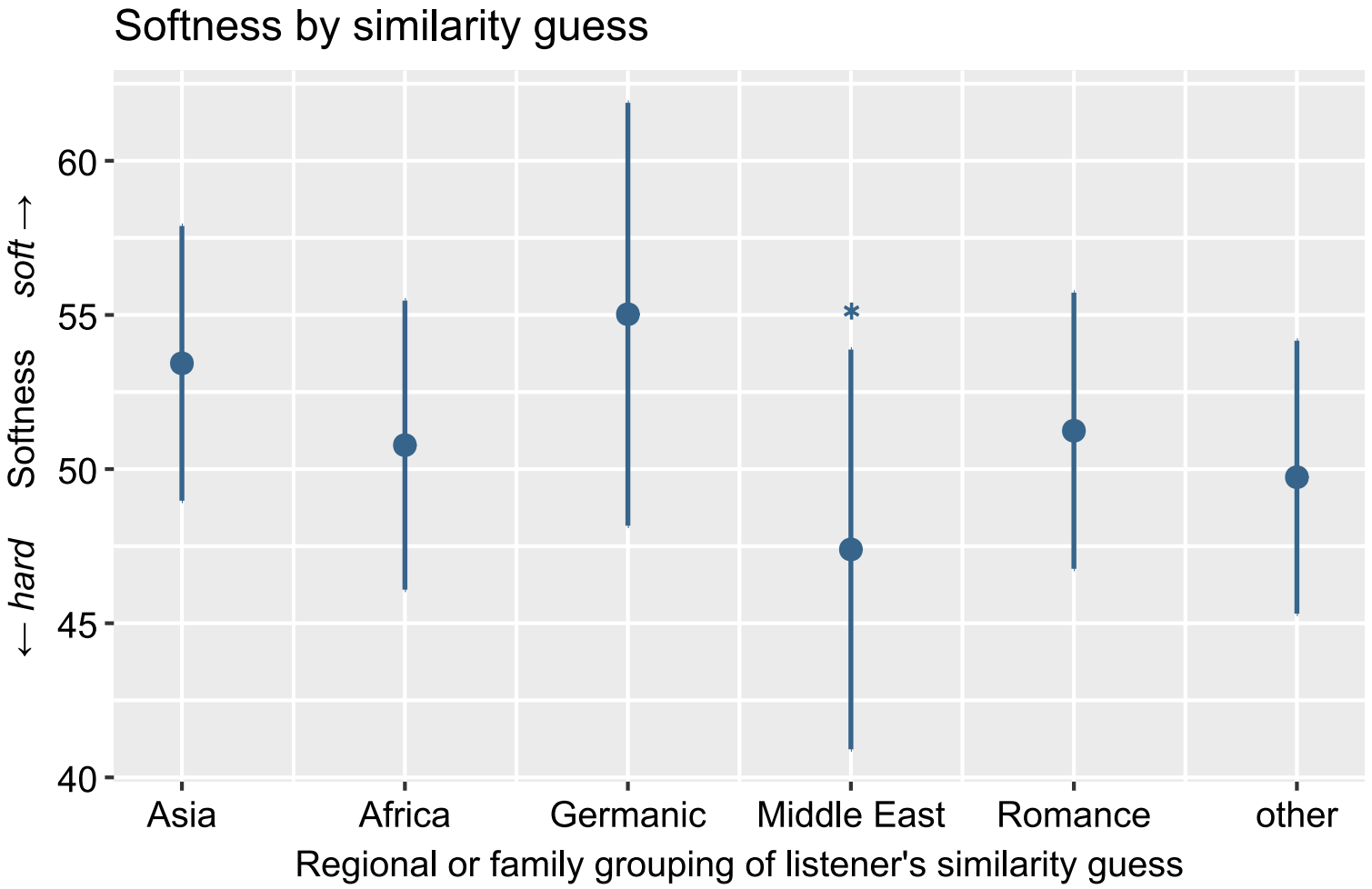
Overview of model with all scales



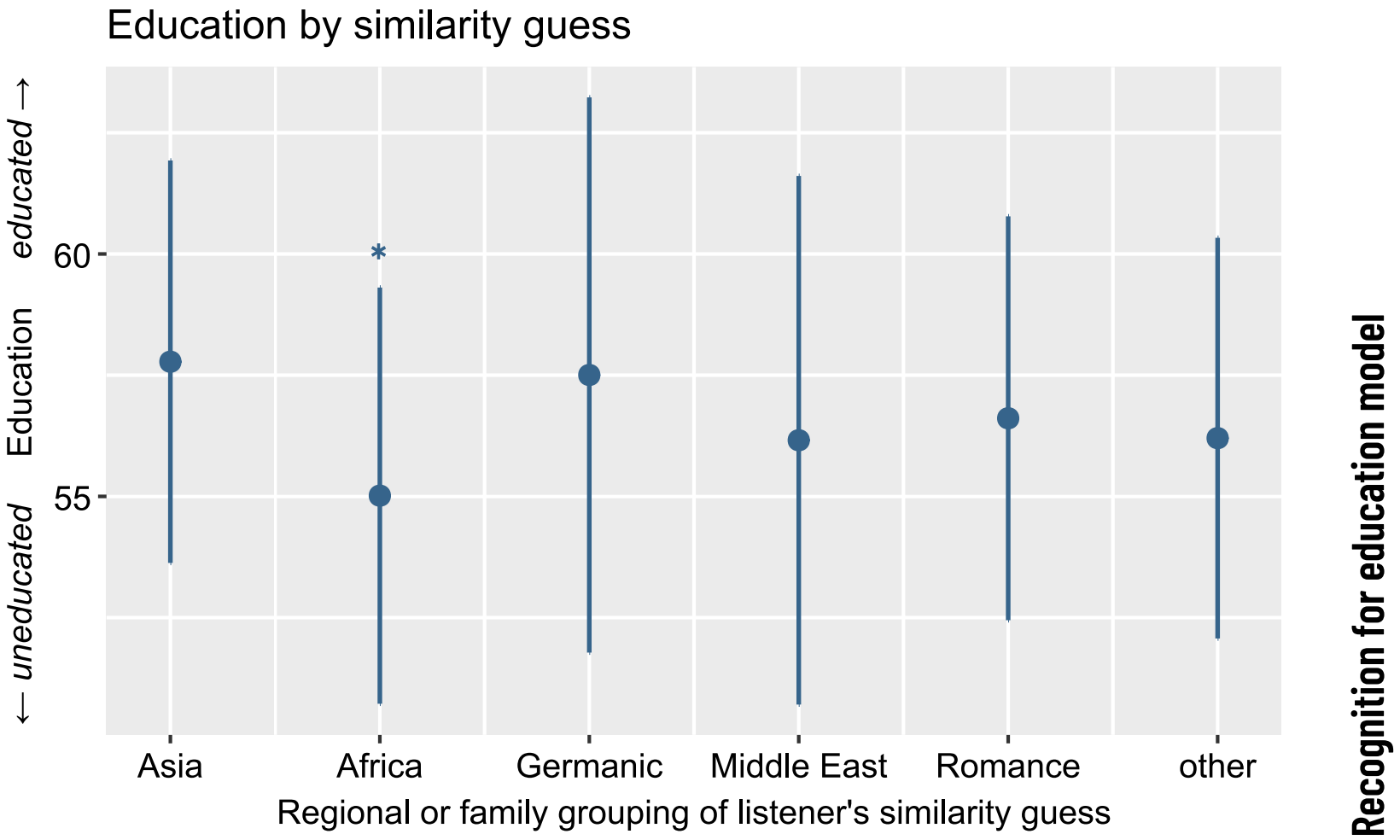
Recognition for model with all scales


Eroticism by similarity guess
← unerotic Eroticism erotic →
30
25
20
Asia
Africa
Germanic
Middle East
Romance
other
Regional or family grouping of listener's similarity guess
Recognition for eroticism model

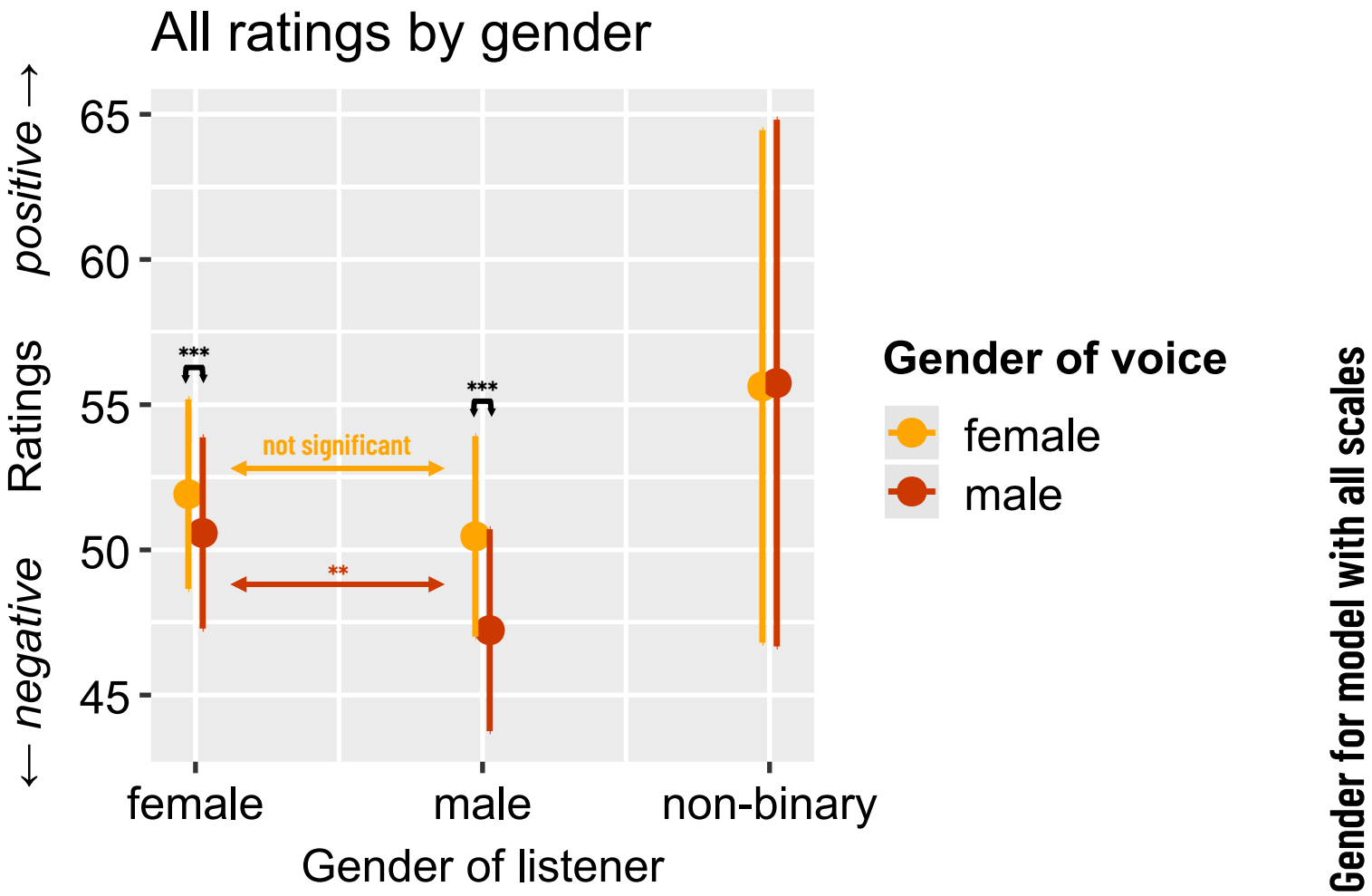

Friendliness by similarity guess
← unfriendly Friendliness friendly →
65
60
55
50
*
*
Asia
Africa
Germanic
Middle East
Romance
other
Regional or family grouping of listener's similarity guess
Recognition for friendliness model

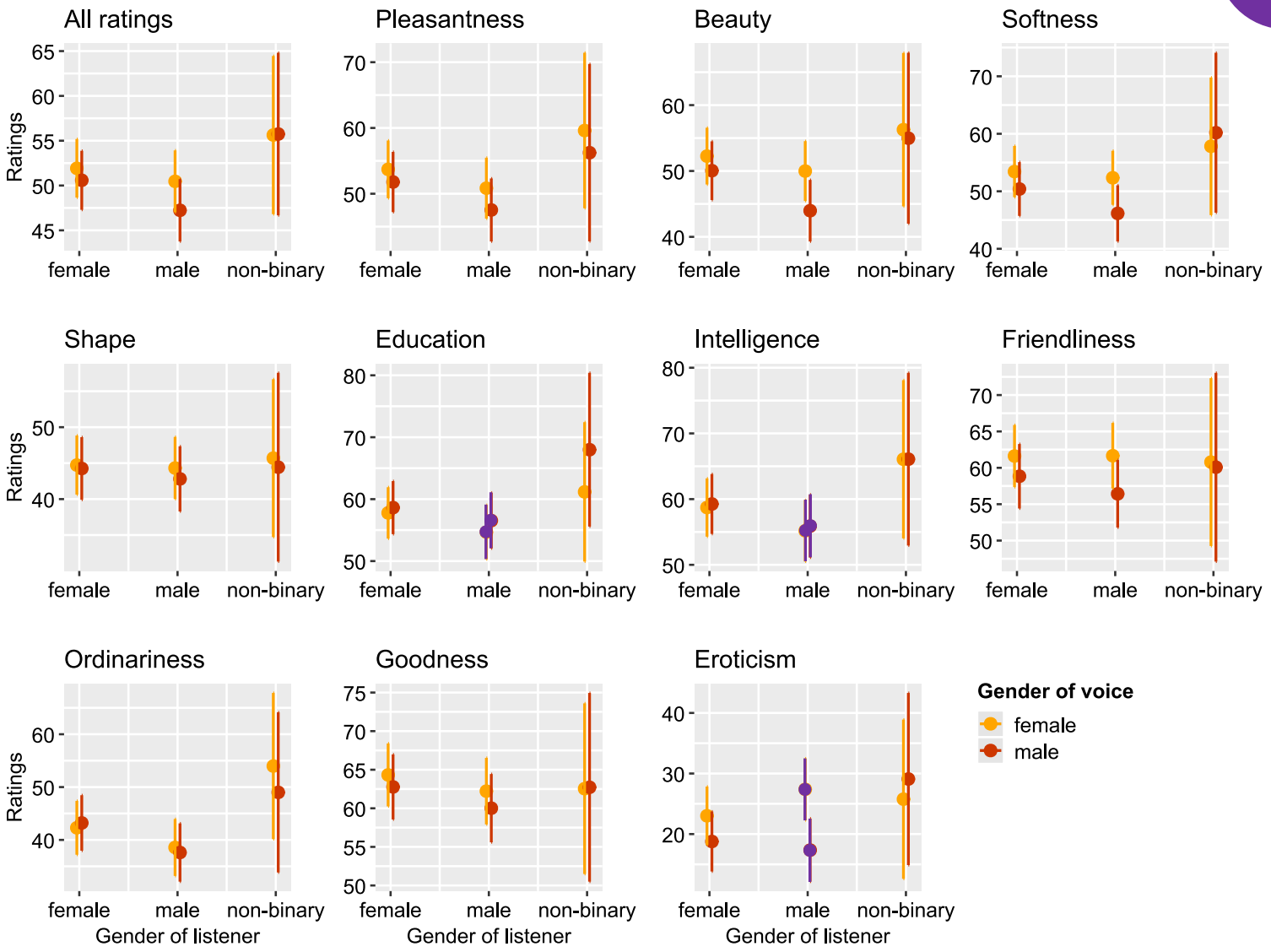


Recognition for softness model


Education by similarity guess
← uneducated Education educated →
60
55
*
Asia
Africa
Germanic
Middle East
Romance
other
Regional or family grouping of listener's similarity guess
Recognition for education model

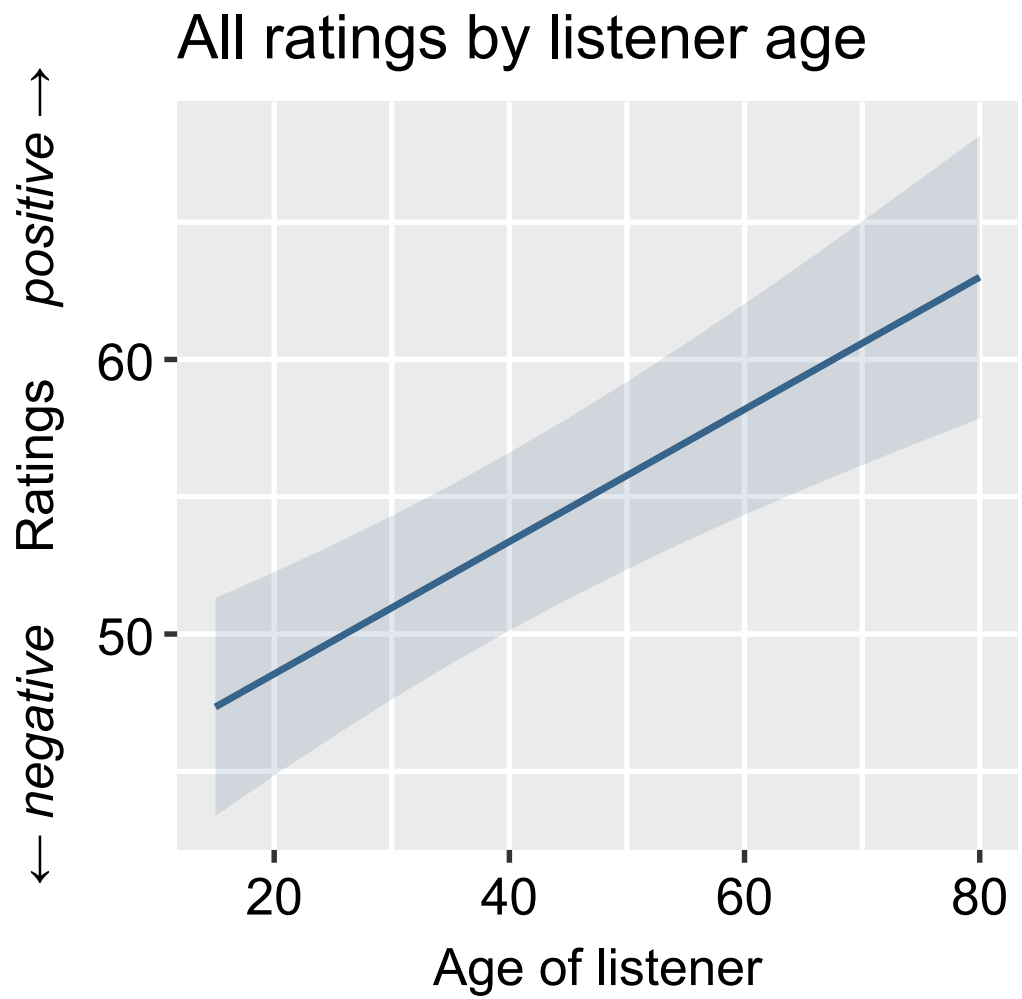
Overview of model with all scales


All ratings by gender
← negative Ratings positive →
65
60
55
50
45
***
***
not significant
**
female
male
non-binary
Gender of listener
Gender of voice
female
male
Gender for model with all scales

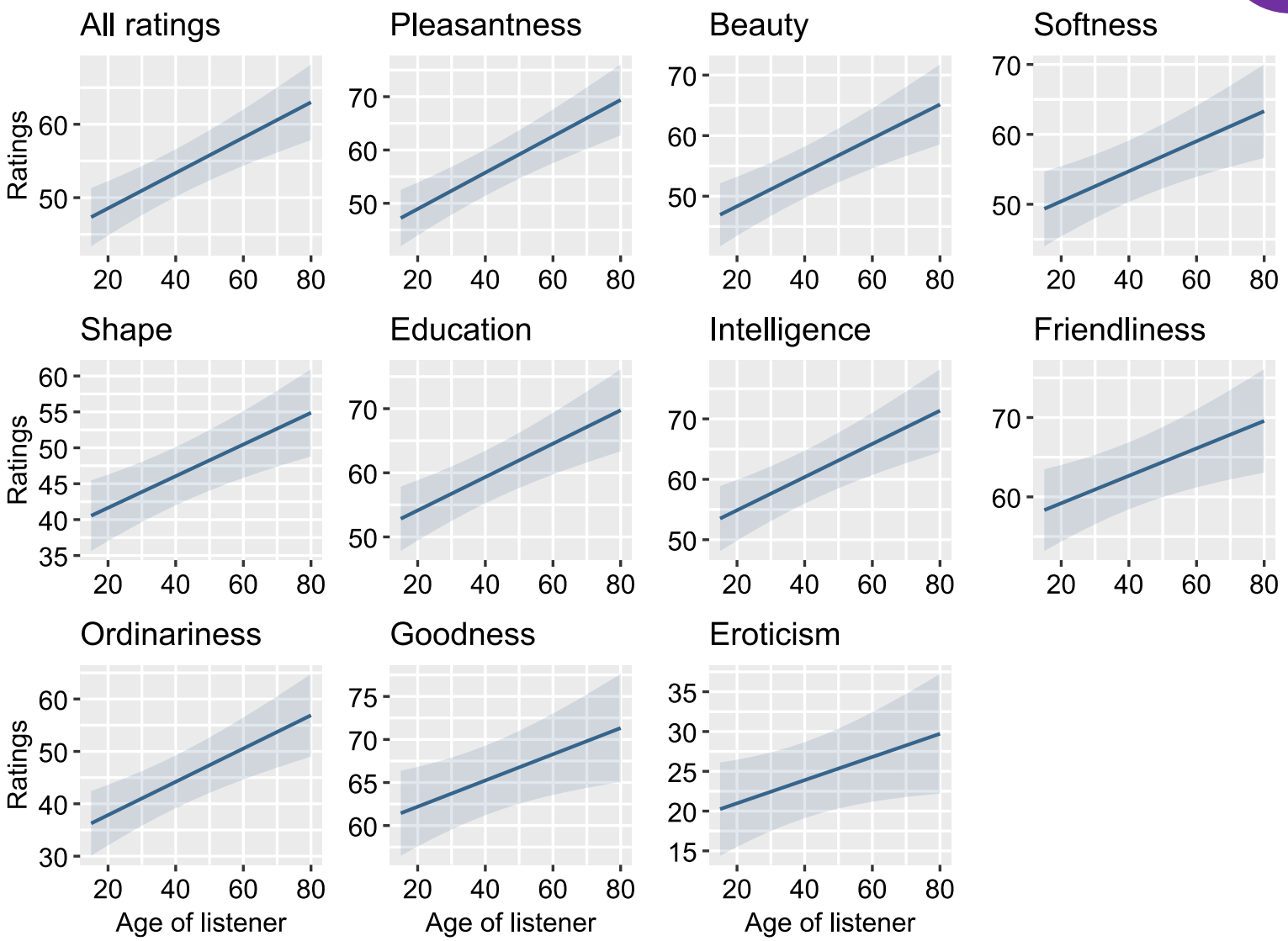


Overview of gender

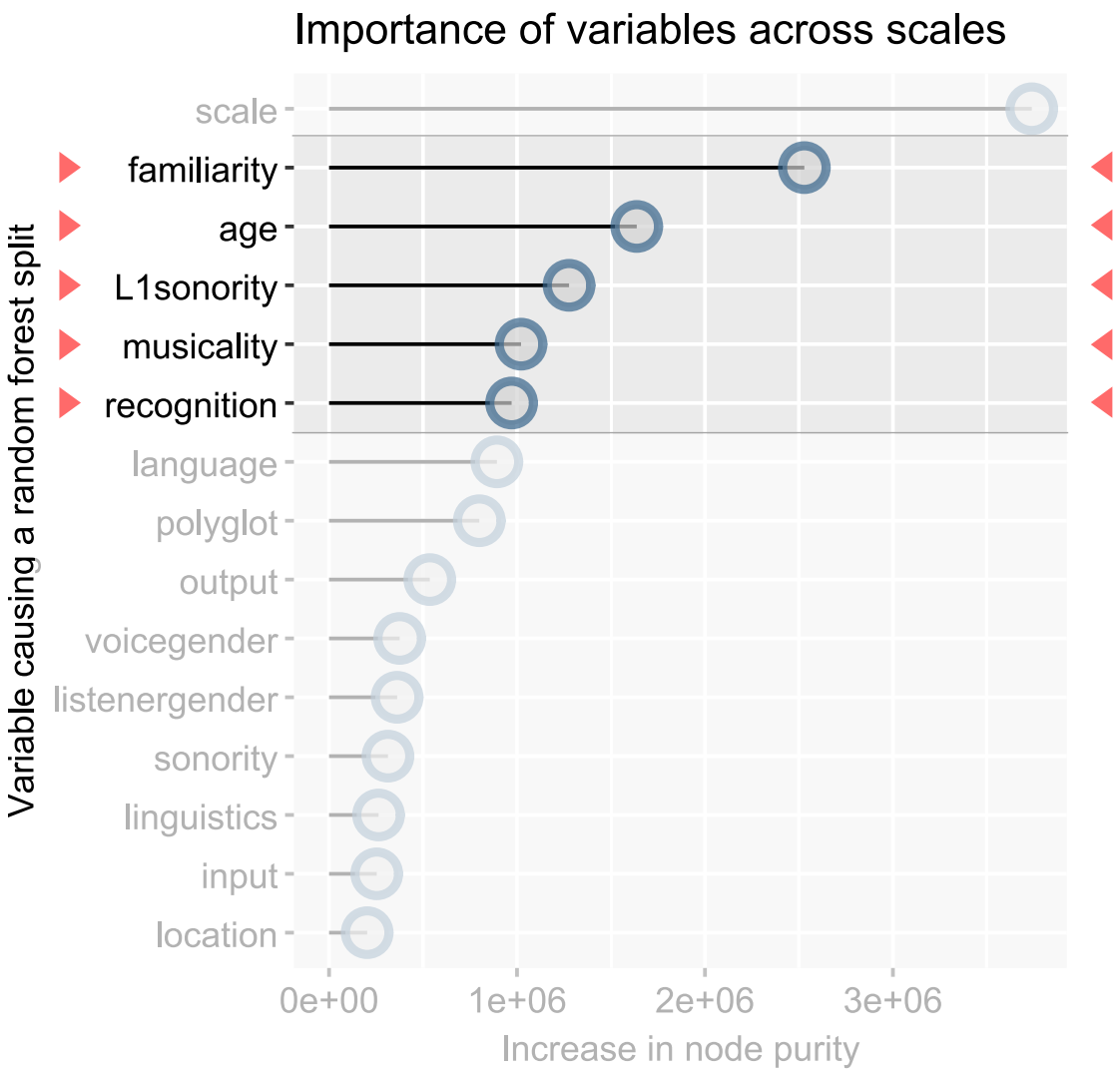
Overview of model with all scales



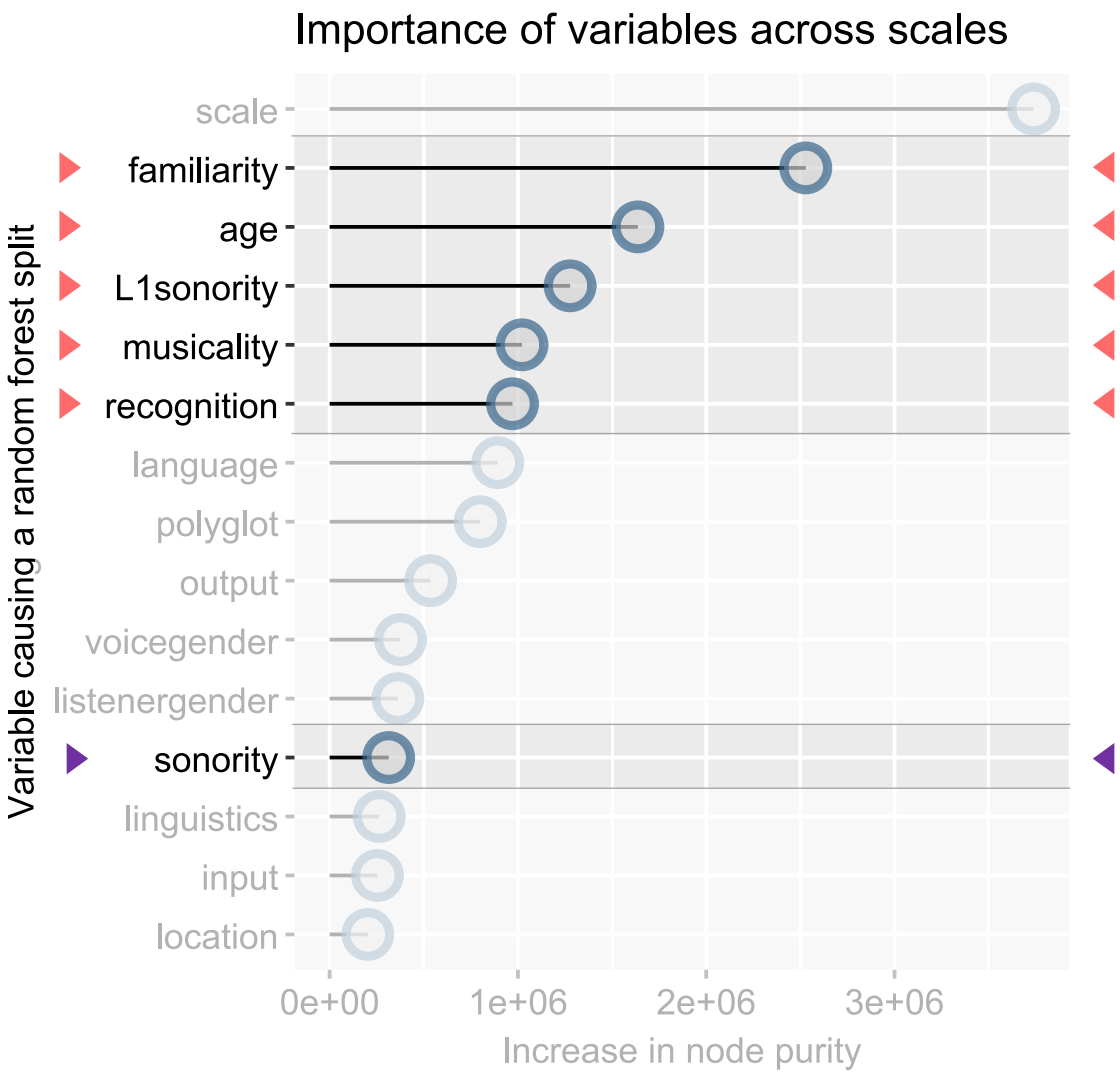
Age for model with all scales



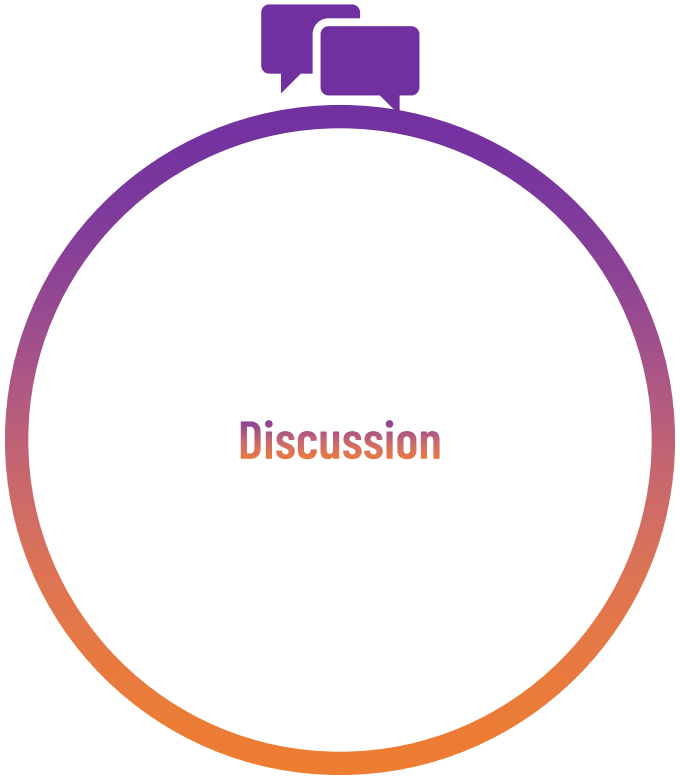
Overview of age



Random forest for model with all 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.

