Judgment Studies

Lecture 03 (Modelling II)

Alessandro Vinciarelli

Outline

- Judgment Studies
- Example: Personality Perception in AAR
- Conclusions

Social AI

University of Glasgow

Outline

- Judgment Studies
- Example: Personality Perception in AAR
- Conclusions

The Judgment Studies

"The term 'judgment studies' refers most generally to those studies in which behaviors, persons, objects or concepts are evaluated by one or more judges, raters, coders, or categorizers, referred to collectively as 'judges'."

Rosenthal, "Conducting Judgment Studies: Some Methodological Issues", in "The New Handbook of Methods in Nonverbal Behavior Research", Harrigan, Rosenthal and Scherer (eds.), 2008.

Social AI

University of Glasgow

Types of Judgment Studies

Dimensions	Examples
Type of Variable	Dependent vs Independent
Measurement Units	Physical vs Psychological
Realiability	Lower vs Higher
Social Meaning	Lower vs Higher

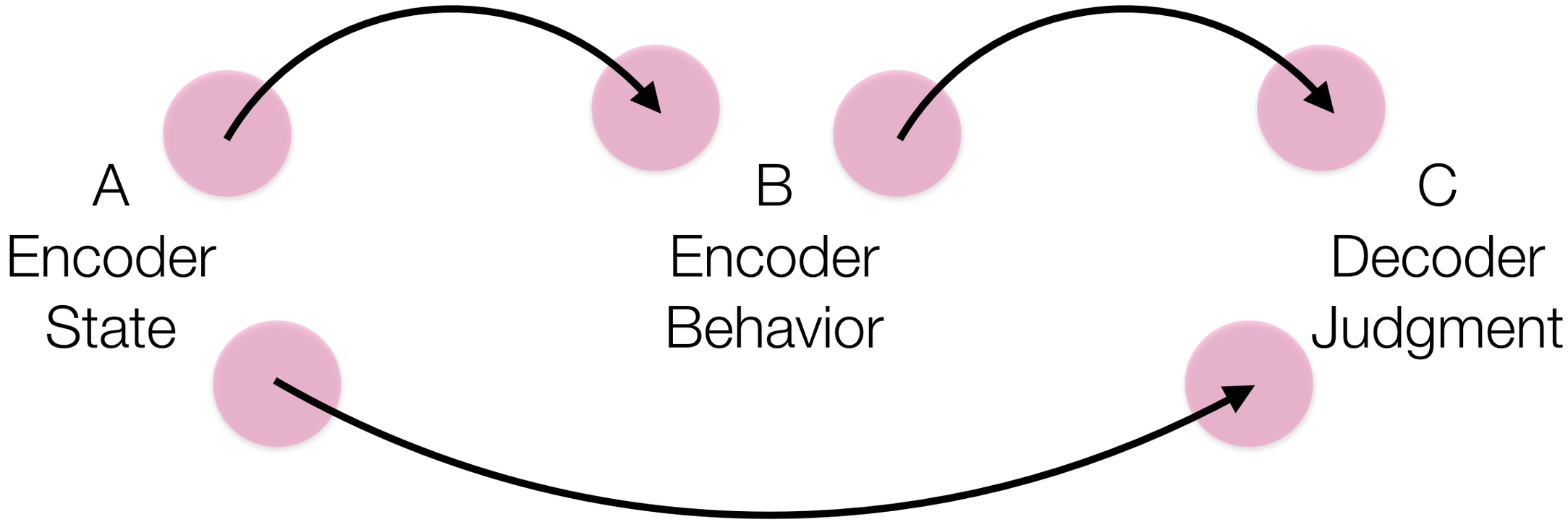
Rosenthal, “Conducting Judgment Studies: Some Methodological Issues”, in “The New Handbook of Methods in Nonverbal Behavior Research”, Harrigan, Rosenthal and Scherer (eds.), 2008.

Social AI

University of Glasgow

How does the encoder manifest her/his state through her/his behaviour?

How do decoders detect the behaviour of the encoder?