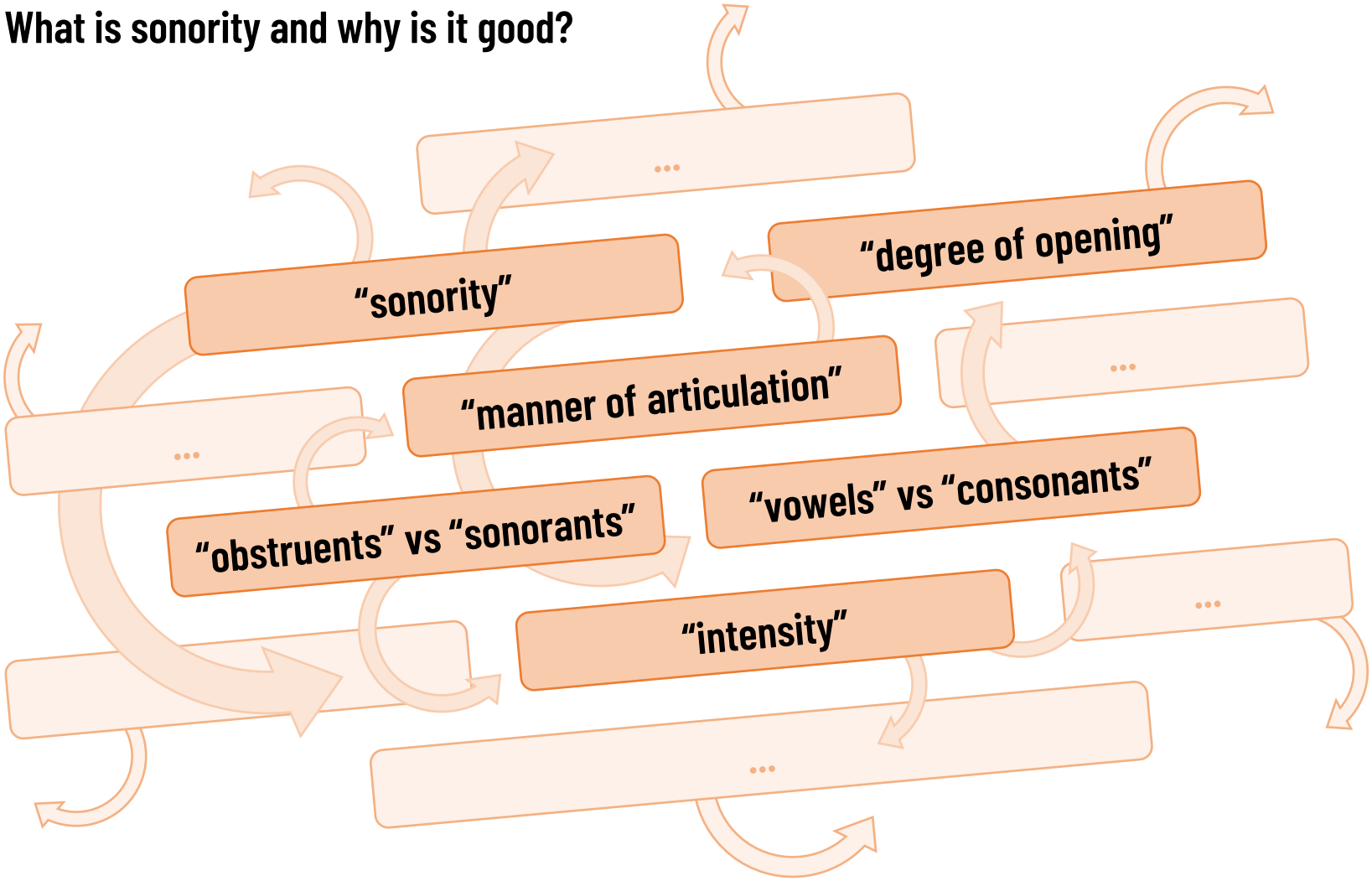
- Listeners may rate languages worse if:
  - they are male and young,
  - they perceive the language as being less familiar.
  - they *felt* it resembled a language from a specific region.

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

We really like when language is sonorous!

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

What is sonority and why is it good?



This series of studies

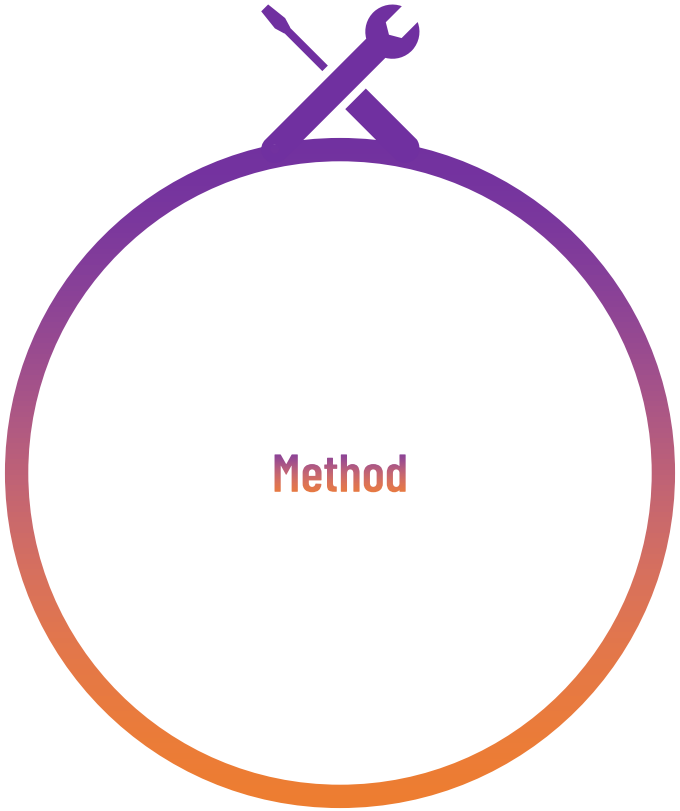
SONORITY

SPECIFIC PHONEMES

/x/

SYLLABLE STRUCTURE

...


Method

/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', '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

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/ Participant quota sampling by PRIMARY LANGUAGE

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

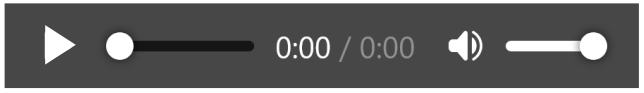
Prolific

/x/ Questionnaire

30% completed

Please listen to the recording of the first robot:

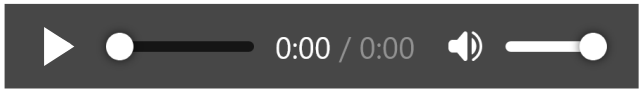
To listen, click the play button.



/X/ Questionnaire

Please listen to the recording of the second robot:

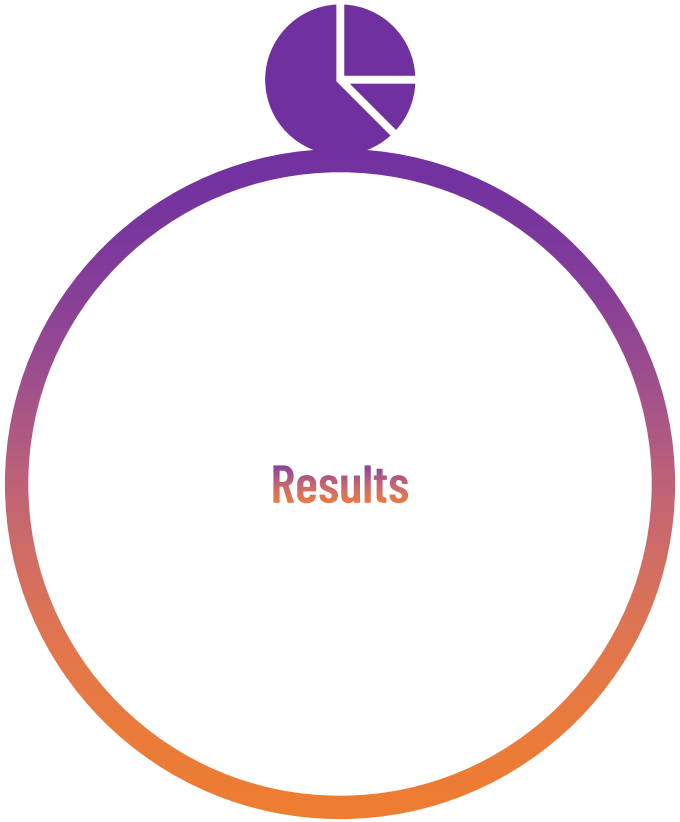
To listen, click the play button.



/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)

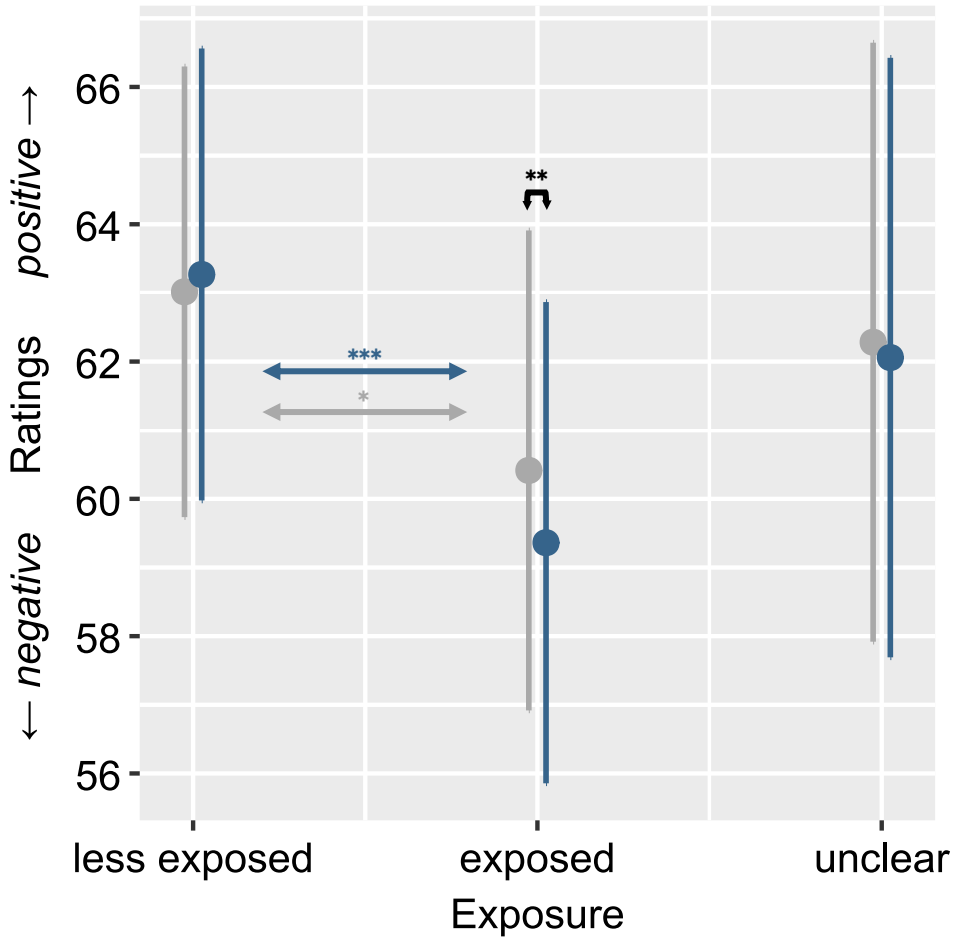
cf., e.g.,
Hilton et al. 2022
Anikin et al. 2023
Reiterer et al. 2020
Mooshammer et al. 2023


Results

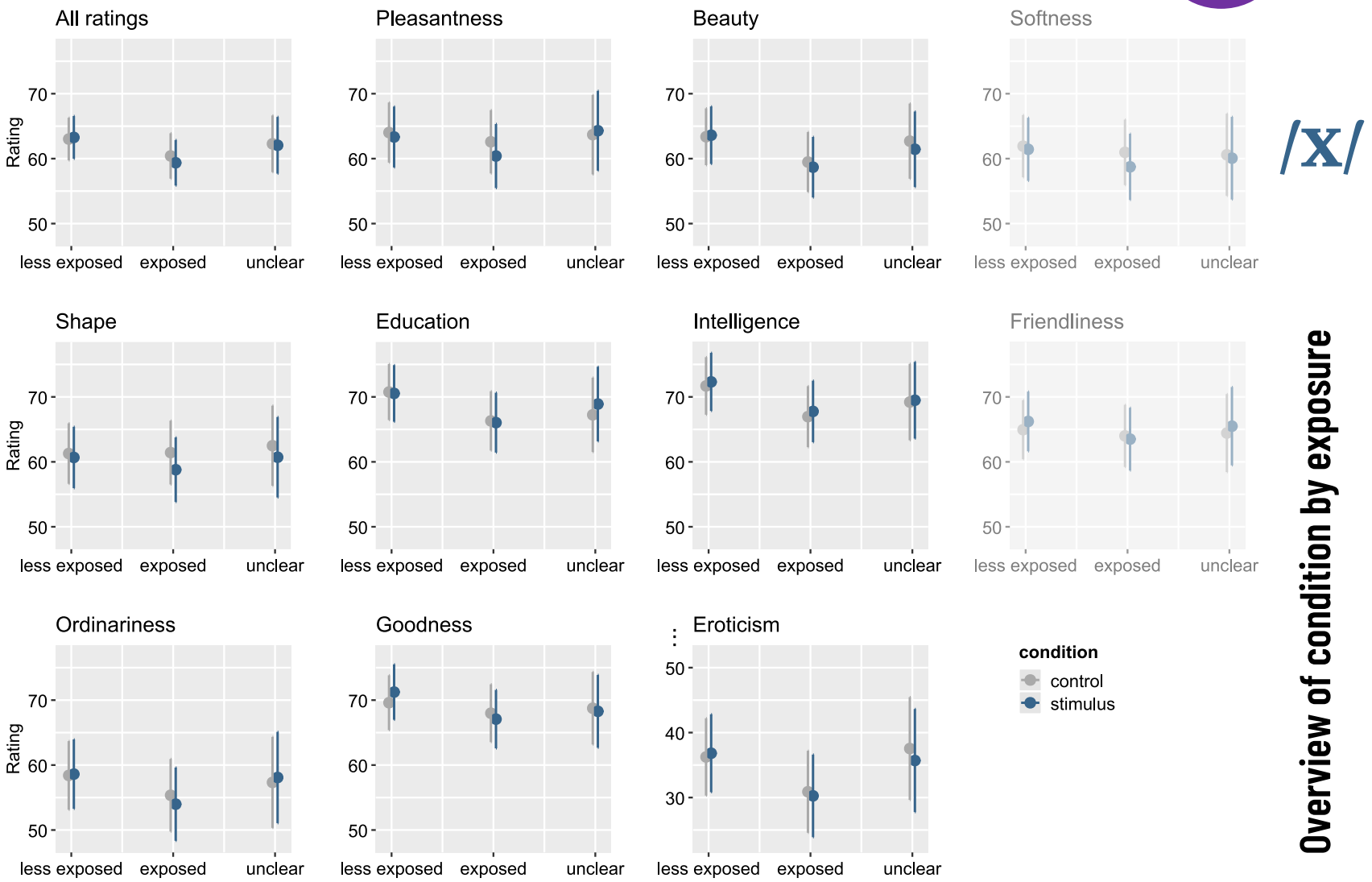
/x/

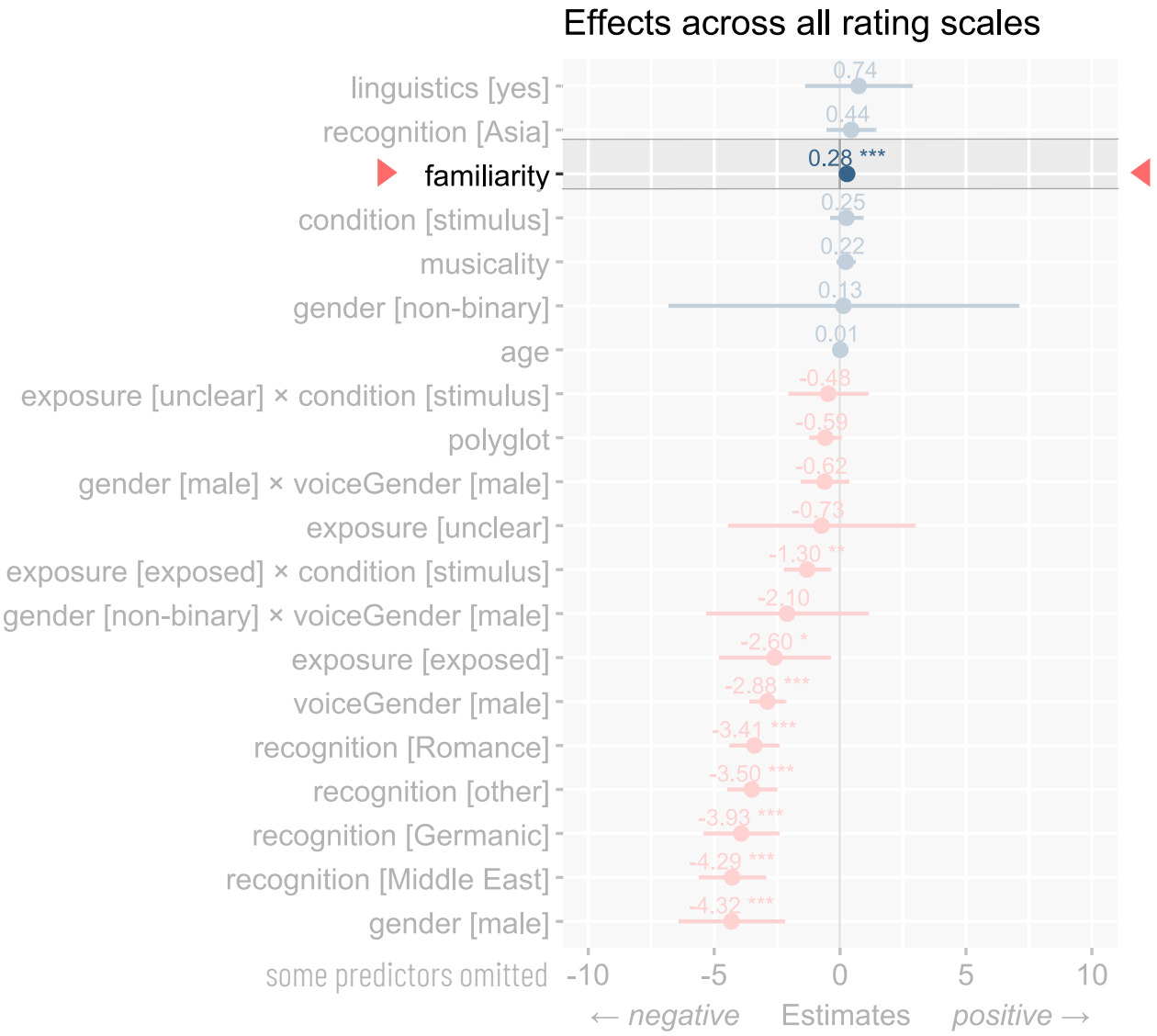
Overview of model with all scales

/x/ All ratings by condition and exposure



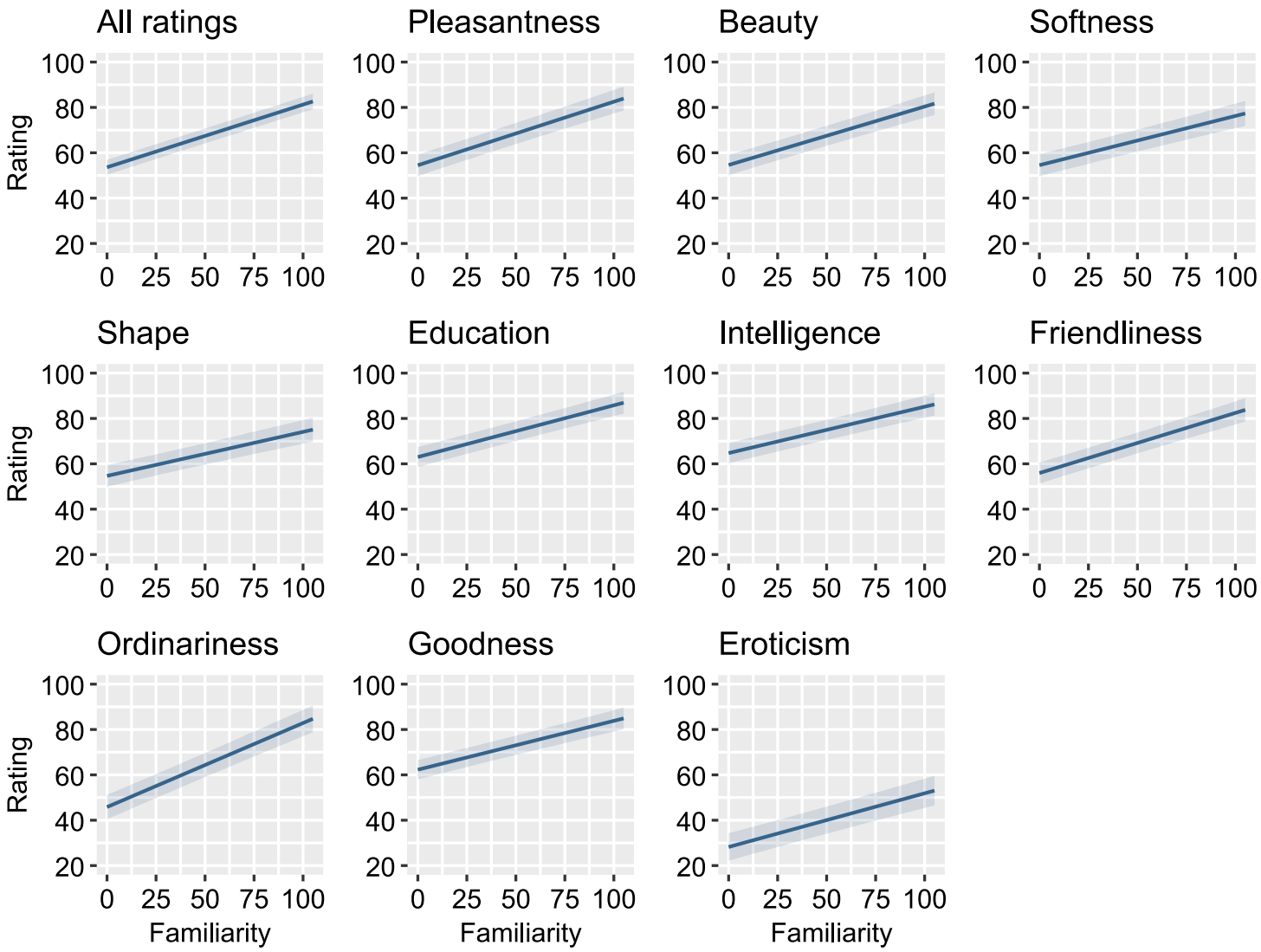
Condition by exposure for model with all scales


All ratings
Pleasantness
Beauty
Softness
Shape
Education
Intelligence
Friendliness
Ordinariness
Goodness
Eroticism
Rating
70
60
50
40
30
less exposed
exposed
unclear
/x/
condition
control
stimulus
Overview of condition by exposure



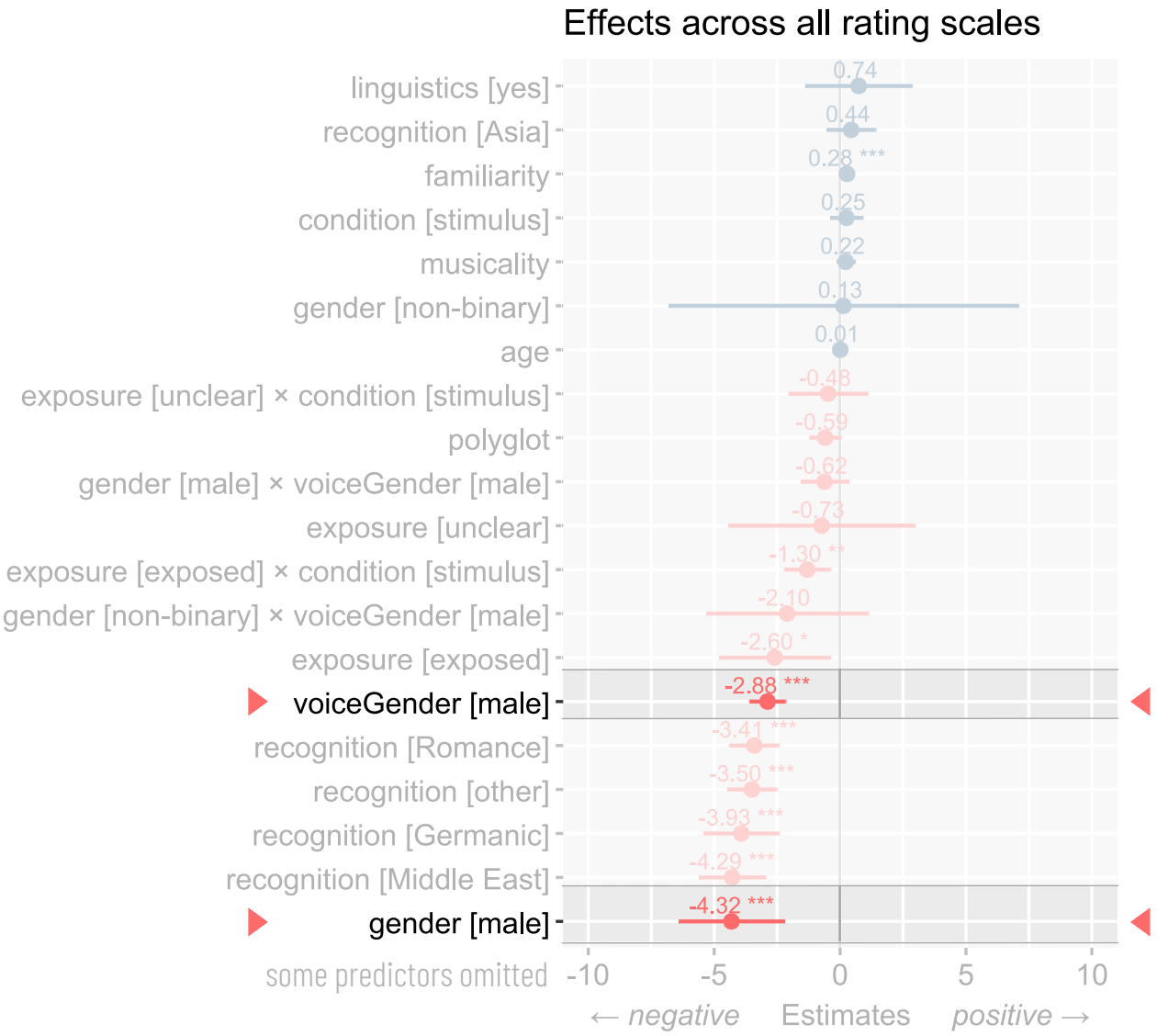
/x/

Overview of model with all scales



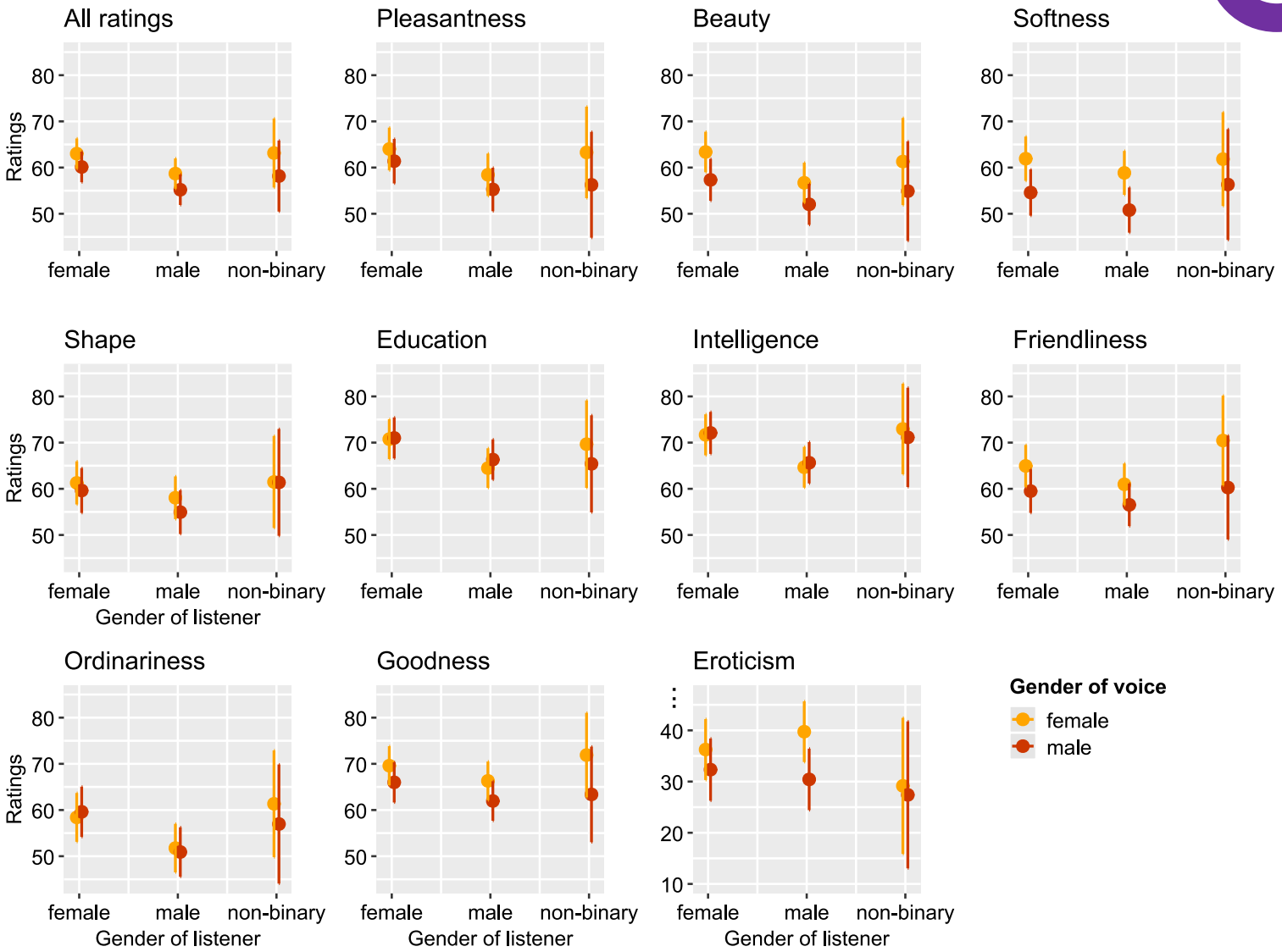
/x/

Overview of familiarity



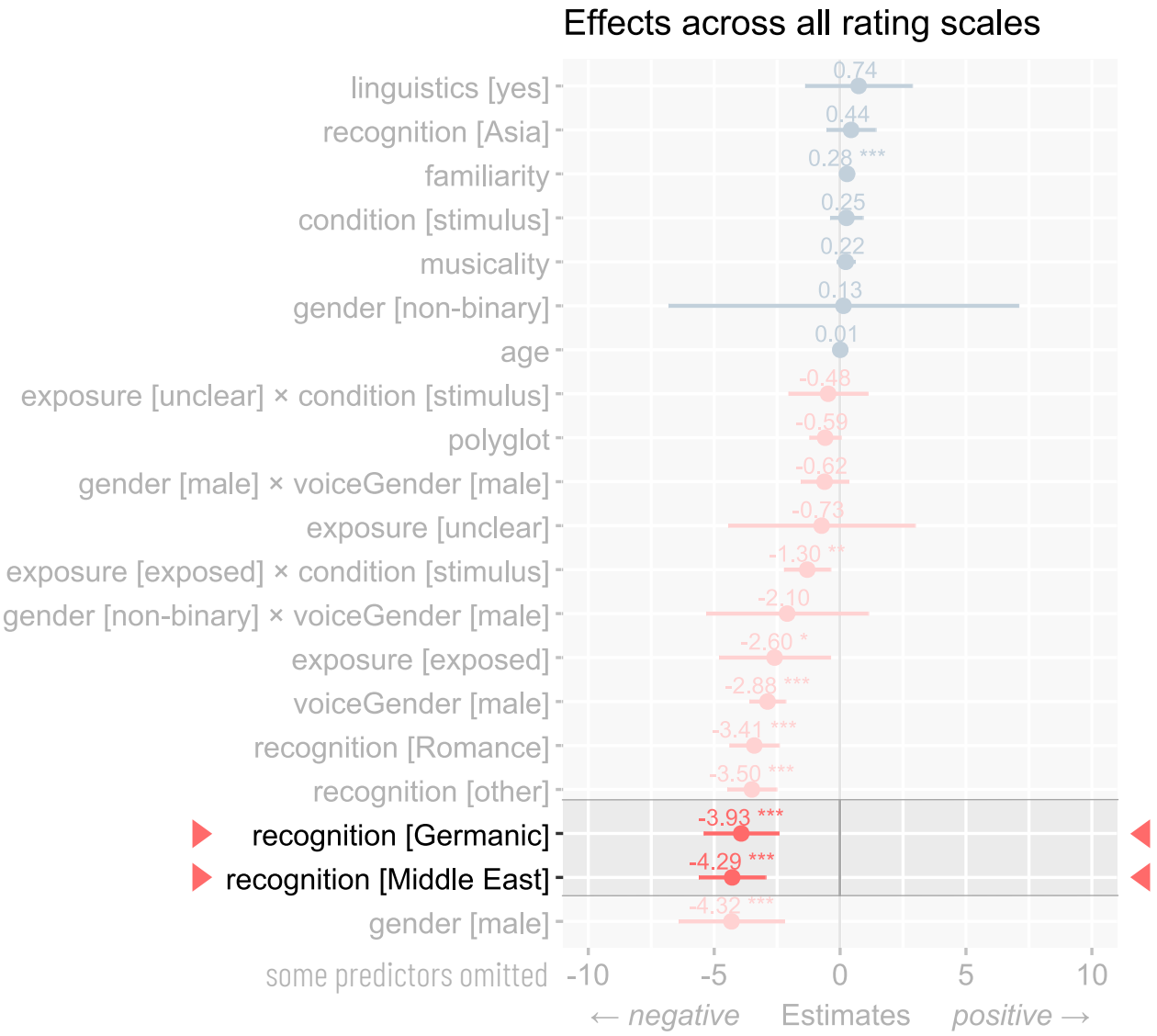
/x/

Overview of model with all scales



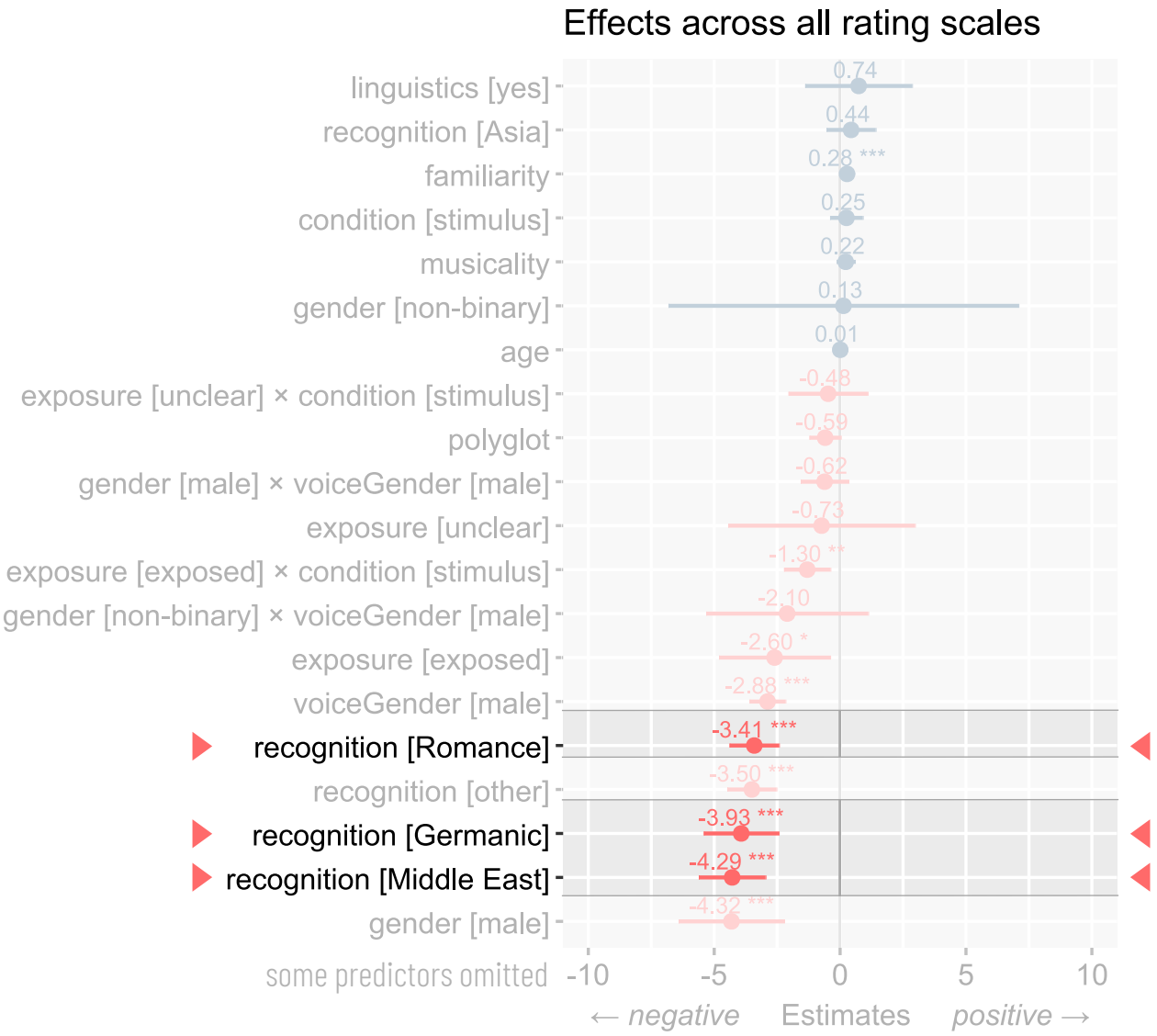
/x/

Overview of gender



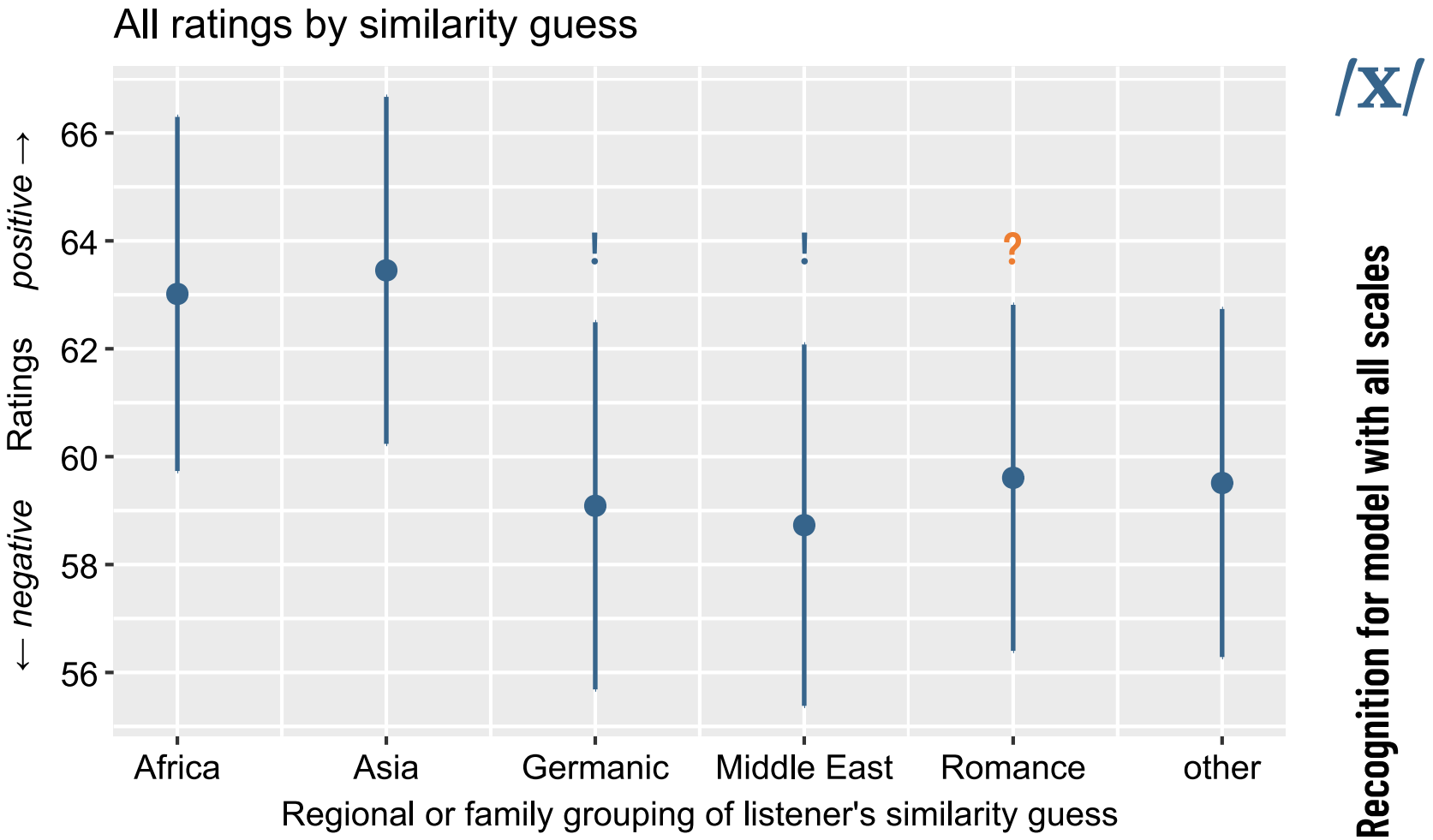
/x/

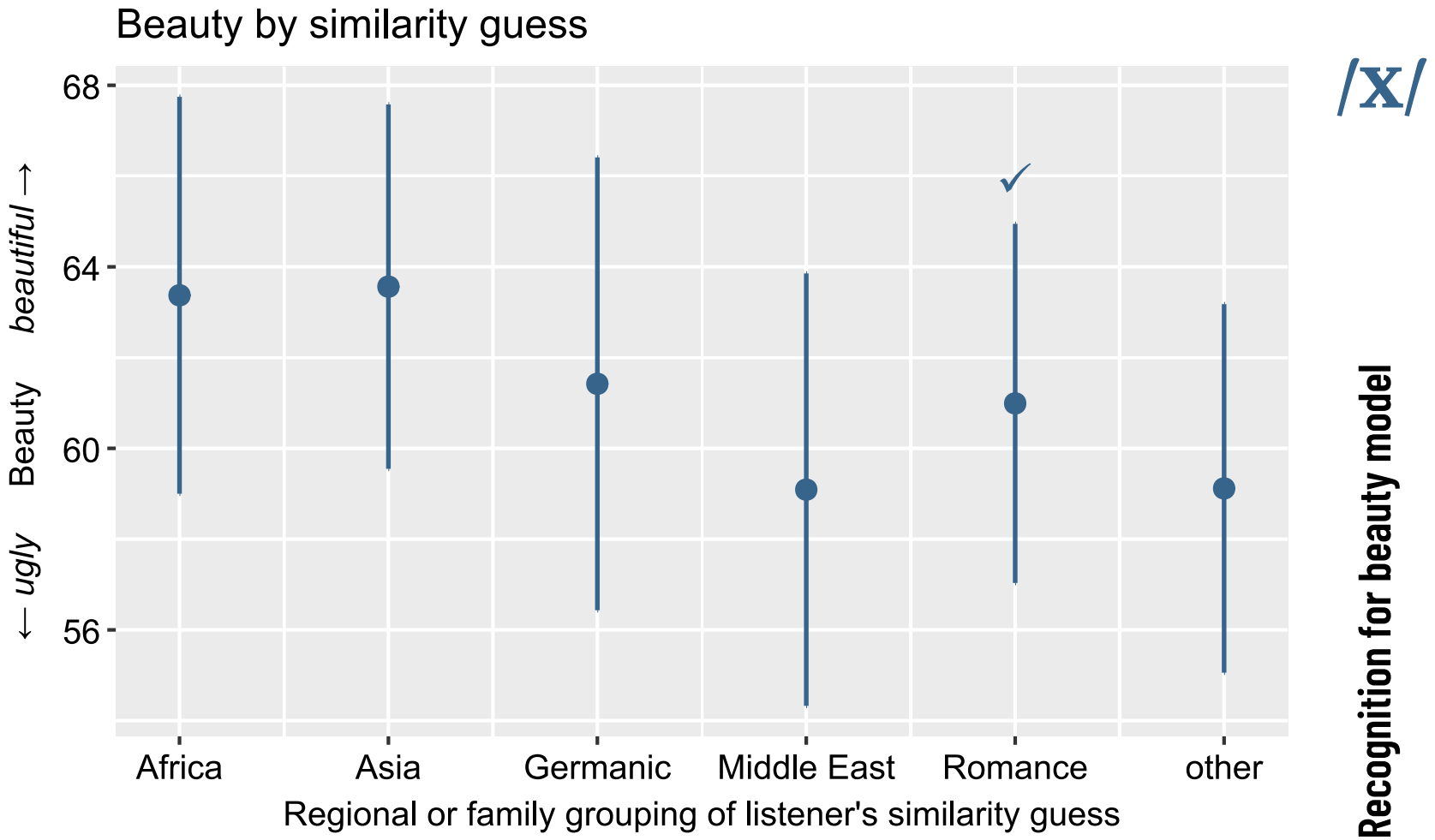
Overview of model with all scales

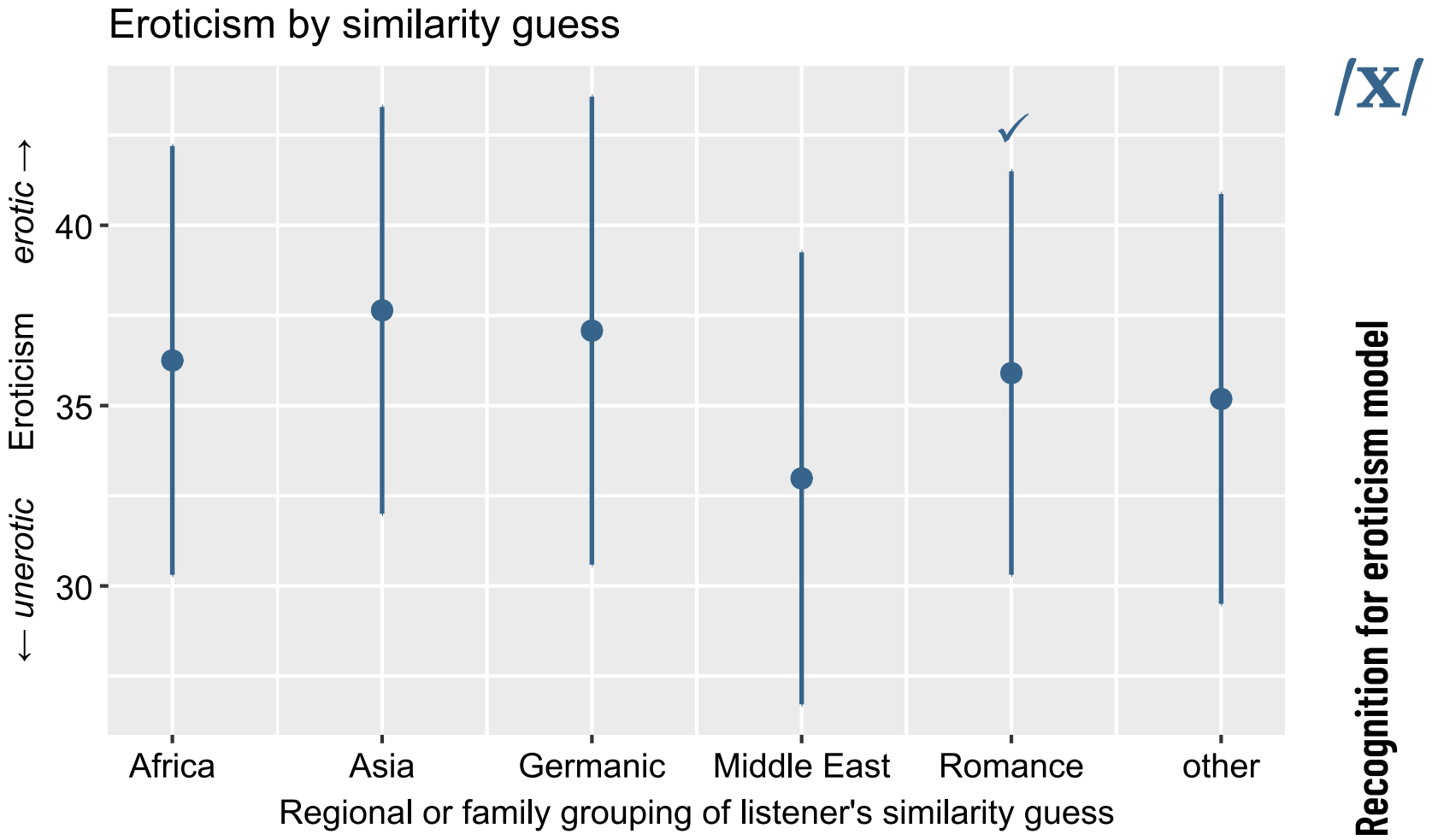


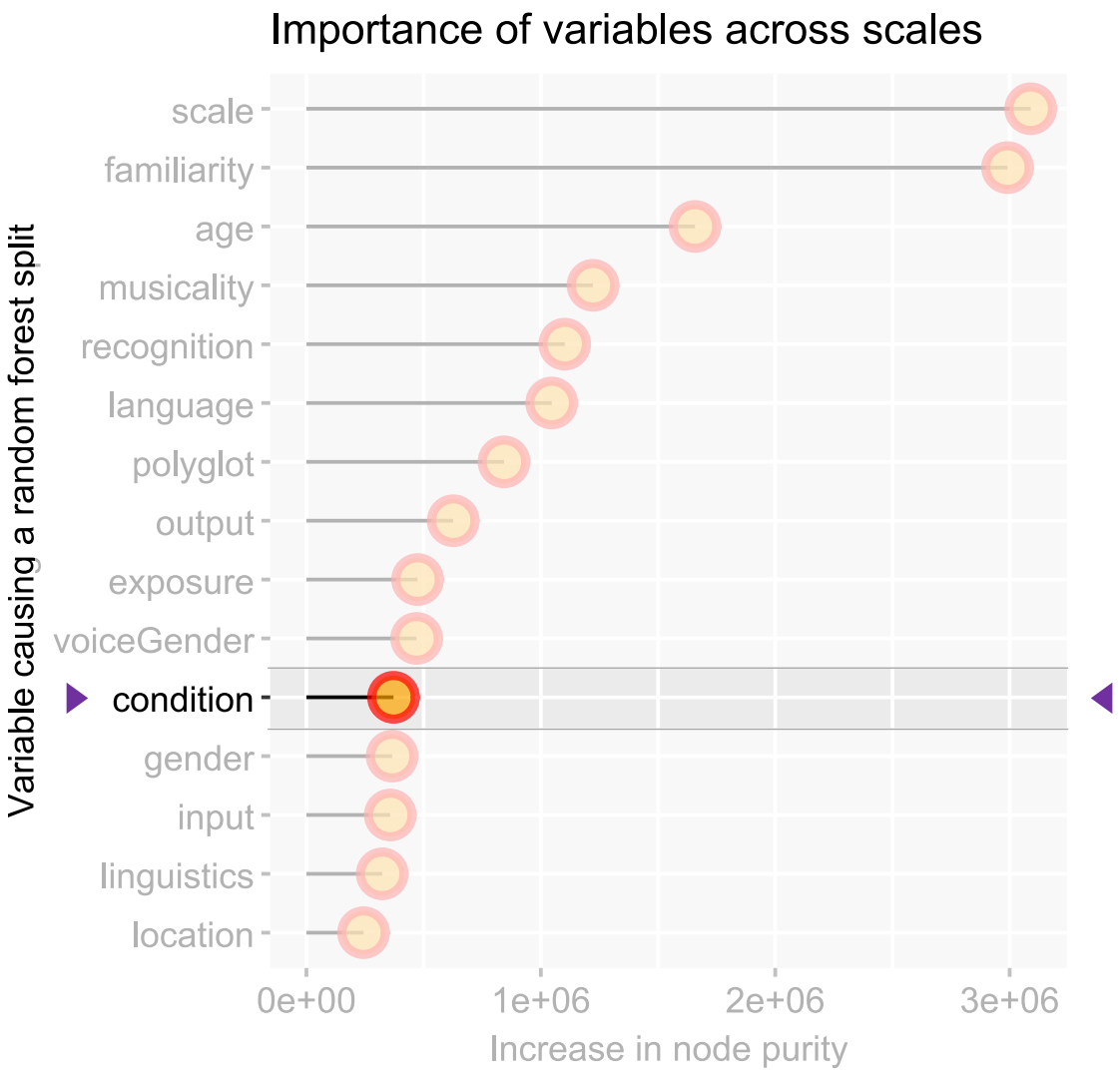
/x/

Overview of model with all scales


All ratings by similarity guess
← negative Ratings positive →
66
64
62
60
58
56
!
!
?
Africa
Asia
Germanic
Middle East
Romance
other
Regional or family grouping of listener's similarity guess
/x/
Recognition for model with all scales

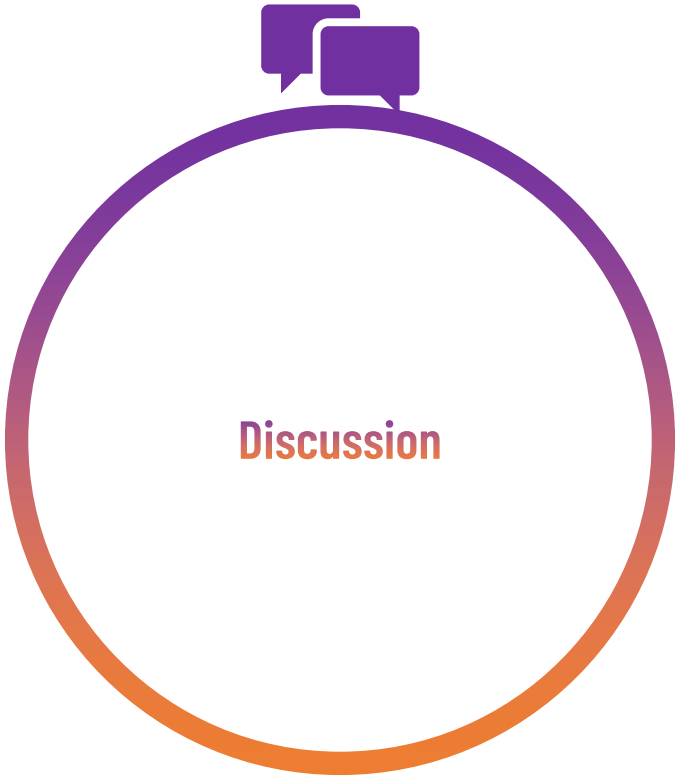

Beauty by similarity guess
68
64
60
56
← ugly Beauty beautiful →
Africa
Asia
Germanic
Middle East
Romance
other
Regional or family grouping of listener's similarity guess
/x/
Recognition for beauty model


Eroticism by similarity guess
/x/
✓
← unerotic Eroticism erotic →
40
35
30
Africa
Asia
Germanic
Middle East
Romance
other
Regional or family grouping of listener's similarity guess
Recognition for eroticism model



/x/

Random forest for model with all scales


Discussion

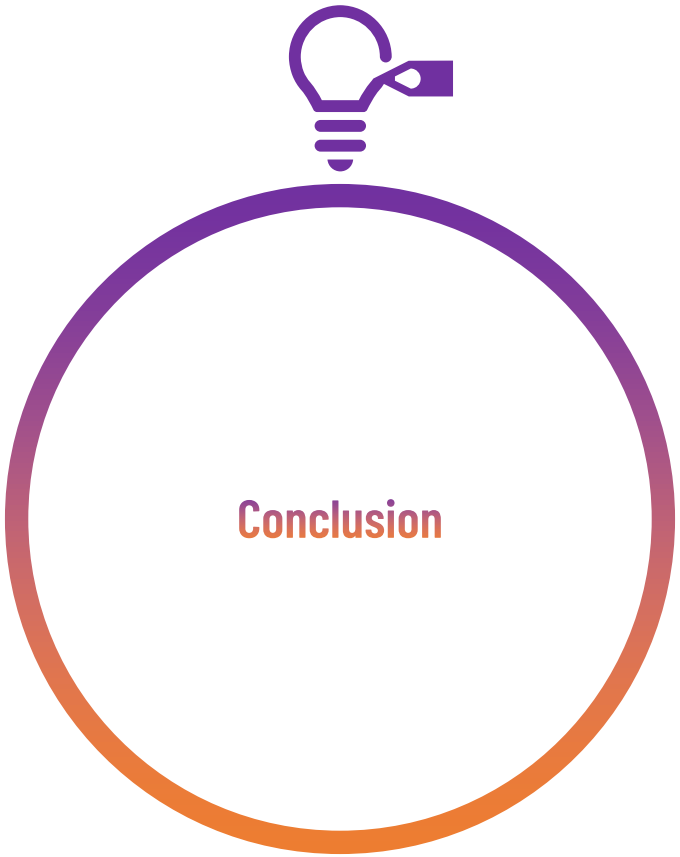
/x/ Indexicality seems to be stronger than iconicity

- 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.


Conclusion

Indexicality versus iconicity

INDEXICALITY

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 voiceless velar fricative

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

This series of studies

SONORITY

SPECIFIC PHONEMES

/x/

SYLLABLE STRUCTURE

...


THANK YOU

- Abercombie, David. 2013. *The North Wind and the Sun*, 1951–1978. University of Edinburgh. School of Philosophy, Psychology, and Language Sciences. Department of Linguistics and English Language. https://doi.org/10.7488/ds/157.
- Anderson, Earl R. 1998. *A grammar of iconism*. Madison, Teaneck: Fairleigh Dickinson University Press.
- Anikin, Andrey, Nikolay Aseyev & Niklas Erben Johansson. 2023. Do some languages sound more beautiful than others? *Proceedings of the National Academy of Sciences of the United States of America* 120.17: e2218367120. https://doi.org/10.1073/pnas.2218367120.
- Barker, Harry & Mirjana Bozic. 2024. The forms, mechanisms, and roles of iconicity: A review. *Advance Preprints*. https://doi.org/10.31124/advance.171233725.51126728/v1.
- Barthes, Roland. 1972. Mythologies. New York: Hill and Wang.
- Baugh, John. 2003. Linguistic profiling. In Sinfree Makoni, Geneva Smitherman, Arnetha Ball & Arthur K. Spears (eds.), *Black linguistics: Language, society and politics in Africa and the Americas*, 155–168. London: Routledge.
- Bayard, Donn, Ann Weatherall, Cynthia Gallois & Jeffery Pittam. 2001. Pax Americana? Accent attitudinal evaluations in New Zealand, Australia and America. *Journal of Sociolinguistics* 5.1: 22–49. https://doi.org/10.1111/1467-9481.00136.
- Bellamy, John. 2022. Discourse analysis of spoken interaction. In Ruth Kircher & Lena Zipp (eds.), *Research methods in language attitudes*, 51–65. Cambridge: Cambridge University Press. https://doi.org/10.1017/9781108867788.006.

- Berthele, Raphael. 2010. Investigations into the folk's mental models of linguistic varieties. In Dirk Geeraerts, Gitte Kristiansen & Yves Peirsman (eds.), *Advances in Cognitive Sociolinguistics* (Cognitive Linguistics Research 45), 265–290. Berlin, New York: De Gruyter Mouton.
- Blasi, Damián E., Søren Wichmann, Harald Hammarström, Peter F. Stadler & Morten H. Christiansen. 2016. Sound-meaning association biases evidenced across thousands of languages. *Proceedings of the National Academy of Sciences of the United States of America* 113.39: 10818–10823. https://doi.org/10.1073/pnas.1605782113.
- Brown, Bruce L. & Wallace E. Lambert. 1976. A cross-cultural study of social status markers in speech. *Canadian Journal of Behavioural Science* 8.1: 39–55. https://doi.org/10.1037/h0081933.
- Cargile, Aaron C., Howard Giles, Ellen B. Ryan & James J. Bradac. 1994. Language attitudes as a social process: A conceptual model and new directions. *Language & Communication* 14.3: 211–236. https://doi.org/10.1016/0271-5309(94)90001-9.
- Chambers, Jack K. 1995. *Sociolinguistic theory: Linguistic variation and its social significance* (Language in Society 22). Oxford: Blackwell.
- Clopper, Cynthia G. & David B. Pisoni. 2004. Some acoustic cues for the perceptual categorization of American English regional dialects. *Journal of Phonetics* 32.1: 111–140. https://doi.org/10.1016/S0095-4470(03)00009-3.
- Clopper, Cynthia G., Bartłomiej Plichta & Jennifer Hay. 2011. Experimental speech perception and perceptual dialectology. In Marianna Di Paolo & Malcah Yaeger-Dror (eds.), *Sociophonetics: A student's guide*, 149–162. London: Routledge.

- Coupland, Nikolas & Hywel Bishop. 2007. Ideologised values for British accents. *Journal of Sociolinguistics* 11.1: 74–93. https://doi.org/10.1111/j.1467-9841.2007.00311.x.
- Ćwiek, Aleksandra, Susanne Fuchs, Christoph Draxler, Eva Liina Asu, Dan Dediu, Katri Hiovain, Shigeto Kawahara, Sofia Koutalidis, Manfred Krifka, Pärtel Lippus, Gary Lupyan, Grace E. Oh, Jing Paul, Caterina Petrone, Rachid Ridouane, Sabine Reiter, Nathalie Schümchen, Ádám Szalontai, Özlem Ünal-Logacev, Jochen Zeller, Marcus Perlman & Bodo Winter. 2022. The bouba/kiki effect is robust across cultures and writing systems. *Philosophical Transactions of the Royal Society B: Biological Sciences* 377.1841: 20200390. https://doi.org/10.1098/rstb.2020.0390.
- Dixon, John A., Berenice Mahoney & Roger Cocks. 2002. Accents of guilt? Effects of regional accent, race, and crime type on attributions of guilt. *Journal of Language and Social Psychology* 21.2: 162–168. https://doi.org/10.1177/02627X02021002004.
- Domizi, Alessandra. 2024. *Die ästhetische Wahrnehmung der deutschen Sprache im europäischen Raum*. Mannheim: IDS-Verlag.
- Dragojevic, Marko & Sean Goatley-Soan. 2022. The verbal-guise technique. In Ruth Kircher & Lena Zipp (eds.), *Research methods in language attitudes*, 203–218. Cambridge: Cambridge University Press. https://doi.org/10.1017/9781108867788.017.
- Durham, Mercedes. 2022. Content analysis of social media. In Ruth Kircher & Lena Zipp (eds.), *Research methods in language attitudes*, 35–50. Cambridge: Cambridge University Press. https://doi.org/10.1017/9781108867788.005.

- Fasoli, Fabio & Anne Maass. 2020. The social costs of sounding gay: Voice-based impressions of adoption applicants. *Journal of Language and Social Psychology* 39.1: 112–131. https://doi.org/10.1177/0261927X19883907.
- Fletcher, Harvey. 1929, 1953. *Speech and hearing in communication*. Toronto: D. Van Nostrand.
- Fought, John G., Robert L. Munroe, Carmen R. Fought & Erin M. Good. 2004. Sonority and climate in a world sample of languages: Findings and prospects. *Cross-Cultural Research* 38.1: 27–51. https://doi.org/10.1177/1069397103259439.
- Fraser, Bruce. 1973. Some 'unexpected' reactions to various American-English dialects. In Roger W. Shuy & Ralph W. Fasold (eds.), *Language attitudes: Current trends and prospects*, 28–35. Washington: Georgetown University Press.
- Fuchs, Susanne & Aleksandra Ćwiek. 2022. Sounds full of meaning and the evolution of language. *Acoustics Today* 18.2: 43–51. https://doi.org/10.1121/AT.2022.18.2.43.
- Giles, Howard & Mikaela L. Marlow. 2011. Theorizing language attitudes: Existing frameworks, an integrative model, and new directions. *Annals of the International Communication Association* 35.1: 161–197. https://doi.org/10.1080/23808985.2011.11679116.
- Giles, Howard & Nancy Niedzielski. 1998. Italian is beautiful, German is ugly. In Laurie Bauer & Peter Trudgill (eds.), *Language myths*, 85–93. London: Penguin.
- Giles, Howard & Peter F. Powesland. 1975. *Speech style and social evaluation* (European Monographs in Social Psychology 7). London, New York, San Francisco: Academic Press.

- Giles, Howard, Pamela Wilson & Anthony Conway. 1981. Accent and lexical diversity as determinants of impression formation and perceived employment suitability. *Language Sciences* 3.1: 91–103. https://doi.org/10.1016/S0388-0001(81)80015-0.
- Giles, Howard, Richard Bourhis & Ann Davies. 1979. Prestige speech styles: The imposed norm and inherent value hypotheses. In William C. McCormack & Stephen A. Wurm (eds.), *Language and society* (World Anthropology), 589–596. The Hague; Paris; New York: De Gruyter Mouton.
- Giles, Howard, Richard Bourhis, Alan Lewis & Peter Trudgill. 1974. The imposed norm hypothesis: A validation. *Quarterly Journal of Speech* 60.4: 405–410. https://doi.org/10.1080/00335637409383249.
- Giles, Howard. 1970. Evaluative reactions to accents. *Educational Review* 22.3: 211–227. https://doi.org/10.1080/0013191700220301.
- Goodall, Grant. 2020. The design(ing) of language. In Jeffrey Punske, Nathan Sanders & Amy V. Fountain (eds.), *Language invention in linguistics pedagogy*, 69–85. Oxford: Oxford University Press. https://doi.org/10.1093/oso/9780198829874.003.0006.
- Gooskens, Charlotte, Wilbert Heeringa & Karin Beijering. 2008. Phonetic and lexical predictors of intelligibility. *International Journal of Humanities and Arts Computing* 2.1–2: 63–81. https://doi.org/10.3366/E1753854809000317.
- Gordon, Matthew K. 2016. *Phoneme inventories*. Oxford University Press. https://doi.org/10.1093/acprof:oso/9780199669004.001.0001.

- Grant, Tim, Urszula Clark, Gertrud Reershemius, David Pollard, Sarah Hayes & Garry Plappert. 2017. Survey of the sexiness of Klingon. In Tim Grant, Urszula Clark, Gertrud Reershemius, David Pollard, Sarah Hayes & Garry Plappert (eds.), *Quantitative research methods for linguists*, 55–66. London: Routledge. https://doi.org/10.4324/9781315181707-4.
- Hall, Stuart. 1999. Encoding, decoding. In Simon During (ed.), *The cultural studies reader*, 2nd edn., 507–517. London: Routledge.
- Haslett, David A. & Zhenguang G. Cai. 2023. Systematic mappings of sound to meaning: A theoretical review. *Psychonomic Bulletin & Review* 31.2: 627-648. https://doi.org/10.3758/s13423-023-02395-y.
- Hawkey, James. 2022. Variable analysis. In Ruth Kircher & Lena Zipp (eds.), *Research methods in language attitudes*, 79–96. Cambridge: Cambridge University Press. https://doi.org/10.1017/9781108867788.008.
- Hilton, Nanna H., Charlotte Gooskens, Anja Schüppert & Chaoju Tang. 2022. Is Swedish more beautiful than Danish? Matched guise investigations with unknown languages. *Nordic Journal of Linguistics* 45.1: 30–48. https://doi.org/10.1017/s0332586521000068.
- Hofmann, Valentin, Pratyusha Ria Kalluri, Dan Jurafsky & Sharese King. 2024. AI generates covertly racist decisions about people based on their dialect. *Nature*. https://doi.org/10.1038/s41586-024-07856-5.
- Hornsby, Michael. 2022. Focus groups. In Ruth Kircher & Lena Zipp (eds.), *Research methods in language attitudes*, 114–128. Cambridge: Cambridge University Press. https://doi.org/10.1017/9781108867788.011.
- Irvine, Judith T. & Susan Gal. 2000. Language ideology and linguistic differentiation. In Paul V. Kroskrity (ed.), *Regimes of language: Ideologies, polities, and identities* (School of American Research Advanced Seminar Series), 35–83. Santa Fe, Oxford: School of American Research Press.

- Jacobs, Arthur M. 2017. Quantifying the beauty of words: A neurocognitive poetics perspective. *Frontiers in Human Neuroscience* 11: 622. https://doi.org/10.3389/fnhum.2017.00622.
- Kalin, Rudof, Donald S. Rayko & Norah Love. 1980. The perception and evaluation of job candidates with four different ethnic accents. In Howard Giles, W. P. Robinson & Philip M. Smith (eds.), *Language: Social psychological perspectives*, 197–202. Oxford: Pergamon Press. https://doi.org/10.1016/B978-0-08-024696-3.50034-X.
- Karatsareas, Petros. 2022. Semi-structured interviews. In Ruth Kircher & Lena Zipp (eds.), *Research methods in language attitudes*, 99–113. Cambridge: Cambridge University Press. https://doi.org/10.1017/9781108867788.010.
- Kawahara, Shigeto, Mahayana C. Godoy & Gakuji Kumagai. 2021. English speakers can infer Pokémon types based on sound symbolism. *Frontiers in Psychology* 12: 648948. https://doi.org/10.3389/fpsyg.2021.648948.
- Kircher, Ruth. 2022. Questionnaires to elicit quantitative data. In Ruth Kircher & Lena Zipp (eds.), *Research methods in language attitudes*, 129–144. Cambridge: Cambridge University Press. https://doi.org/10.1017/9781108867788.012.
- Kjeldgaard-Christiansen, Jens, Zac Boyd, Míša Hejná & Mark Ø Iholm Eaton. 2025. Good and evil in the voices of fictional characters. *Journal of Language and Pop Culture*. https://doi.org/10.1075/jlpop.24025.kje.
- Köhler, Wolfgang. 1929. *Gestalt psychology*. New York: Horace Liveright.
- Körtvélyessy, Lívia & Pavol Štekauer. 2024. Introduction: Why onomatopoeia? In Lívia Körtvélyessy & Pavol Štekauer (eds.), *Onomatopoeia in the world's languages* (Comparative Handbooks of Linguistics 10). Berlin, Boston: De Gruyter Mouton. https://doi.org/10.1515/9783111053226.
- Kristiansen, Tore & Howard Giles. 1992. Compliance-gaining as a function of accent: Public requests in varieties of Danish. *International Journal of Applied Linguistics* 2.1: 17–35. https://doi.org/10.1111/j.1473-4192.1992.tb00021.x.

- Kristiansen, Tore. 2011. Attitudes, ideology and awareness. In Ruth Wodak, Barbara Johnstone & Paul Kerswill (eds.), *The SAGE handbook of sociolinguistics*. London: SAGE. https://doi.org/10.4135/9781446200957.
- Kroskrity, Paul V. (ed.). 2000. *Regimes of language: Ideologies, polities, and identities* (School of American Research Advanced Seminar Series). Santa Fe, Oxford: School of American Research Press.
- Kwon, Nahyun. 2016. Empirically observed iconicity levels of English phonaesthemes. *Public Journal of Semiotics* 7.2: 73–93. https://doi.org/10.37693/pjos.2016.7.16470.
- Lambert, Wallace E., Richard C. Hodgson, Robert C. Gardner & Samuel Fillenbaum. 1960. Evaluational reactions to spoken languages. *Journal of Abnormal and Social Psychology* 60: 44–51. https://doi.org/10.1037/h0044430.
- Lev-Ari, Shiri & Boaz Keysar. 2010. Why don't we believe non-native speakers? The influence of accent on credibility. *Journal of Experimental Social Psychology* 46.6: 1093–1096. https://doi.org/10.1016/j.jesp.2010.05.025.
- Lev-Ari, Shiri & Ryan McKay. 2022. The sound of swearing: Are there universal patterns in profanity? *Psychonomic Bulletin & Review*. https://doi.org/10.3758/s13423-022-02202-0.
- Levon, Erez, Devyani Sharma, Yang Ye, Amanda Cardoso & Dominic Watt. 2019. Real-time evaluations of accent and professional competence. Paper presented at *Experimental Approaches to Perception and Production*, Münster, 26–28 September 2019.
- Li, Aini & Gareth Roberts. 2023. Co-occurrence, extension, and social salience: The emergence of indexicality in an artificial language. *Cognitive Science* 47.5: e13290. https://doi.org/10.1111/cogs.13290.

- Lippi-Green, Rosina. 2012. *English with an accent: Language, ideology and discrimination in the United States*, 2nd edn. London, New York: Routledge.
- Loureiro-Rodríguez, Verónica & Elif F. Acar. 2022. The matched-guise technique. In Ruth Kircher & Lena Zipp (eds.), *Research methods in language attitudes*, 185–202. Cambridge: Cambridge University Press. https://doi.org/10.1017/9781108867788.016.
- Maddieson, Ian. 2013a. Consonant inventories. In Matthew S. Dryer & Martin Haspelmath (eds.), *The World Atlas of Language Structures Online*. Zenodo. https://doi.org/10.5281/zenodo.7385533.
- Maddieson, Ian. 2013b. Syllable structure. In Matthew S. Dryer & Martin Haspelmath (eds.), *The World Atlas of Language Structures Online*. Zenodo. https://doi.org/10.5281/zenodo.7385533.
- Malik-Moraleda, Saima, Maya Taliaferro, Steve Shannon, Niharika Jhingan, Sara Swords, David J. Peterson, Paul Frommer, Marc Okrand, Jessie Sams, Ramsey Cardwell, Cassie Freeman & Evelina Fedorenko. 2023. Constructed languages are processed by the same brain mechanisms as natural languages. *BioRxiv*. https://doi.org/10.1101/2023.07.28.550667.
- Mays, David V. 1982. Cross cultural social status perception in speech. *Studies in Second Language Acquisition* 5.1: 52–64. https://doi.org/10.1017/s0272263100004599.
- McLean, Bonnie & Yasamin Motamedi. 2022. A robustness approach to operationalisations of iconicity. Paper presented at *Iconicity Seminar* 2022 (IcoSem2022), 14 November 2022.
- Montgomery, Chris. 2022. Perceptual dialectology. In Ruth Kircher & Lena Zipp (eds.), *Research methods in language attitudes*, 160–182. Cambridge: Cambridge University Press. https://doi.org/10.1017/9781108867788.014.

- Mooshammer, Christine, Dominique Bobeck, Henrik Hornecker, Kierán Meinhardt, Olga Olina, Marie Christin Walch & Qiang Xia. 2023. Does Orkish sound evil? Perception of fantasy languages and their phonetic and phonological characteristics. *Language and Speech*: 238309231202944. https://doi.org/10.1177/00238309231202944.
- Moran, Steven & Daniel McCloy (eds.). 2019. *PHOIBLE 2.0*. Jena: Max Planck Institute for the Science of Human History. https://phoible.org/.
- Moreau, Marie-Louise, Ndiassé Thiam, Bernard Harmegnies & Kathy Huet. 2014. Can listeners assess the sociocultural status of speakers who use a language they are unfamiliar with? A case study of Senegalese and European students listening to Wolof speakers. *Language in Society* 43.3: 333–348. https://doi.org/10.1017/s0047404514000220.
- Munson, Benjamin. 2007. The acoustic correlates of perceived masculinity, perceived femininity, and perceived sexual orientation. *Language and Speech* 50.1: 125–142. https://doi.org/10.1177/00238309070500010601.
- Nielsen, Alan K. S. & Mark Dingemanse. 2021. Iconicity in word learning and beyond: A critical review. *Language and Speech* 64.1: 52–72. https://doi.org/10.1177/0023830920914339.
- Occhino, Corrine, Benjamin Anible, Erin Wilkinson & Jill P. Morford. 2017. Iconicity is in the eye of the beholder. *Gesture* 16.1: 100–126. https://doi.org/10.1075/gest.16.1.04occ.
- O'Connor, Jillian J. M. & Pat Barclay. 2017. The influence of voice pitch on perceptions of trustworthiness across social contexts. *Evolution and Human Behavior* 38.4: 506-512. https://doi.org/10.1016/j.evolhumbehav.2017.03.001.

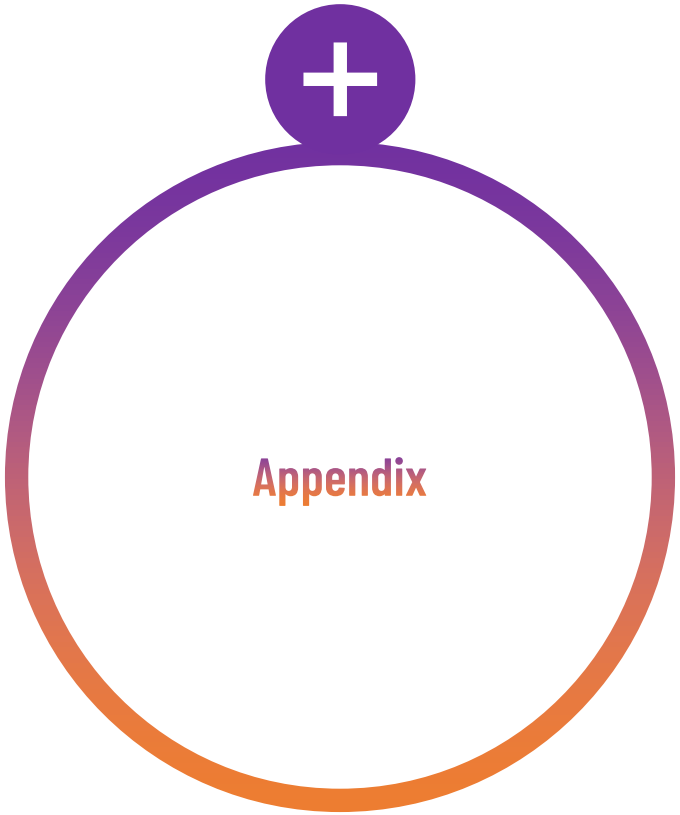
- Ohala, John J. 2010. The frequency code underlies the sound-symbolic use of voice pitch. In Leanne Hinton, Johanna Nichols & John J. Ohala (eds.), *Sound symbolism*, 325–347. Cambridge: Cambridge University Press. https://doi.org/10.1017/CBO9780511751806.022.
- Parker, Steve. 2008. Sound level protrusions as physical correlates of sonority. *Journal of Phonetics* 36.1: 55–90. https://doi.org/10.1016/j.wocn.2007.09.003.
- Peirce, Charles S. 1958. *Selected writings* (Dover Books on Philosophy). New York: Dover.
- Preston, Dennis R. 1999. A language attitude approach to the perception of regional variety. In Dennis R. Preston (ed.), *Handbook of perceptual dialectology*, 359–373. Amsterdam: John Benjamins. https://doi.org/10.1075/z.hpd1.30pre.
- Preston, Dennis R. 2017. Perceptual dialectology. In Charles Boberg, John Nerbonne & Dominic Watt (eds.), *The handbook of dialectology*, 177–203. Oxford: Wiley. https://doi.org/10.1002/9781118827628.ch10.
- Podhorodecka, Joanna. 2007. Is lámatyáve a linguistic heresy? In Elżbieta Tabakowska, Christina Ljungberg & Olga Fischer (eds.), *Insistent images* (Iconicity in Language and Literature 5), 103–110. Amsterdam: John Benjamins. https://doi.org/10.1075/ill.5.11pod.
- Purnell, Thomas, William Idsardi & John Baugh. 1999. Perceptual and phonetic experiments on American English dialect identification. *Journal of Language and Social Psychology* 18.1: 10–30. https://doi.org/10.1177/0261927X99018001002.
- Ramachandran, Vilayanur S. & Edward Hubbard. 2001. Synaesthesia — A window into perception, thought and language. *Journal of Consciousness Studies* 8.12: 3–34.

- Reiterer, Susanne M., Vita Kogan, Annemarie Seither-Preisler & Gašper Pesek. 2020. Foreign language learning motivation: Phonetic chill or Latin lover effect? Does sound structure or social stereotyping drive FLL? In Kara D. Federmeier & Hsu-Wen Huang (eds.), *Adult and second language learning* (Psychology of Learning and Motivation 72), 165–205. Cambridge; San Diego; Oxford; London: Elsevier.
- Rickford, John R. & Sharese King. 2016. Language and linguistics on trial: Hearing Rachel Jeantel (and other vernacular speakers) in the courtroom and beyond. *Language* 92.4: 948–988. https://doi.org/10.1353/LAN.2016.0078.
- Rosseel, Laura. 2022. The implicit association test paradigm. In Ruth Kircher & Lena Zipp (eds.), *Research methods in language attitudes*, 250–268. Cambridge: Cambridge University Press. https://doi.org/10.1017/9781108867788.020.
- Ryan, Ellen B. 1973. Subjective reactions toward accented speech. In Roger W. Shuy & Ralph W. Fasold (eds.), *Language attitudes: Current trends and prospects*, 60–73. Washington: Georgetown University Press.
- Sachdev, Itesh, Nita Elmufti & Pat Collins. 1998. Oral assessment and accent evaluation: Some British data. In Rama K. Agnihotri, Amrit L. Khanna & Itesh Sachdev (eds.), *Social psychological perspectives on second language learning* (Research in Applied Linguistics 4), 187–203. New Delhi, London: SAGE.
- Schüppert, Anja, Nanna H. Hilton & Charlotte Gooskens. 2015. Swedish is beautiful, Danish is ugly? Investigating the link between language attitudes and spoken word recognition. *Linguistics* 53.2. https://doi.org/10.1515/ling-2015-0003.
- Sebeok, Thomas A. 2001. *Signs: An introduction to semiotics*, 2nd edn. (Toronto Studies in Semiotics and Communication). Toronto, London: University of Toronto Press.

- Silverstein, Michael. 2003. Indexical order and the dialectics of sociolinguistic life. *Language & Communication* 23.3–4: 193–229. https://doi.org/10.1016/S0271-5309(03)00013-2.
- Stein, Simon D. 2023. Space rednecks, robot butlers, and feline foreigners: Language attitudes toward varieties of English in videogames. *Games and Culture* 18.8. https://doi.org/10.1177/15554120221150156.
- Stewart, Mark A., Ellen B. Ryan & Howard Giles. 1985. Accent and social class effects on status and solidarity evaluations. *Personality and Social Psychology Bulletin* 11.1: 98–105. https://doi.org/10.1177/0146167285111009.
- Tamasi, Susan & Lamont Antieau. 2014. *Language and linguistic diversity in the US*. New York: Routledge. https://doi.org/10.4324/9780203154960.
- Thomas, Erik R. & Jeffrey Reaser. 2004. Delimiting perceptual cues used for the ethnic labeling of African American and European American voices. *Journal of Sociolinguistics* 8.1: 54–87. https://doi.org/10.1111/j.1467-9841.2004.00251.x.
- van Bezooijen, Renée. 1988. The relative importance of pronunciation, prosody, and voice quality for the attribution of social status and personality characteristics. *Language attitudes in the Dutch language area*, 85–104. https://doi.org/10.1515/9783110857856.85.
- Walsh, Olivia. 2022. Discourse analysis of print media. In Ruth Kircher & Lena Zipp (eds.), *Research methods in language attitudes*, 19–34. Cambridge: Cambridge University Press. https://doi.org/10.1017/9781108867788.004.
- Wang, Tianheng, Søren Wichmann, Quansheng Xia, Qibin Ran & Emilio Moran. 2023. Temperature shapes language sonority: Revalidation from a large dataset. *PNAS Nexus* 2.12. https://doi.org/10.1093/pnasnexus/pgad384.
- Weinberger, Steven. 2015. *Speech Accent Archive*. George Mason University. http://accent.gmu.edu.

- Williams, Frederick. 1973. Some research notes on dialect attitudes and stereotypes. In Roger W. Shuy & Ralph W. Fasold (eds.), *Language attitudes: Current trends and prospects*, 113–128. Washington: Georgetown University Press.
- Winter, Bodo, Paula Pérez-Sobrino & Lucien Brown. 2019. The sound of soft alcohol: Crossmodal associations between interjections and liquor. *PLoS ONE* 14.8. https://doi.org/10.1371/journal.pone.0220449.
- Winter, Bodo & Marcus Perlman. 2021. Size sound symbolism in the English lexicon. *Glossa: A Journal of General Linguistics* 6.1: 1–13. https://doi.org/10.5334/gjgl.1646.
- Winter, Bodo, Grace E. Oh, Iris Hübscher, Kaori Idemaru, Lucien Brown, Pilar Prieto & Sven Grawunder. 2021. Rethinking the frequency code: A meta-analytic review of the role of acoustic body size in communicative phenomena. *Philosophical Transactions of the Royal Society B: Biological Sciences* 376.1840: 20200400. https://doi.org/10.1098/rstb.2020.0400.
- Winter, Bodo, Márton Sóskuthy, Marcus Perlman & Mark Dingemanse. 2022. Trilled /r/ is associated with roughness, linking sound and touch across spoken languages. *Scientific Reports* 12.1: 1035. https://doi.org/10.1038/s41598-021-04311-7.
- Wong, Li S., Jinhwan Kwon, Zane Zheng, Suzy J. Styles, Maki Sakamoto & Ryo Kitada. 2022. Japanese sound-symbolic words for representing the hardness of an object are judged similarly by Japanese and English speakers. *Frontiers in sychology* 13: 830306. https://doi.org/10.3389/fpsyg.2022.830306.
- Wright, Kelly & Kevin McGowan. 2018. Covert segregation: Investigating dialect discrimination in the housing market. Paper presented at *Linguistic Society of America Annual Meeting* 2018, Grand America Salt Lake City, January 4–7.

- Zipp, Lena. 2022. Questionnaires to elicit qualitative data. In Ruth Kircher & Lena Zipp (eds.), *Research methods in language attitudes*, 145–159. Cambridge: Cambridge University Press. https://doi.org/10.1017/9781108867788.013.



Appendix

Language attitudes

French sounds beautiful and romantic.

German sounds harsh and aggressive.

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 sweary', /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

ICONICITY

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

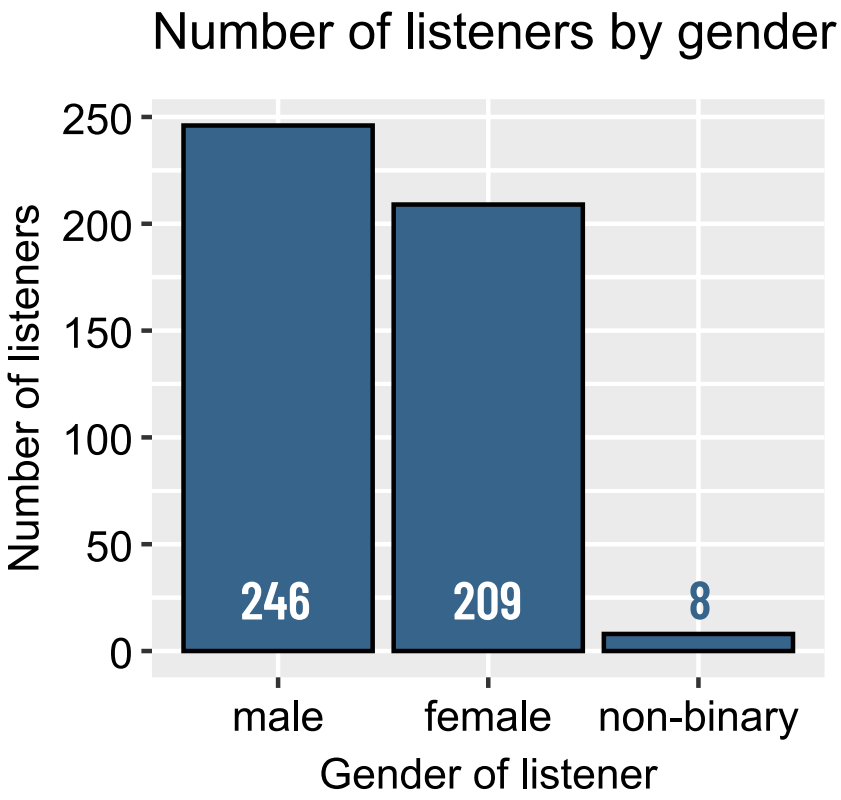
Natlangs are rated as more or less beautiful depending on familiarity, not sounds, phonetics doesn't play a role — Anikin et al. 2023

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

- 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

Participant demographics n = 463



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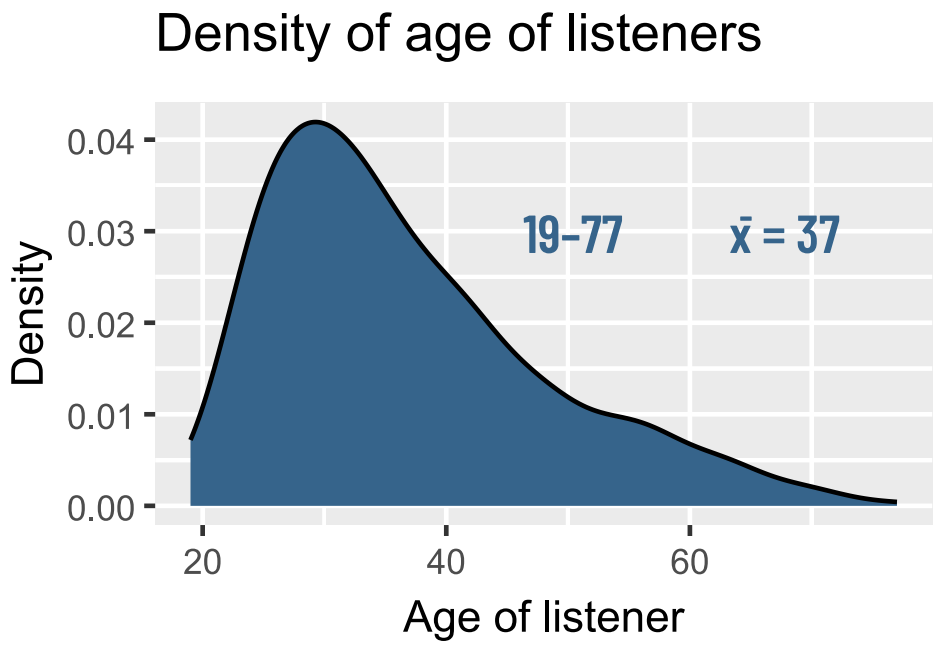

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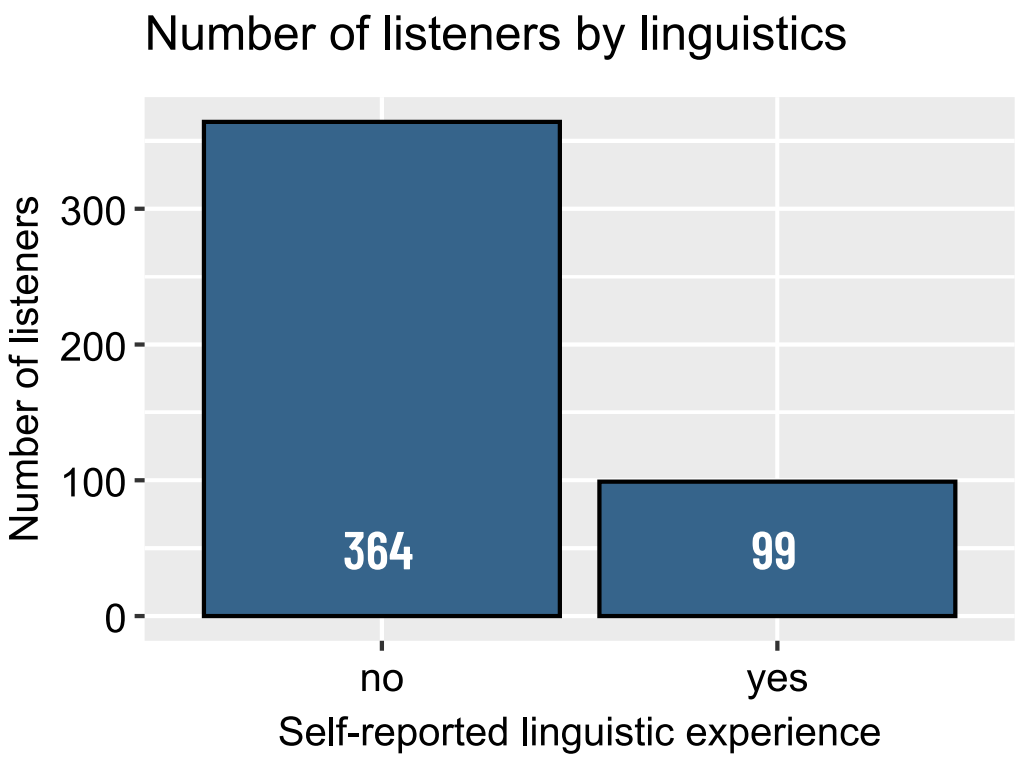

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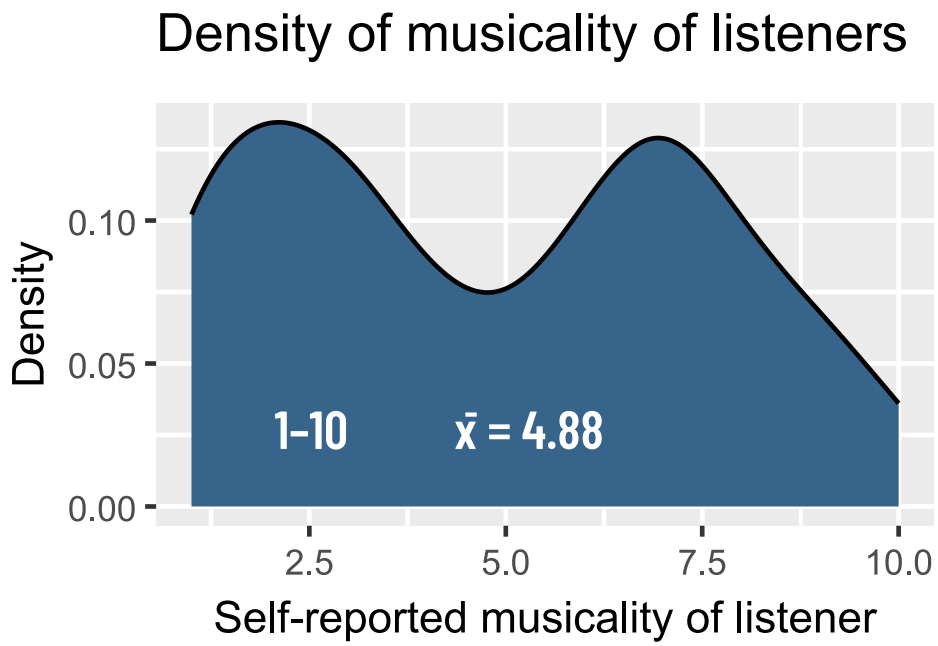

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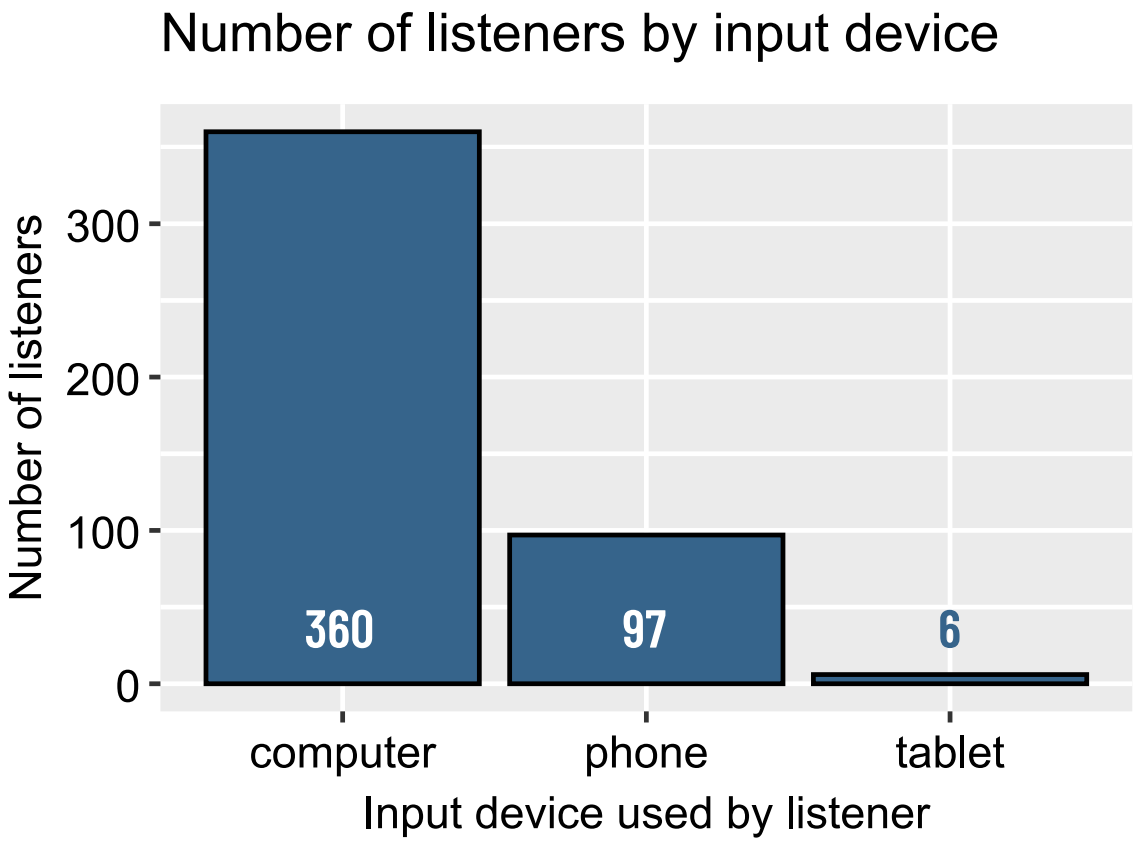

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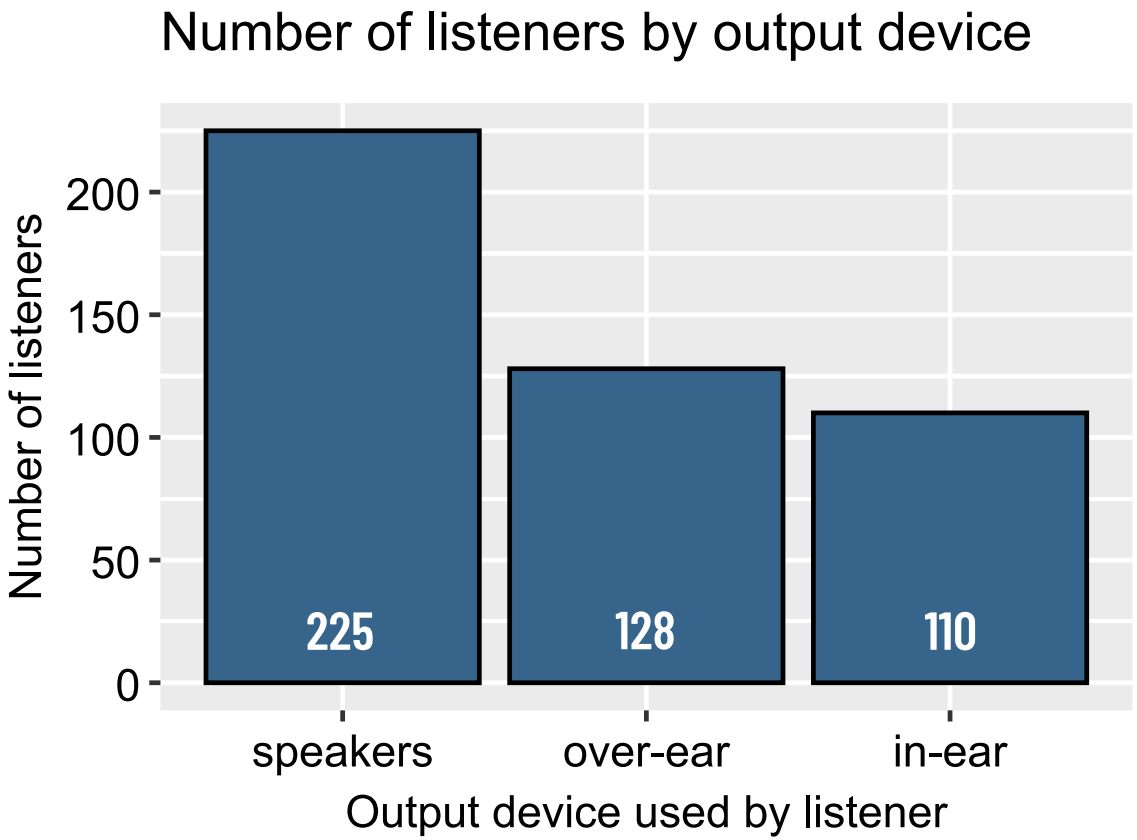

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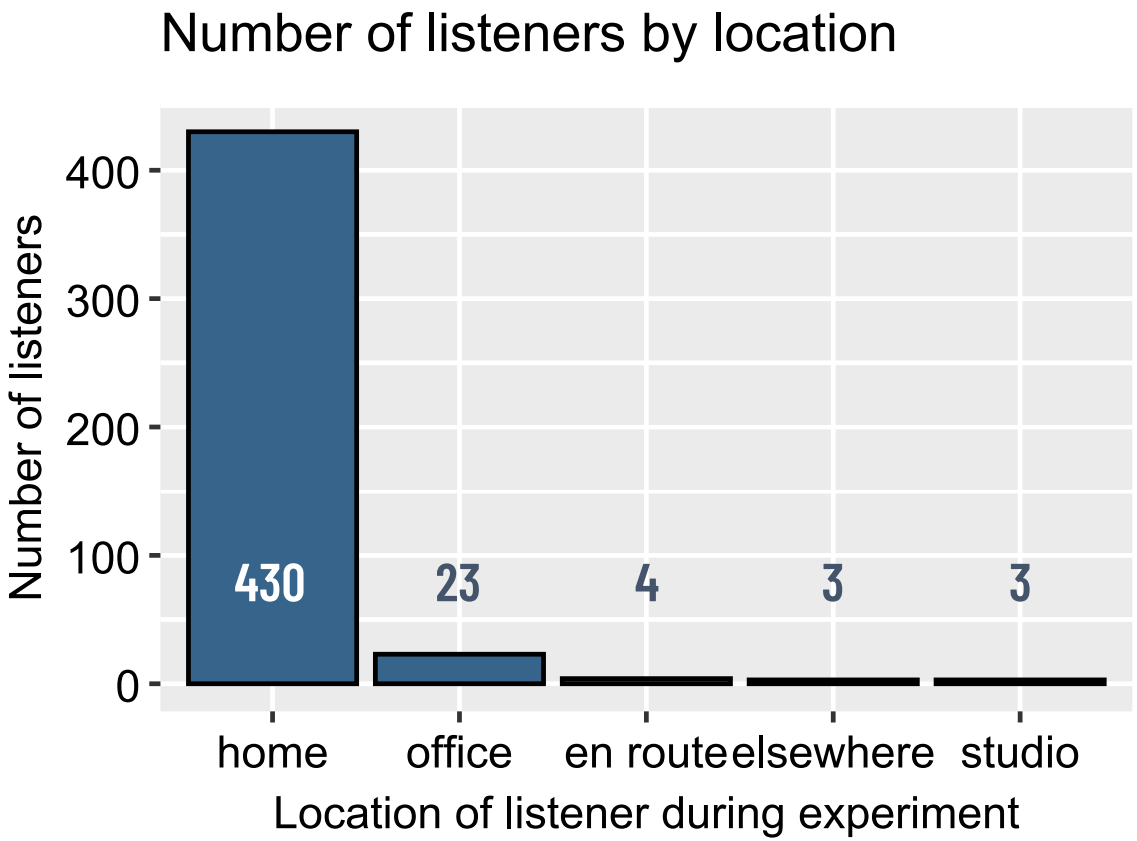

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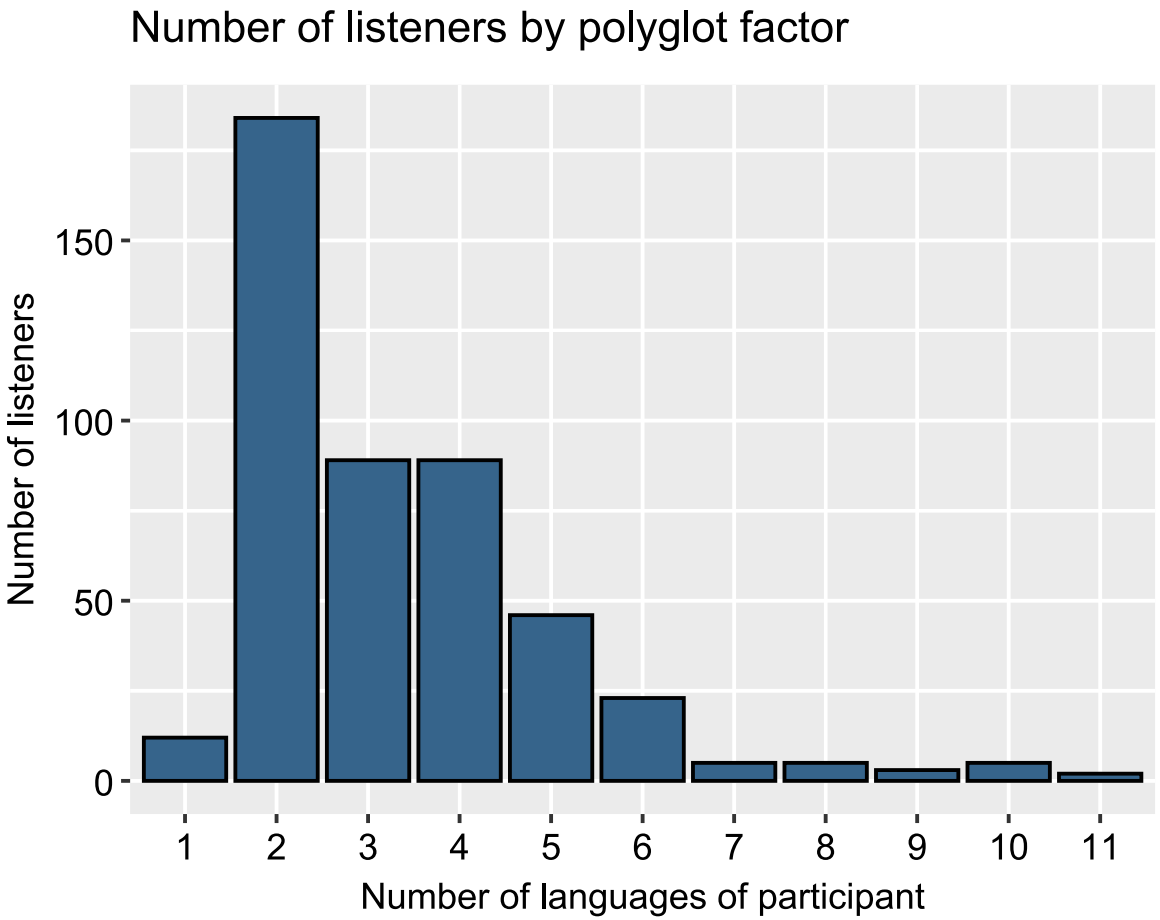

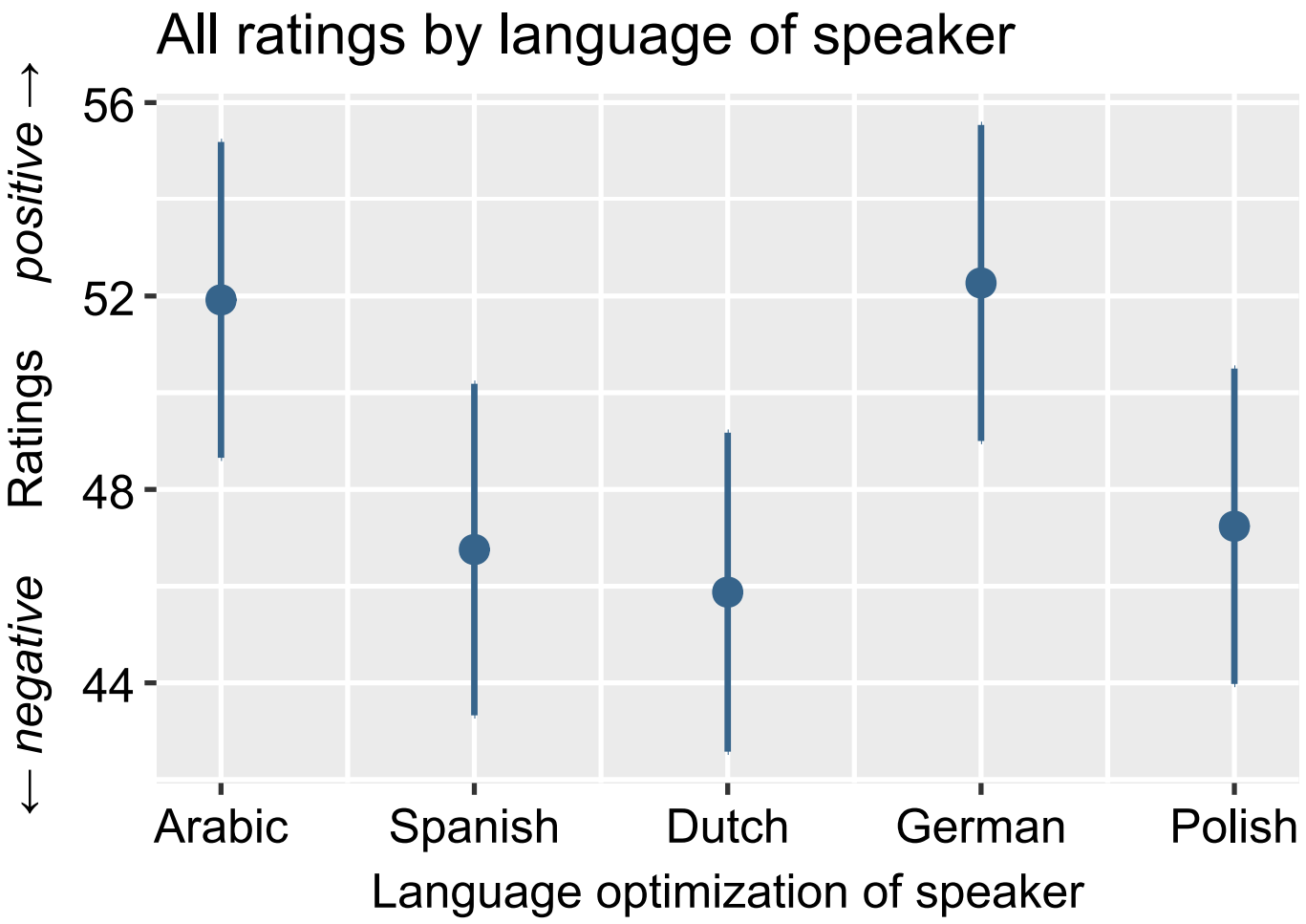
All ratings by language of speaker
← negative Ratings positive →
56
52
48
44
Arabic
Spanish
Dutch
German
Polish
Language optimization of speaker
Language for model with all scales

Variable ▽
sonority ~~int~~
lson^{H} x son^{H}
sonority$^{H[H]}$
sonority$^{H[L]}$
lsonority$^{H[H]}$
lsonority$^{H[L]}$
recognition^{AF}
recognition^{GE}
recognition^{ME}
recognition^{RO}
age
familiarity
vgender$^{M[IM]}$
vgender$^{M[IF]}$
lgender$^{M[VM]}$
lgender$^{M[VF]}$
polyglot

terms not included in this table: lsonority^{UN} language$^{NL, AR, DE, PL, ES}$ linguistics musicality input… output… location…

Variable ▽	All scales	Pleasantness	Beauty	Softness	Shape	Education	Intelligence	Friendliness	Ordinariness	Goodness	Eroticism
sonority ~~int~~											
lson^{H} x son^{H}											
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Variable ▽	All scales	Pleasantness	Beauty	Softness	Shape	Education	Intelligence	Friendliness	Ordinariness	Goodness	Eroticism
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terms not included in this table: lsonority^{UN} language$^{NL, AR, DE, PL, ES}$ linguistics musicality input… output… location…

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lgender$^{M[VM]}$											
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Variable ▽	All scales	Pleasantness	Beauty	Softness	Shape	Education	Intelligence	Friendliness	Ordinariness	Goodness	Eroticism
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vgender$^{M[IF]}$	***	.	*	*				**		.	***
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polyglot											

terms not included in this table: lsonority^{UN} language$^{NL, AR, DE, PL, ES}$ linguistics musicality input… output… location…

Variable ▽	All scales	Pleasantness	Beauty	Softness	Shape	Education	Intelligence	Friendliness	Ordinariness	Goodness	Eroticism
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lson^{H} x son^{H}	*							.			
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sonority$^{H[L]}$	***	*	**	***	***	**	***	**	***	*	***
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lsonority$^{H[L]}$						*					.
recognition^{AF}	***			.		*	.		.		
recognition^{GE}											
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recognition^{RO}	**			.				*		.	
age	***	***	***	***	***	***	***	**	***	*	*
familiarity	***	***	***	***	***	***	***	***	***	***	***
vgender$^{M[IM]}$	***	**	***	***		*		***		**	***
vgender$^{M[IF]}$	***	.	*	*				**		.	***
lgender$^{M[VM]}$	**	*	***	*			.		**	.	
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terms not included in this table: lsonority^{UN} language$^{NL, AR, DE, PL, ES}$ 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

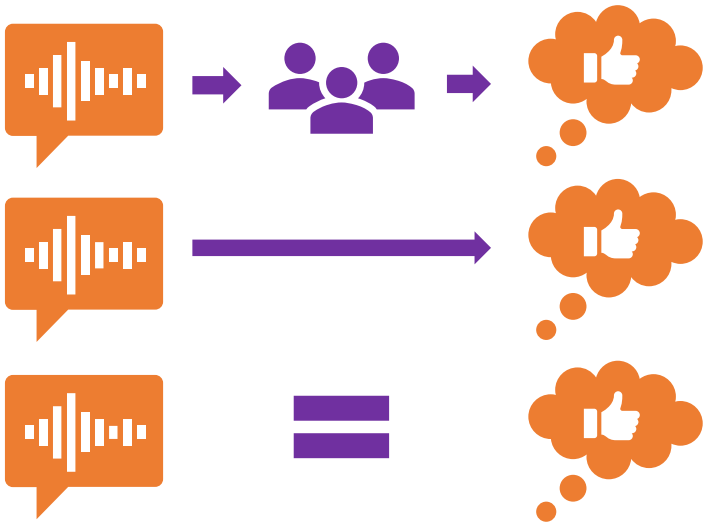
Listeners evaluate the same linguistic properties differently

- 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 & Dingemanse, 2021

The ontology of the rating scales

Is everything underlyingly simply positive or negative?

Maybe not:

- e.g., trustworthiness independent from attractiveness for pitch — O'Connor & Barclay 2017
- e.g., participants distinguish between moral descriptors — Kjeldgaard-Christiansen et al. 2025

Maybe yes:

- round is positive, spiky is negative — Domizi 2024
- soft, smooth, sweet are positive, hard, rough, bitter is negative — Winter et al. 2019
- here: all scales correlate with the basic scale pleasantness — the present study

Limitations

- social salience – do we need it, after all? Li & Roberts 2023
- 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 Domizi 2024

/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 jesoa 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 control condition

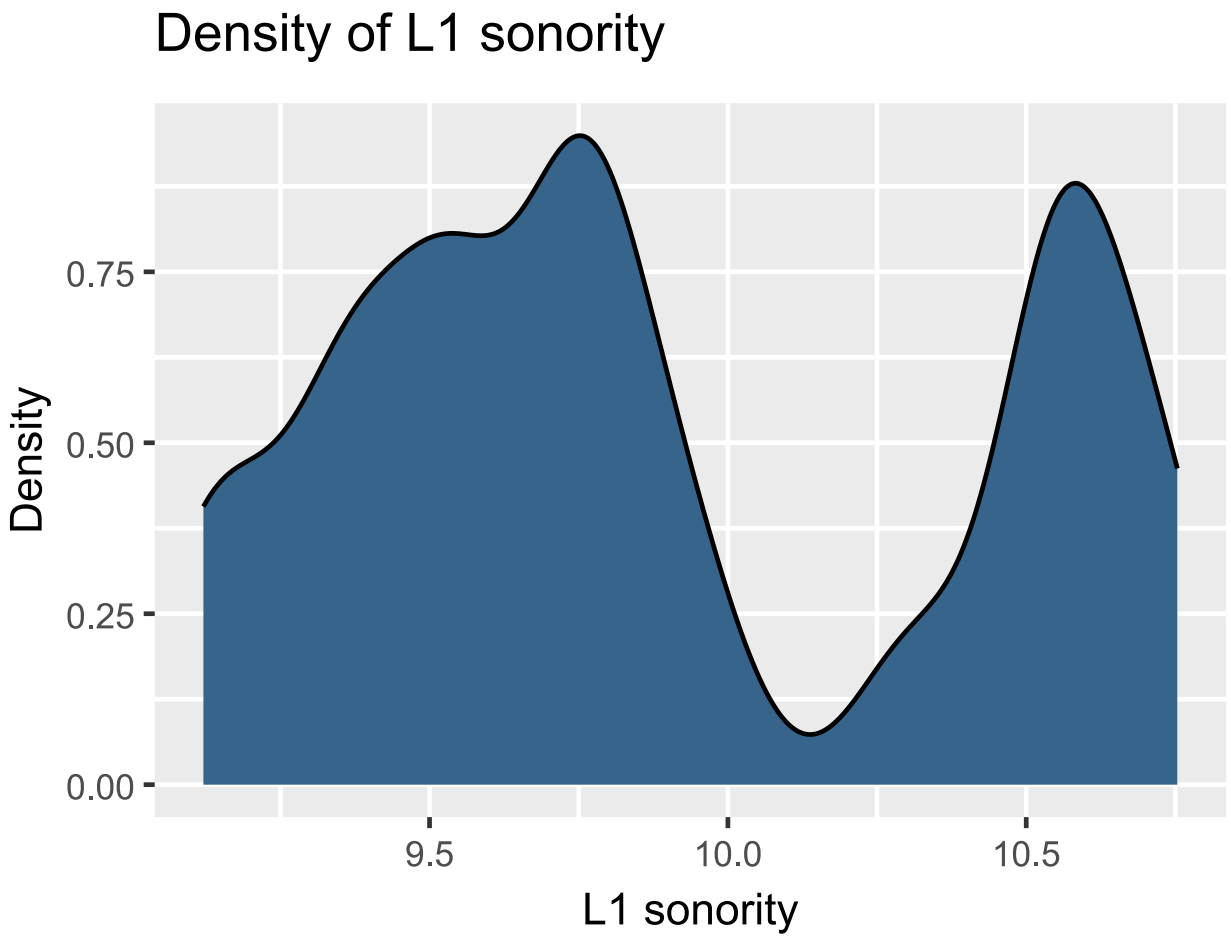
<speak> <phoneme alphabet="ipa" ph="mo mutu kima le napo soteoi lubita bisi mabumopi tapesi satiu sue sobabise si painu nopu wupeto je sipawi bu nake muba no pa"></phoneme> <break strength="strong"/> <phoneme alphabet="ipa" ph=" pe ne jako u po munilawi o jetuwi nu mo kuloa wiwiji somawejo"></phoneme> <break strength="strong"/> <phoneme alphabet="ipa" ph=" nosobape juji pu kopopobo waka toajonu mi takeka jabakeja tisu tuelu kepe jewo luwo jesoa 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

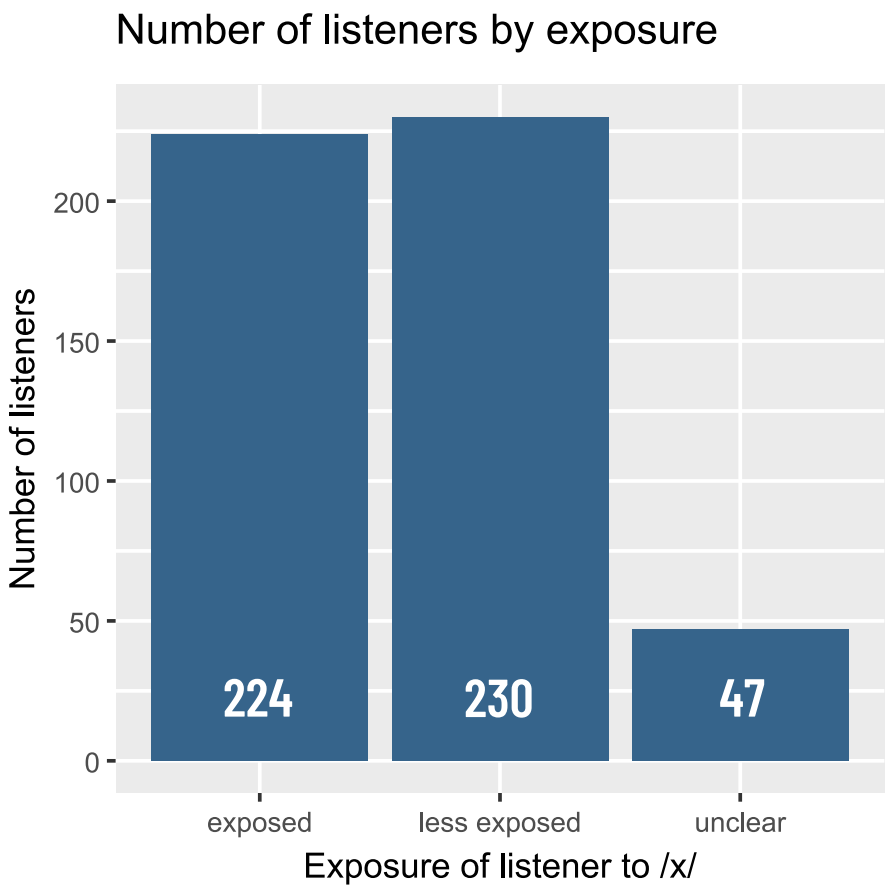
Example for target condition

<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=" teloju 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>

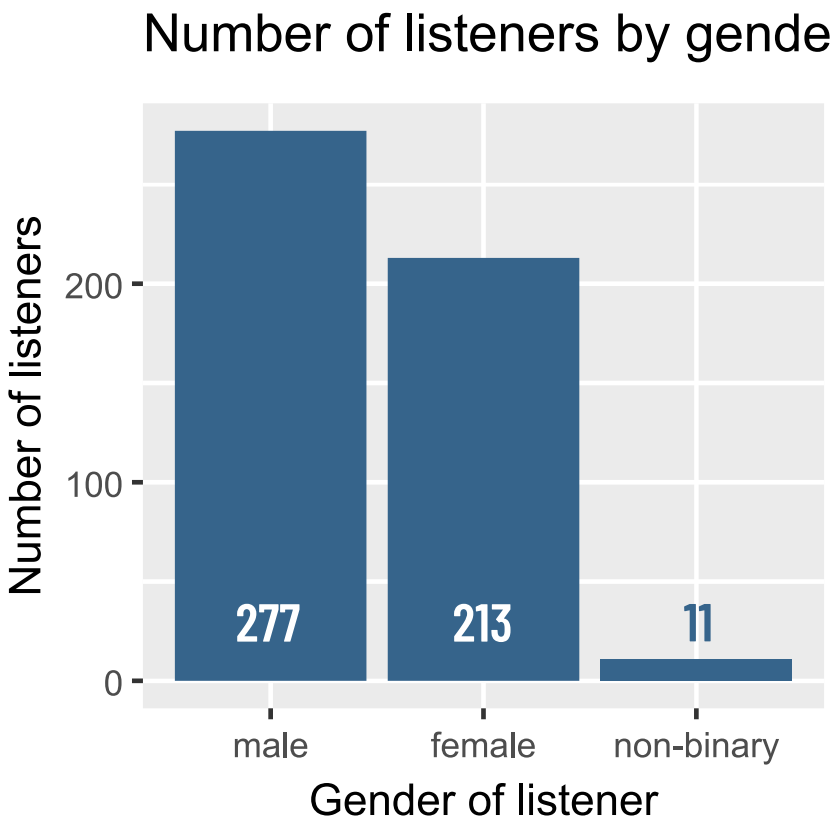
/X/ Participant quota sampling by FIRST LANGUAGE Prolific



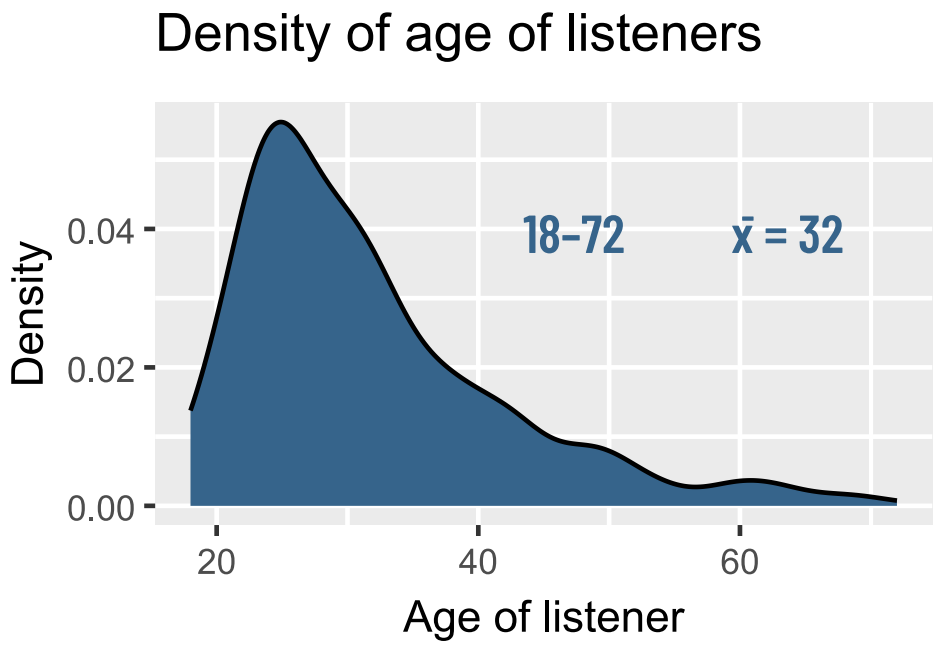
/x/ Participant quota sampling by FIRST LANGUAGE Prolific



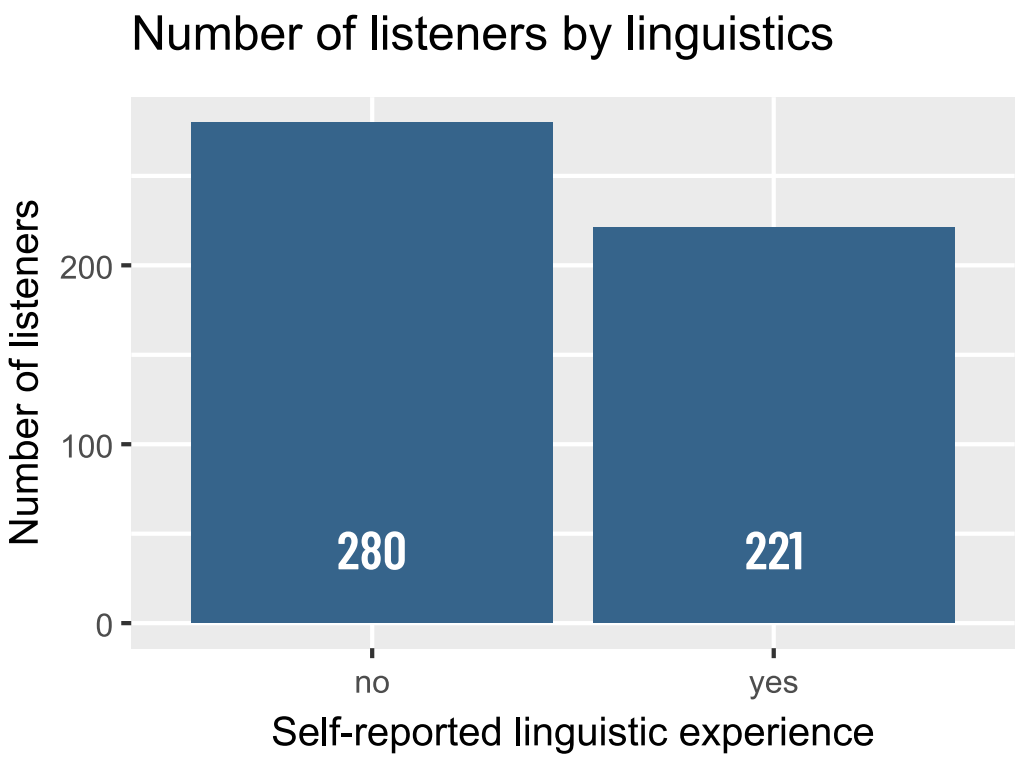
/X/ Participant quota sampling by FIRST LANGUAGE Prolific



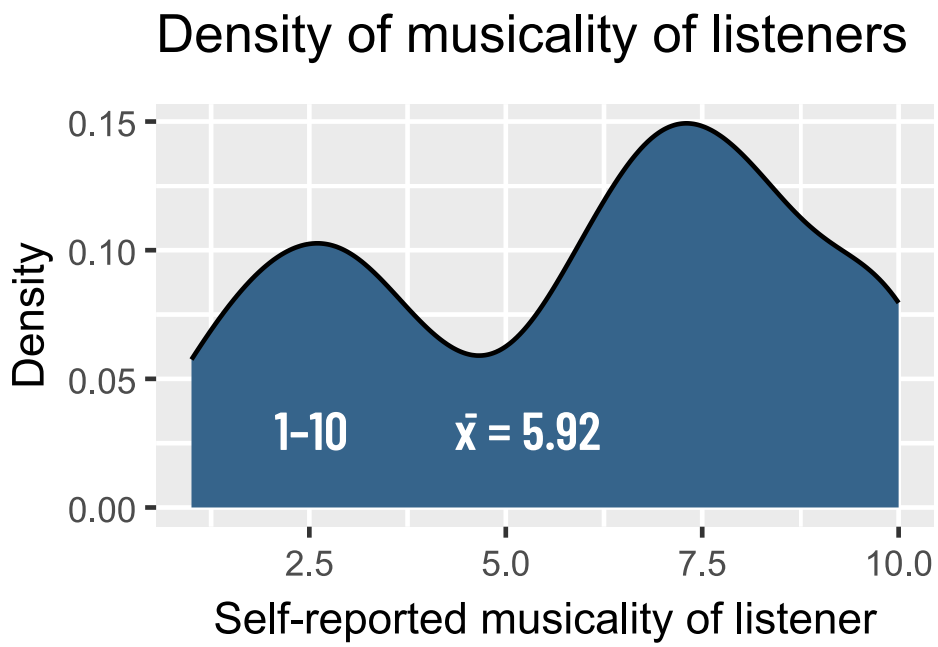
/X/ Participant quota sampling by FIRST LANGUAGE Prolific



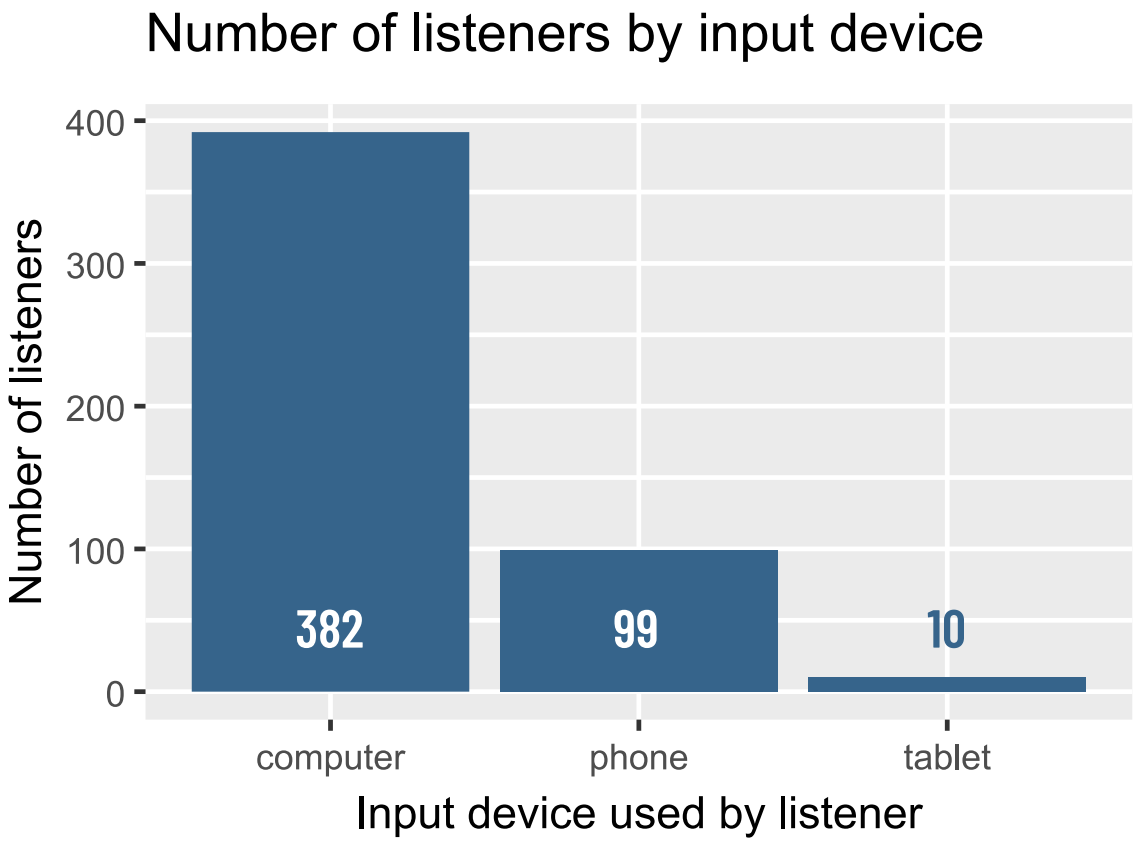
/X/ Participant quota sampling by FIRST LANGUAGE Prolific



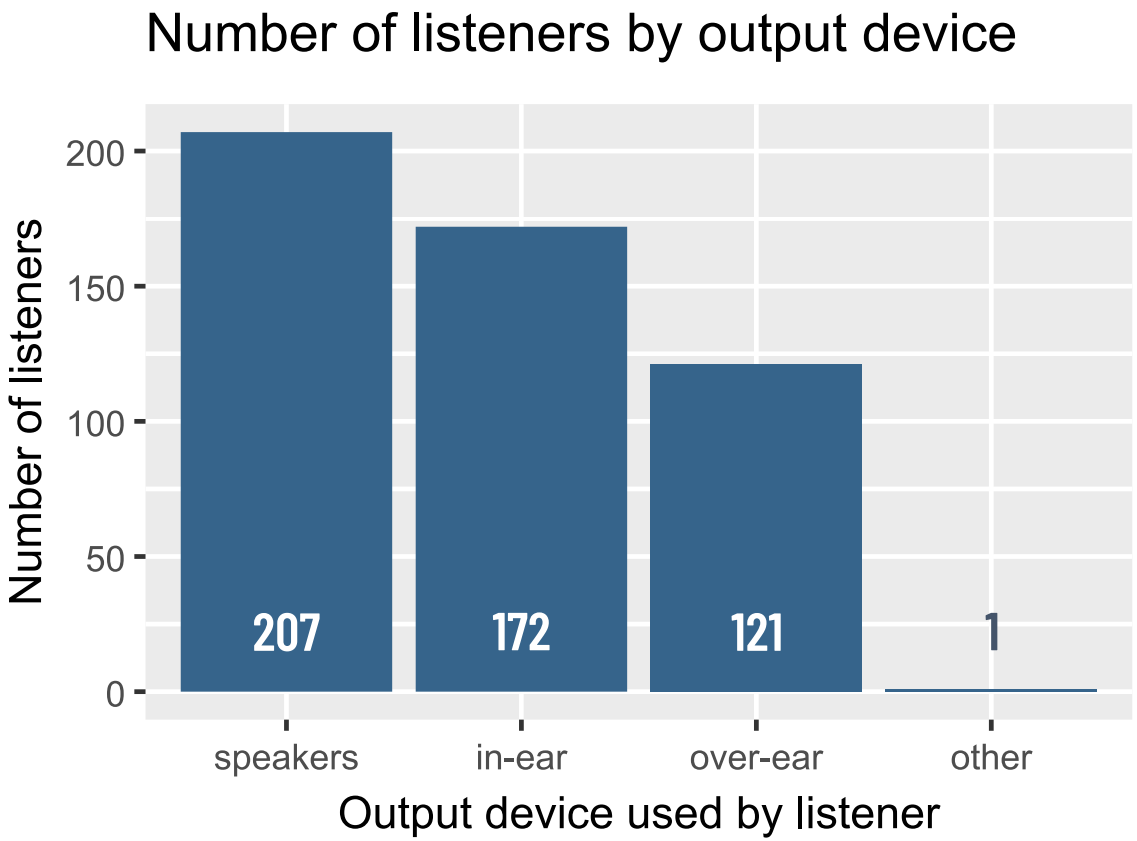
/X/ Participant quota sampling by FIRST LANGUAGE Prolific



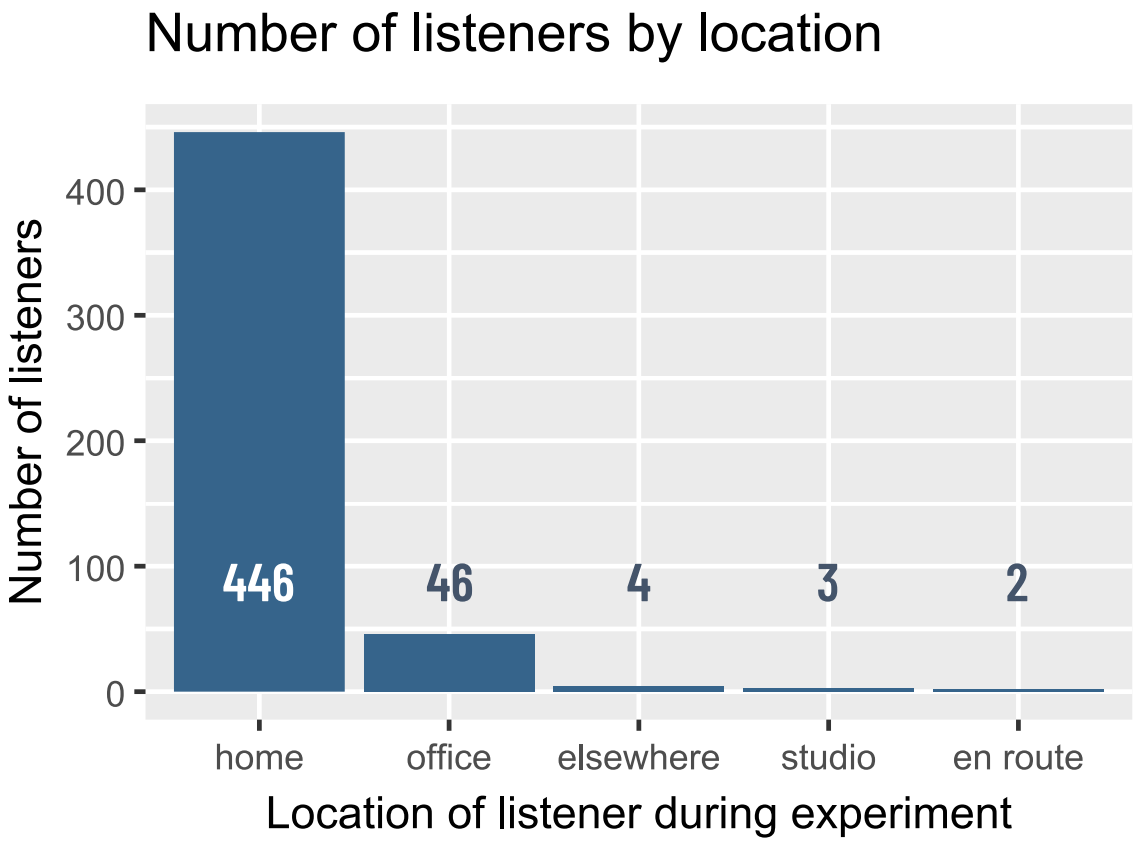
/X/ Participant quota sampling by FIRST LANGUAGE Prolific



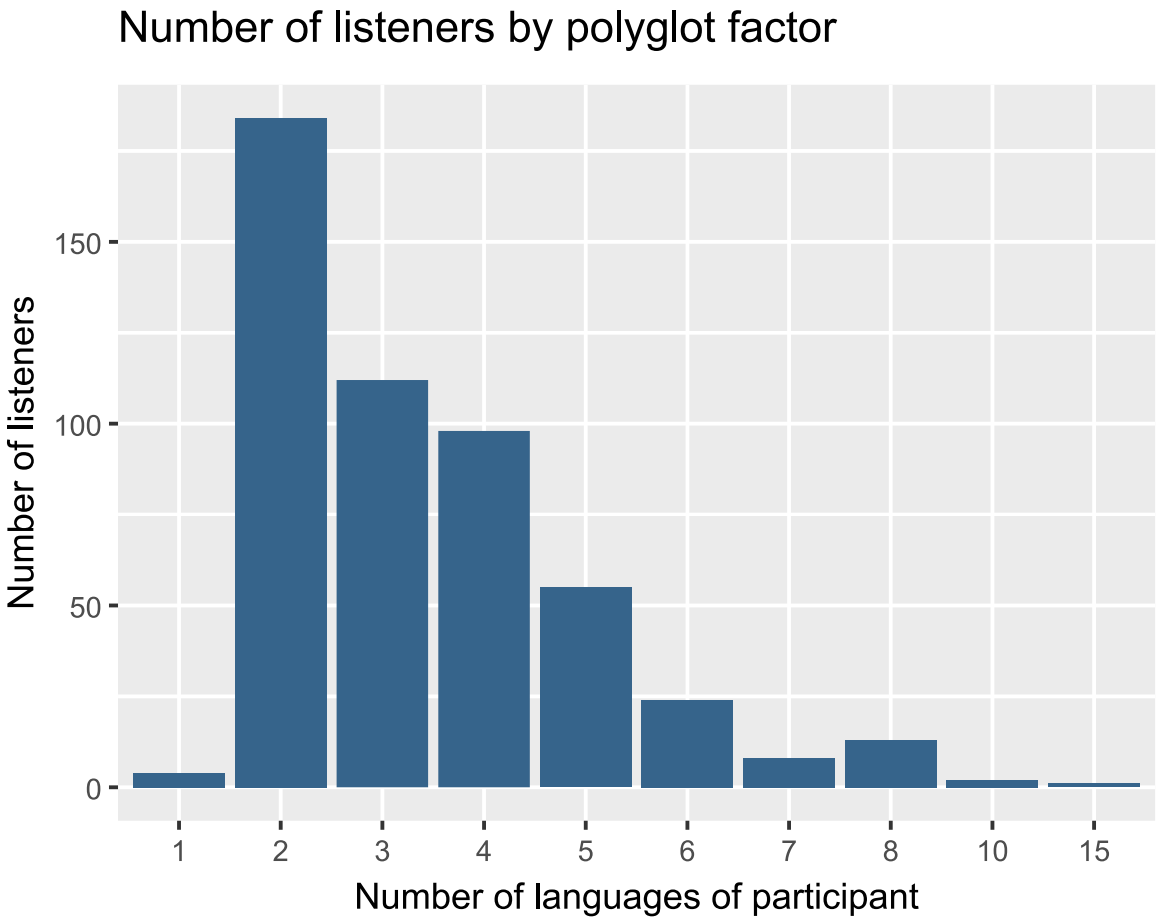
/X/ Participant quota sampling by FIRST LANGUAGE Prolific

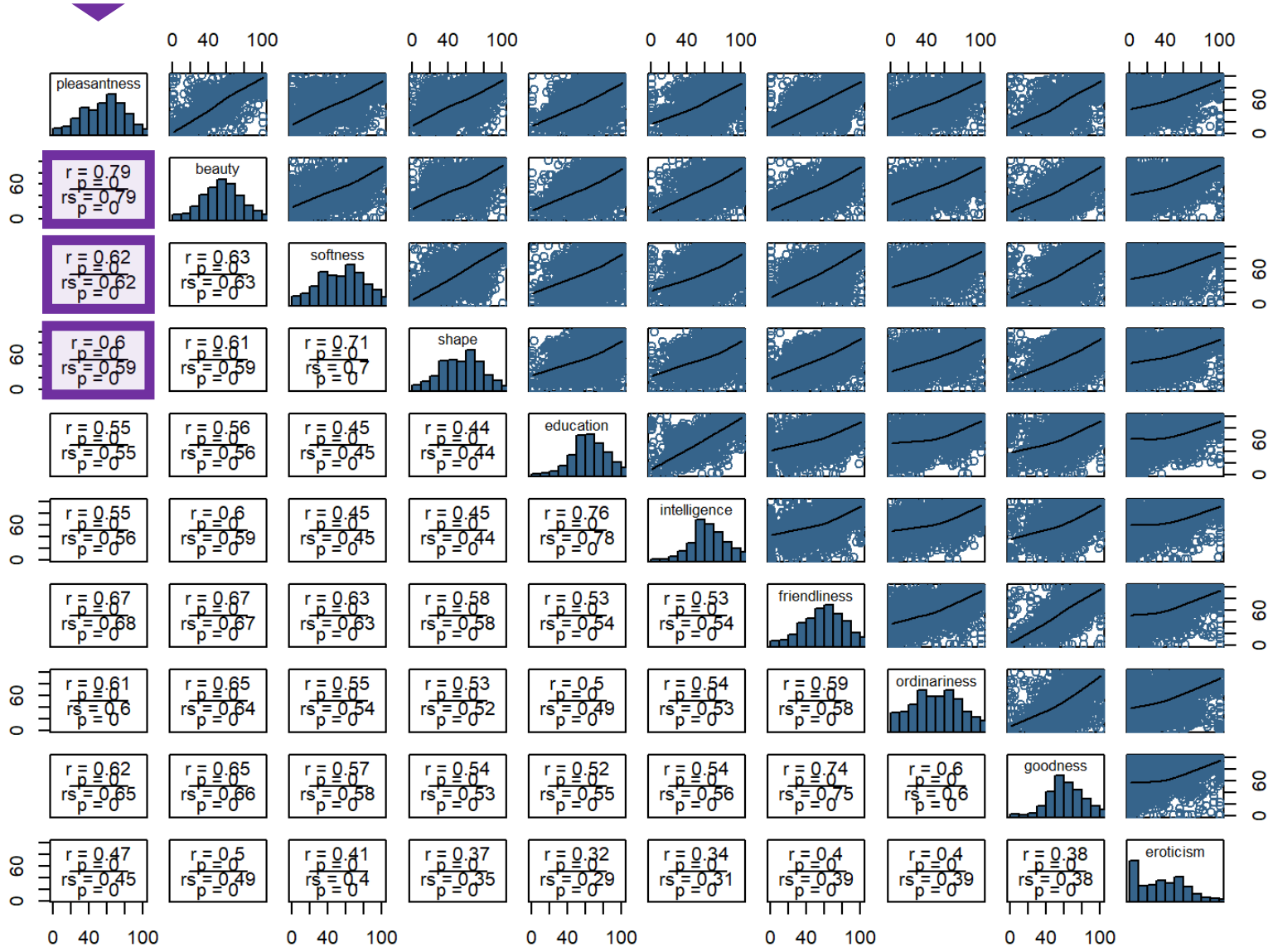


/X/ Participant quota sampling by FIRST LANGUAGE Prolific



/X/ Participant quota sampling by FIRST LANGUAGE Prolific





/x/

Correlation matrix of all semantic scales

/x/

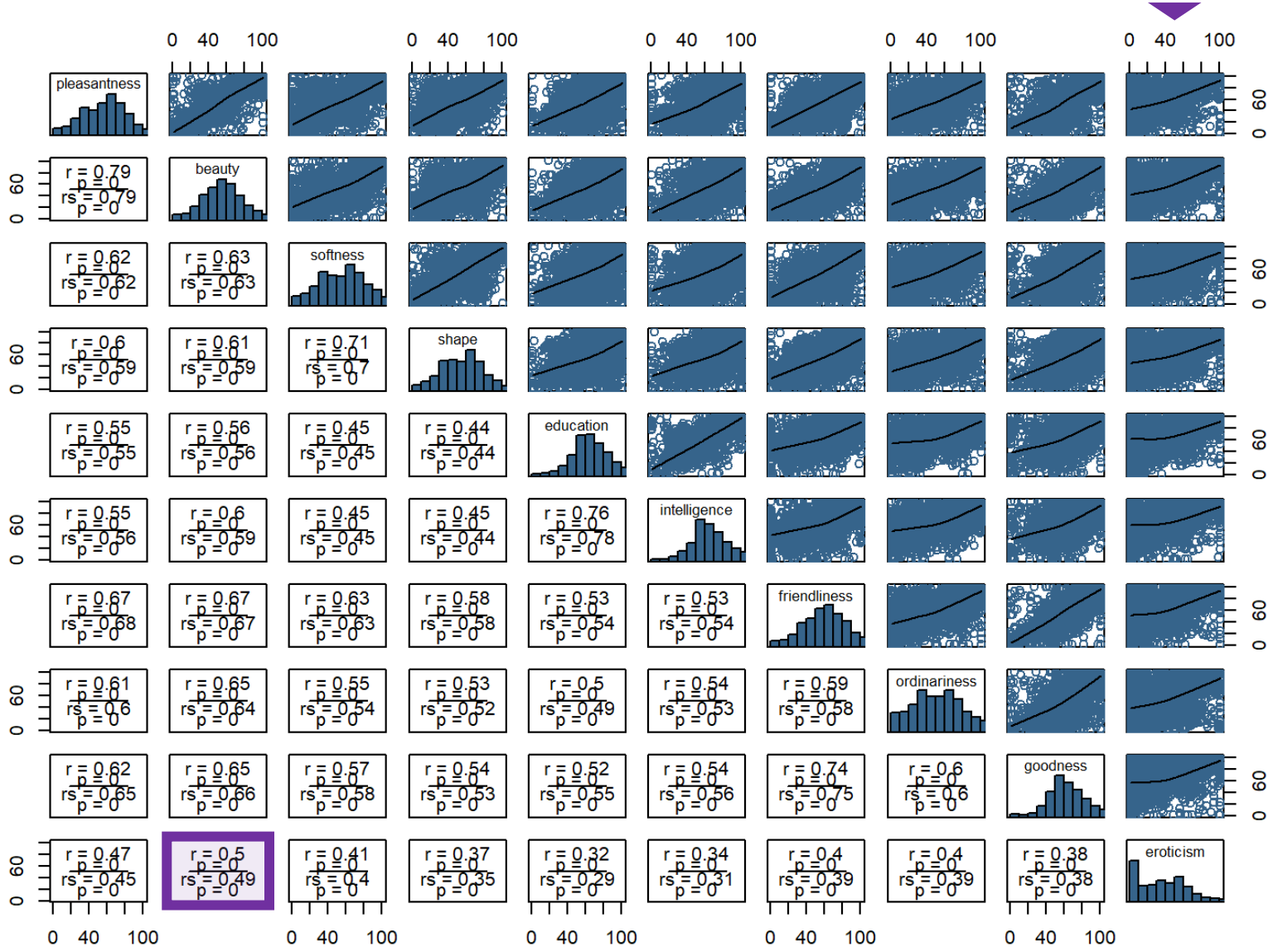
Correlation matrix of all semantic scales

/x/

Correlation matrix of all semantic scales

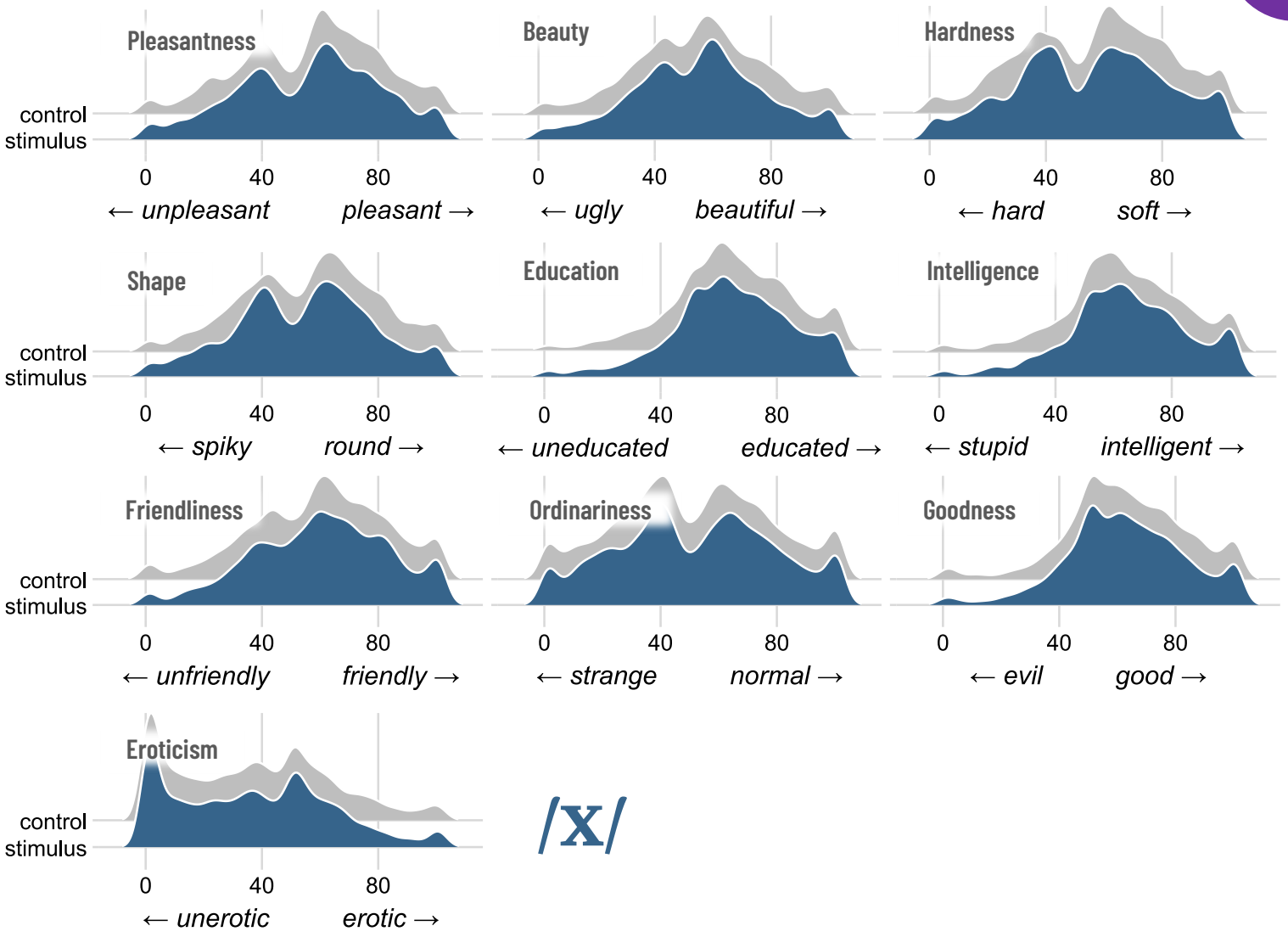
/x/

Correlation matrix of all semantic scales



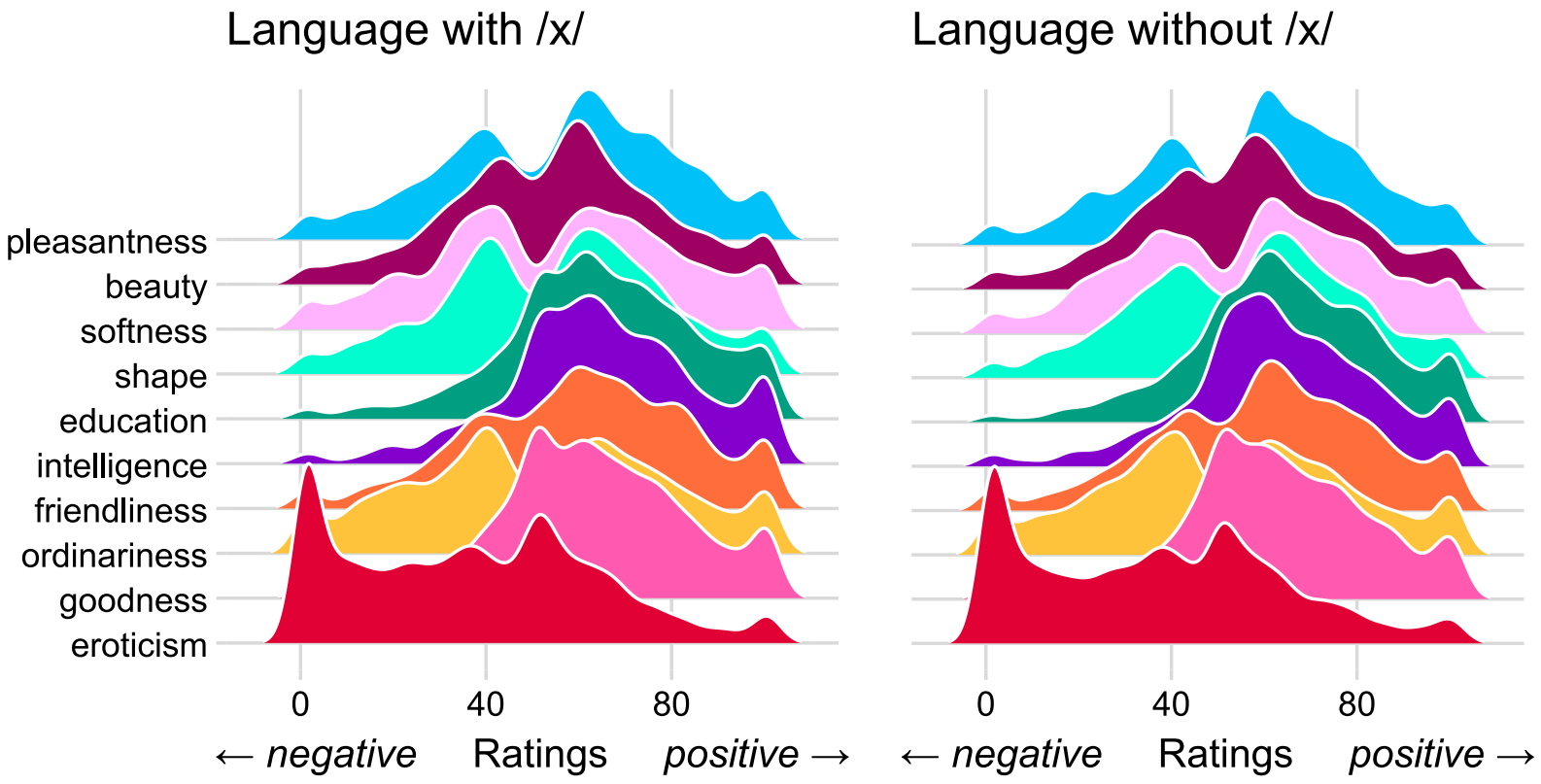
/x/

Correlation matrix of all semantic scales



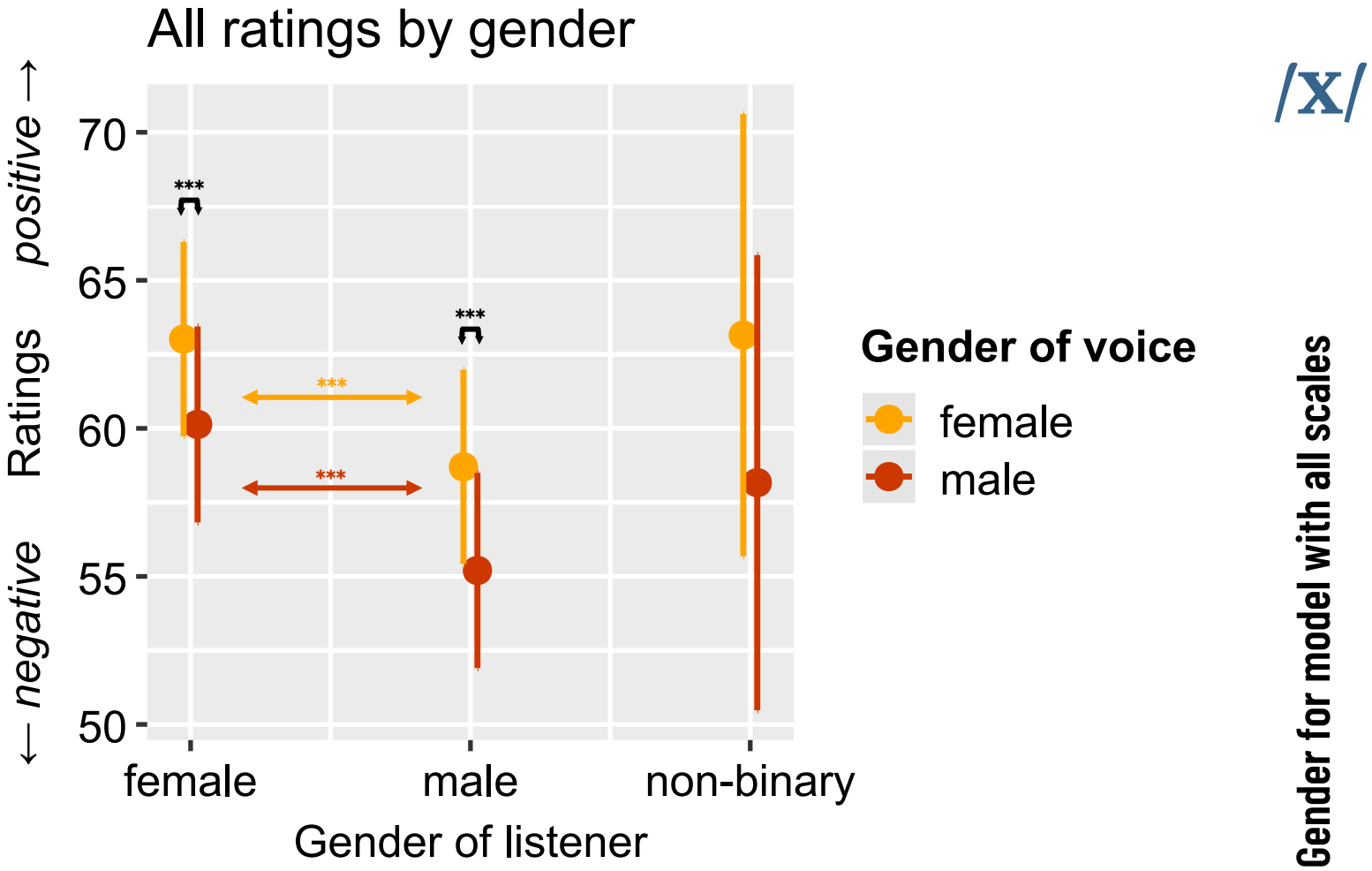
Distribution of ratings by condition for each scale

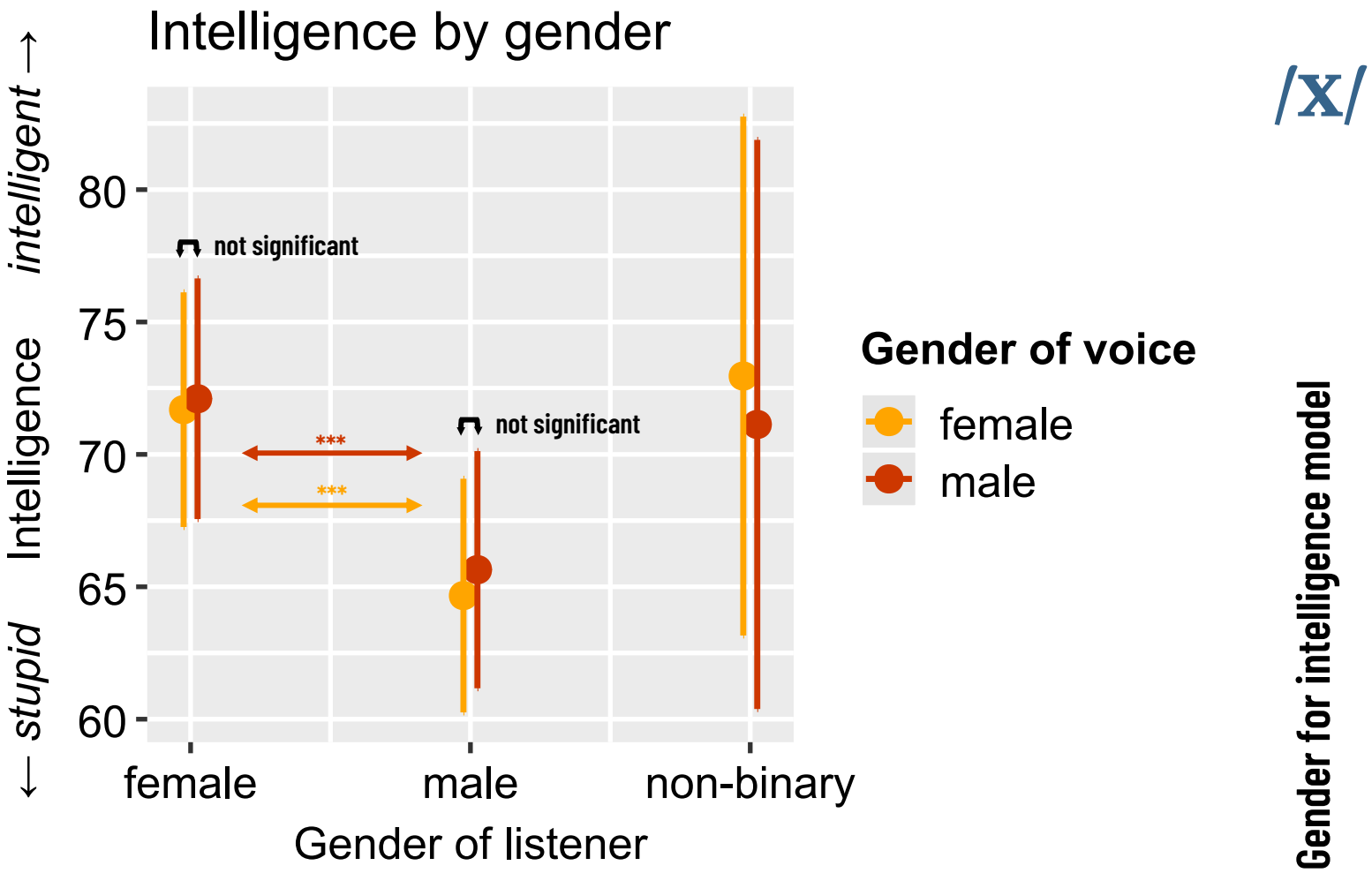
/x/ Distribution of ratings by scale for each condition

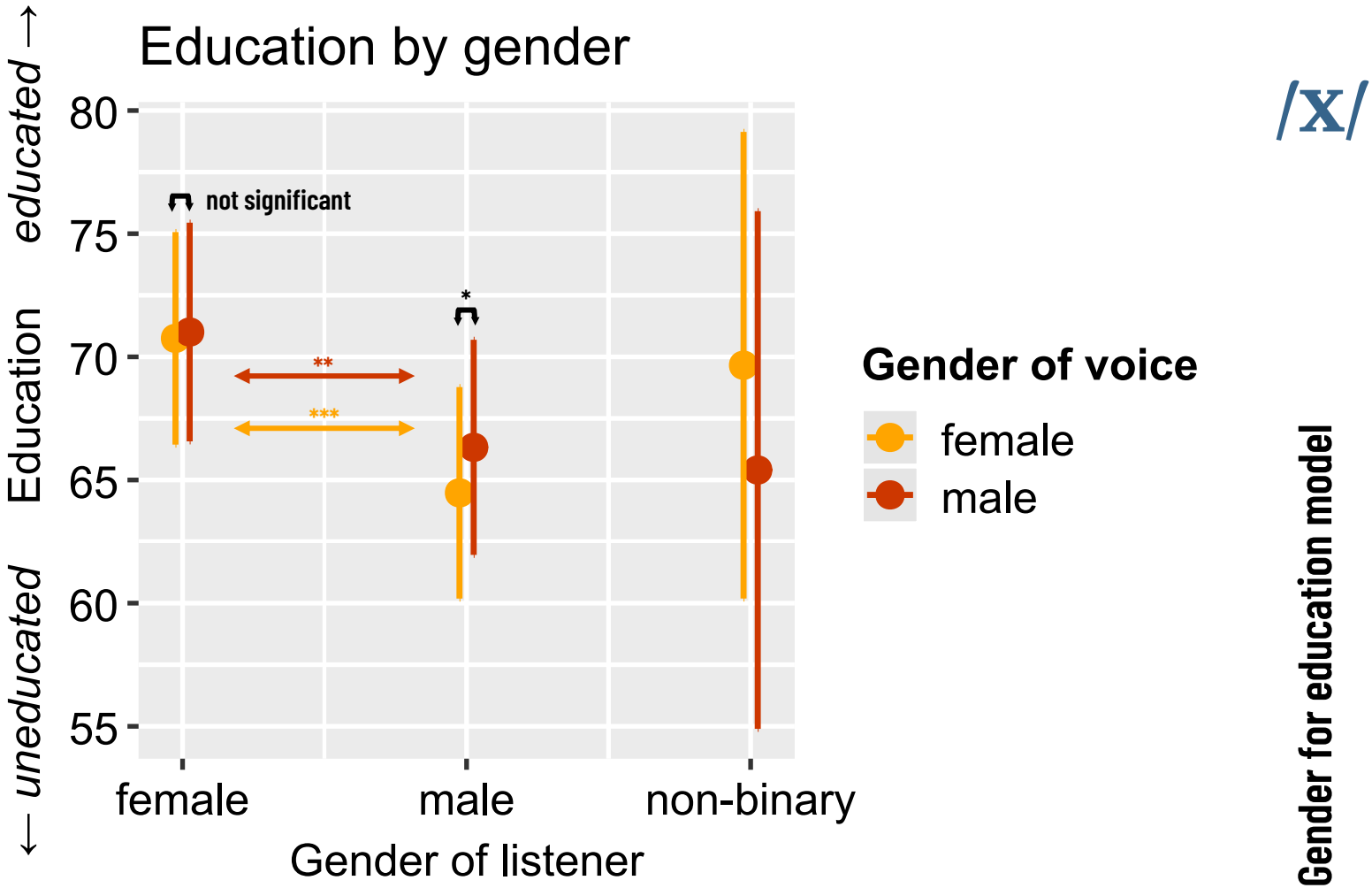


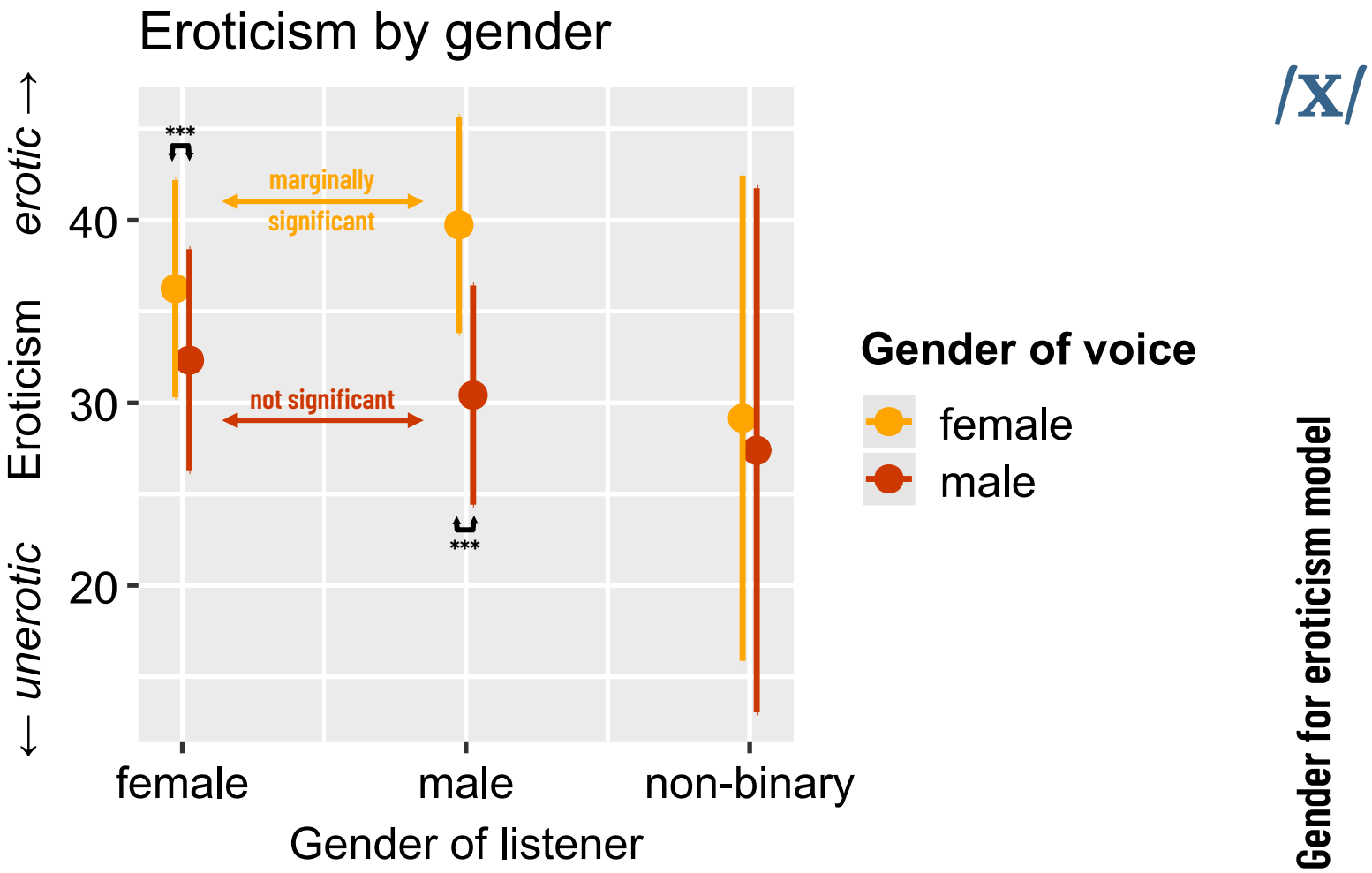
/x/

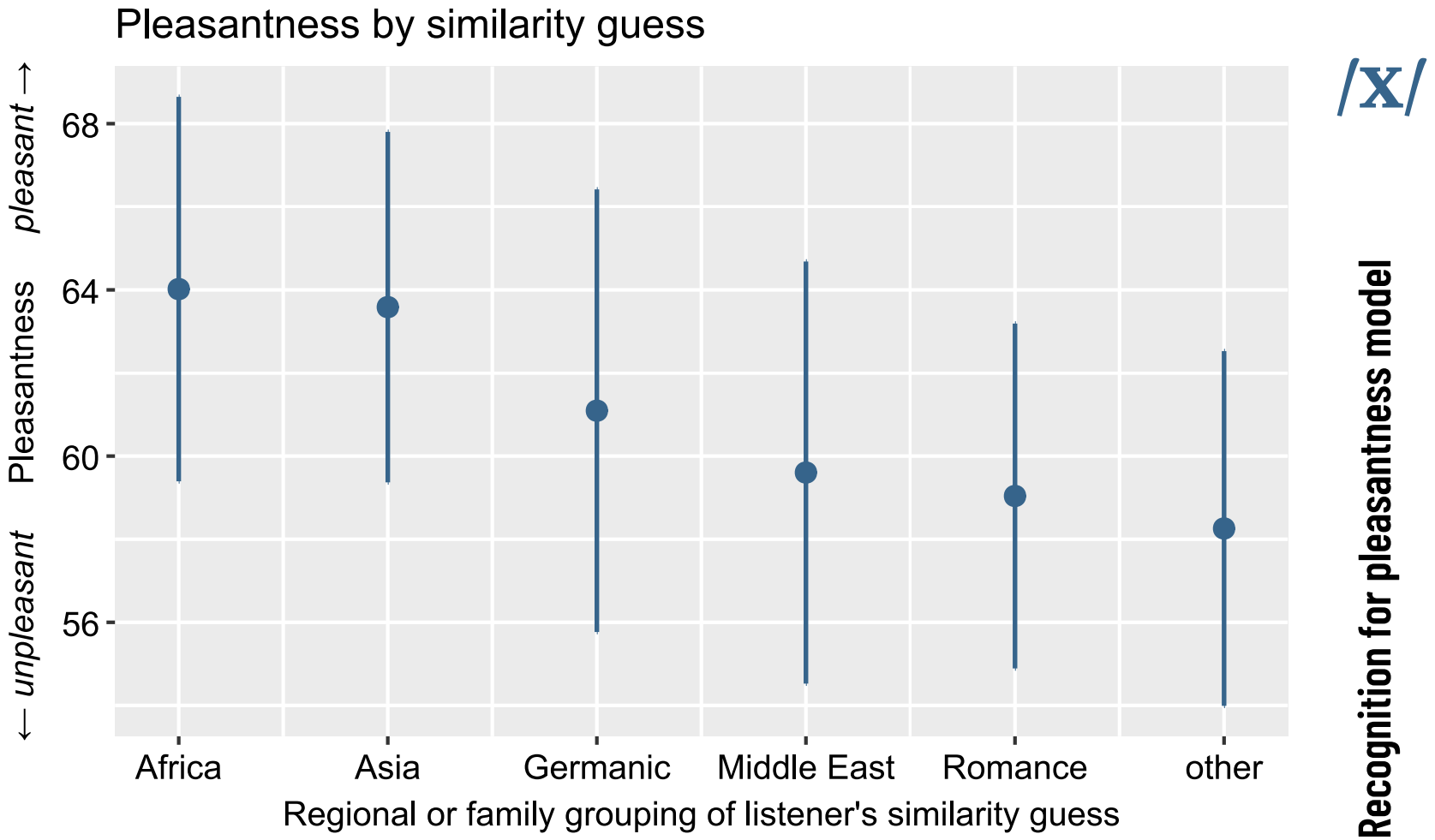
Familiarity for model with all scales

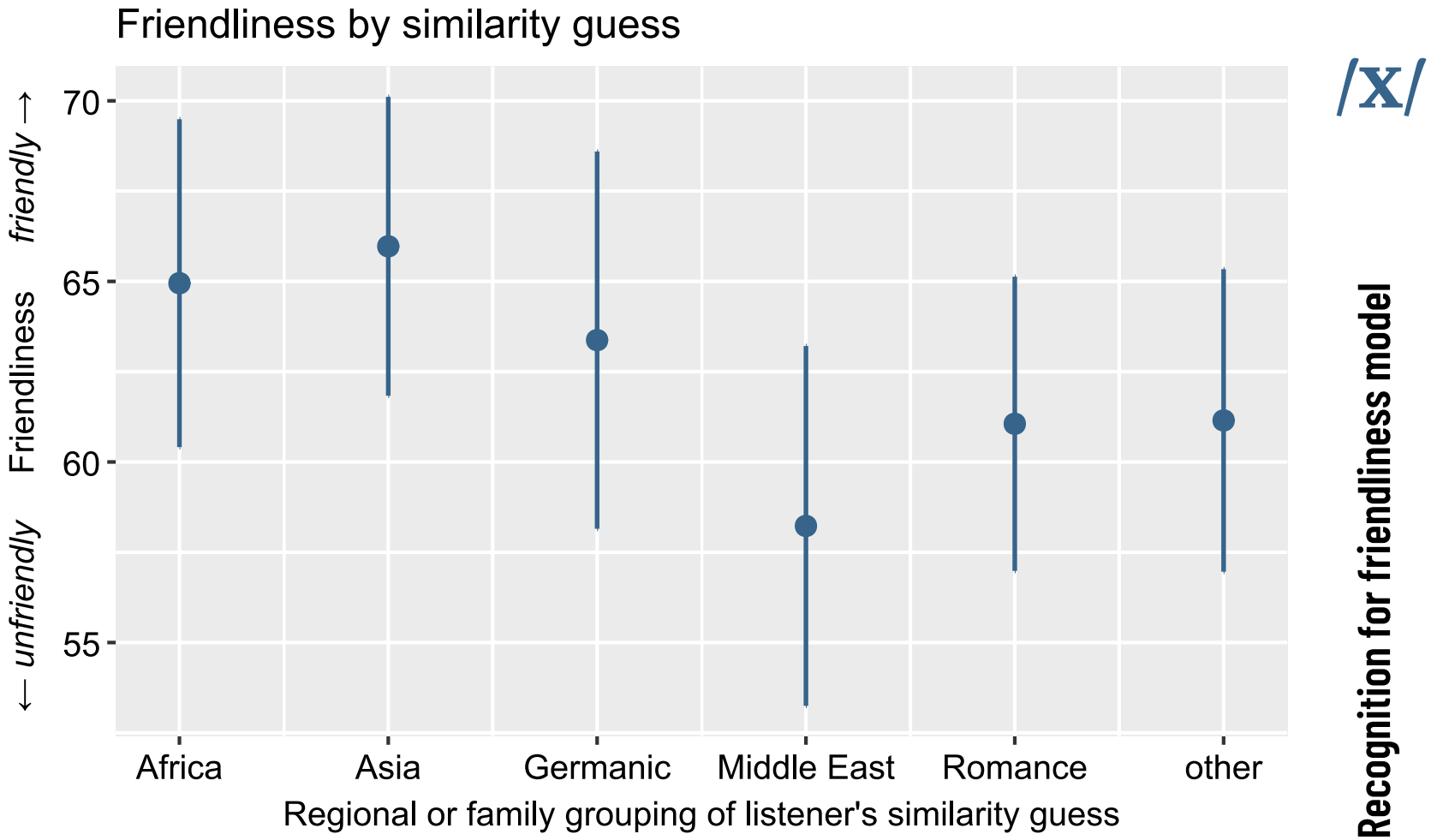

All ratings by gender
/x/
← negative Ratings positive →
70
65
60
55
50
***
***
***
***
female
male
non-binary
Gender of listener
Gender of voice
female
male
Gender for model with all scales

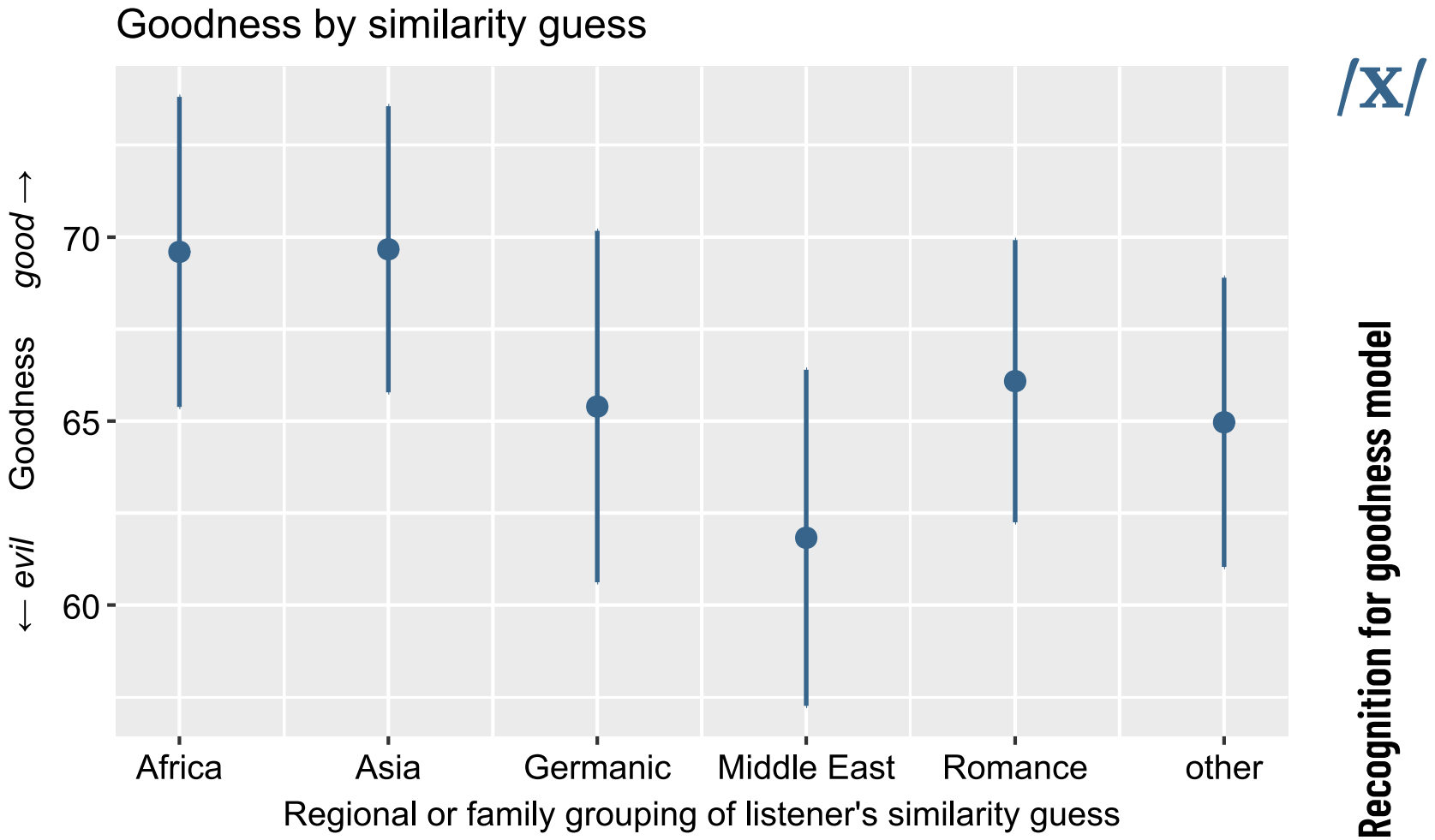

Intelligence by gender
/x/
← stupid Intelligence intelligent →
80
75
70
65
60
not significant
not significant
***
***
female
male
non-binary
Gender of listener
Gender of voice
female
male
Gender for intelligence model

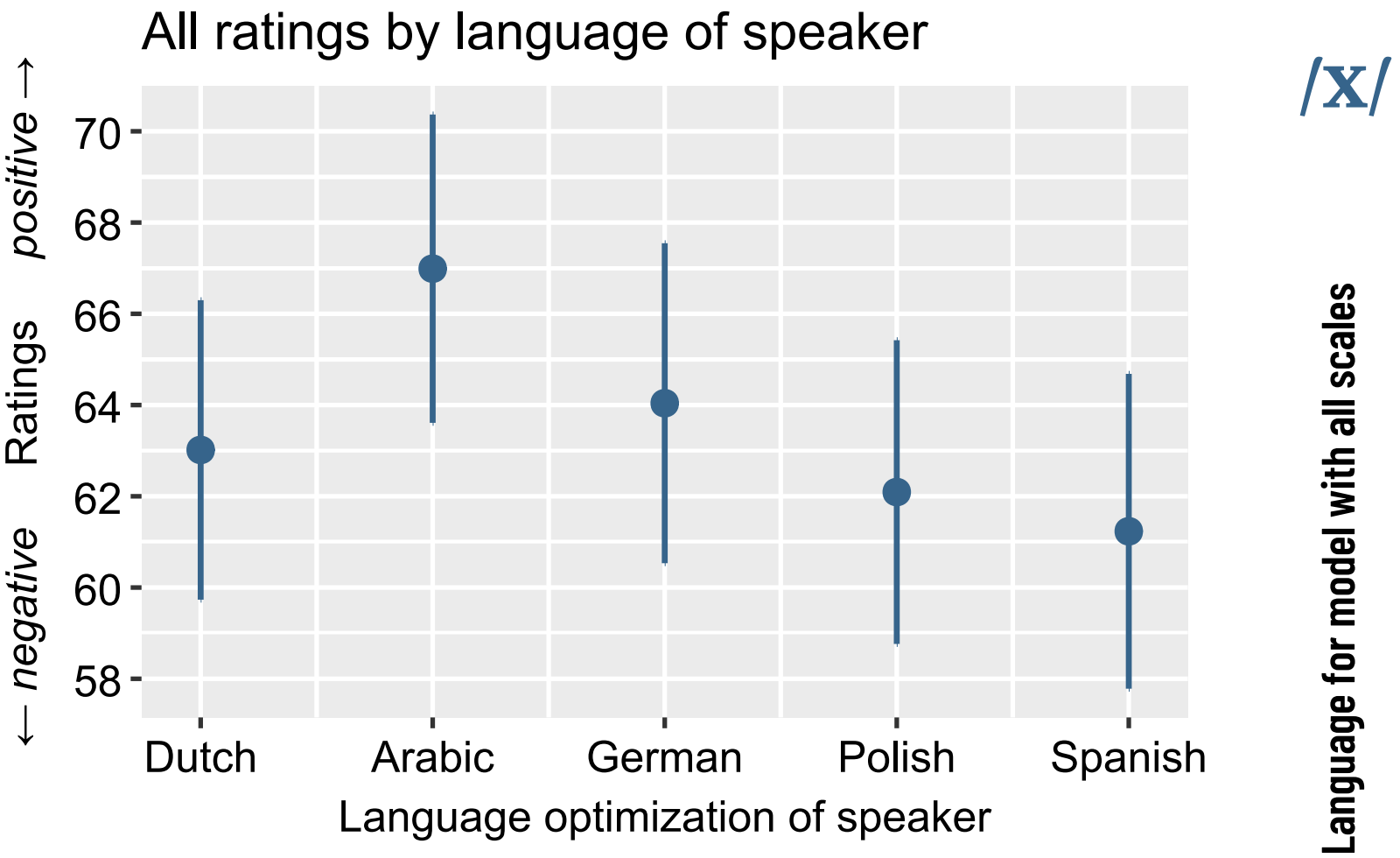

Education by gender
← uneducated Education educated →
80
75
70
65
60
55
not significant
*
**
***
female
male
non-binary
Gender of listener
/x/
Gender of voice
female
male
Gender for education model


Eroticism by gender
/x/
← unerotic Eroticism erotic →
40
30
20
***
***
marginally
significant
not significant
female
male
non-binary
Gender of listener
Gender of voice
female
male
Gender for eroticism model


Pleasantness by similarity guess
← unpleasant Pleasantness pleasant →
68
64
60
56
Africa
Asia
Germanic
Middle East
Romance
other
Regional or family grouping of listener's similarity guess
/x/
Recognition for pleasantness model


Friendliness by similarity guess
← unfriendly Friendliness friendly →
70
65
60
55
Africa
Asia
Germanic
Middle East
Romance
other
Regional or family grouping of listener's similarity guess
/x/
Recognition for friendliness model


Goodness by similarity guess
/x/
← evil Goodness good →
70
65
60
Africa
Asia
Germanic
Middle East
Romance
other
Regional or family grouping of listener's similarity guess
Recognition for goodness model


All ratings by language of speaker
← negative Ratings positive →
70
68
66
64
62
60
58
Dutch
Arabic
German
Polish
Spanish
Language optimization of speaker
/x/
Language for model with all scales

/x/	All scales	Pleasantness	Beauty	Softness	Shape	Education	Intelligence	Friendliness	Ordinariness	Goodness	Eroticism
condition ~~int~~	.	.			*						
condition$^{ST[EX]}$	**	*		.	*						
condition$^{ST[LE]}$										.	
exposed$^{EX[ST]}$	***	.	***	.		**	**	.	**	**	**
exposed$^{EX[CT]}$	*		**			**	**		.		**
recognition^{AS}						*					
recognition^{GE}	***			*	**					*	
recognition^{ME}	***	*	*	*	**			***		***	.
recognition^{RO}	***	***	.		,		.	**		**	
recognition^{O}	***	***	***		**			**	*	***	
familiarity	***	***	***	***	***	***	***	***	***	***	***
vGender$^{M[GM]}$	***	**	***	***	**	*		***		***	***
vGender$^{M[GF]}$	***	*	***	***				***		***	***
gender$^{M[VM]}$	***	***	***	*	**	**	***	.	***	**	
gender$^{M[VF]}$	***	***	***	*	*	***	***	**	***	*	.
polyglot	.			.		.	.			.	.
musicality		*									*

terms not included in this table: condition^{x}exposed exposed^{UN} language$^{NL, AR, DE, PL, ES}$ linguistics age input… output… location…