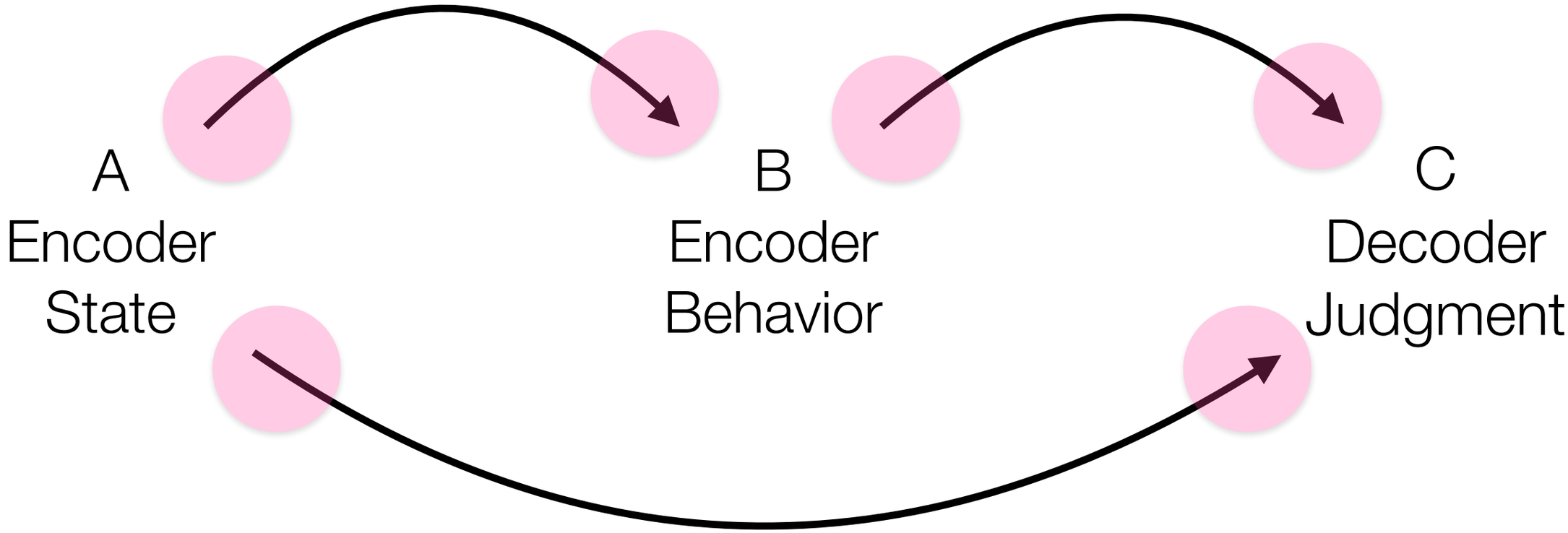
What is the state the decoder attributes to the encoder?

Social AI

University of Glasgow

The State is the independent variable, the behaviour the dependent one

The behaviour is the independent variable, the detection the dependent one



The State is the independent variable, the judgment is the dependent one

Social AI

University of Glasgow

Key-Issues in Judgment Studies

- Selection: How to select the judges? Should they be expert or naive? Are the demographic characteristic important? Are there risks of self-selection? Do the results depend on the judges?
- Reliability: How reliable are the judgments? Are they the result of chance or they reflect a tendency common to all judges? How many judges are necessary to obtain reliable judgments?

Social AI

University of Glasgow

The WEIRD Problem

- The acronym WEIRD stands for White, Educated, Industrialised, Rich, Democratic;
- WEIRD people represent roughly 12% of the world's population, but they are over-represented in psychological studies;
- This bias affects how we understand human nature, social interaction, and development, as WEIRD populations have specificities;
- Some phenomena do not generalise to other populations.

Social AI

University of Glasgow

The Reliability

- The reliability can be thought of as the measure of the consensus among multiple judges;
- The consensus among multiple judges suggests that there is consistency between observations and judgments;
- Judgments are subjective, but this does not mean that they are random;
- In principle, the higher the consensus, the higher the reliability.

Social AI

University of Glasgow

Average Correlation

$$r = \frac{2\sum_{i=1}^{N}\sum_{j=i+1}^{N} r_{ij}}{N(N-1)}$$

- r is the average of the correlations r_{ij} between judge i and judge j;
- N is the number of judges involved in the study.

Social AI

University of Glasgow

Reliability (Spearman Brown)

$$r_{SB} = \frac{Nr}{1 + (N - 1)r}$$

- N is the number of raters who assessed the data;
- r_{SB} is the average correlation between two raters that assessed the same data;
- r_{SB} is bound between 0 and 1 and it measures the reliability, the typical requirement is $r_{SB} \geq 0.7$.

Rosenthal, “Conducting Judgment Studies: Some Methodological Issues”, in “The New Handbook of Methods in Nonverbal Behavior Research”, Harrigan, Rosenthal and Scherer (eds.), 2008.

Social AI

University of Glasgow

Example

Sample	Judge 1	Judge 2	Judge 3	Total
1	5	6	7	18
2	3	6	4	13
3	3	4	6	13
4	2	2	3	7
5	1	4	4	9
		S_2^2		

S_{tot}^2

The variance of the scores for one judge

The variance of the total for each encoder

Social AI

University of Glasgow

Cronbach's α

$$\alpha = \left(\frac{N}{N-1} \right) \frac{S_{tot}^2 - \sum_{j=1}^{N} S_j^2}{S_{tot}^2}$$

- N is the number of raters who assessed the data;
- S_{tot}^2 is the total variance of the judgments;
- S_j^2 is the variance of judge j.

Rosenthal, "Conducting Judgment Studies: Some Methodological Issues", in "The New Handbook of Methods in Nonverbal Behavior Research", Harrigan, Rosenthal and Scherer (eds.), 2008.

Social AI

University of Glasgow

Pros and Cons

- The Spearman Brown Coefficient provides an indication about the correlation between the judgments of two randomly selected Judges;
- However, the Coefficient does not say whether all Judges are correlated to the same extent or not.

- The Cronbach's α allows one to avoid calculating a large number of correlations when the number of judges is large;
- The value of the Cronbach's α tends to be similar to the one of the other reliability measures.

Social AI

University of Glasgow

Outline

- Judgment Studies
- Example: Personality Perception in AAR
- Conclusions

Social AI

University of Glasgow

Why Perception?

"People make social inferences without intentions, awareness, or effort, i.e., spontaneously."

Uleman, Adil Saribay, and Gonzalez, "Spontaneous inferences, implicit impressions, and implicit theories", Annual Reviews of Psychology, 59(1), pp.329-360, 2008.

Social AI

University of Glasgow

Why Perception?

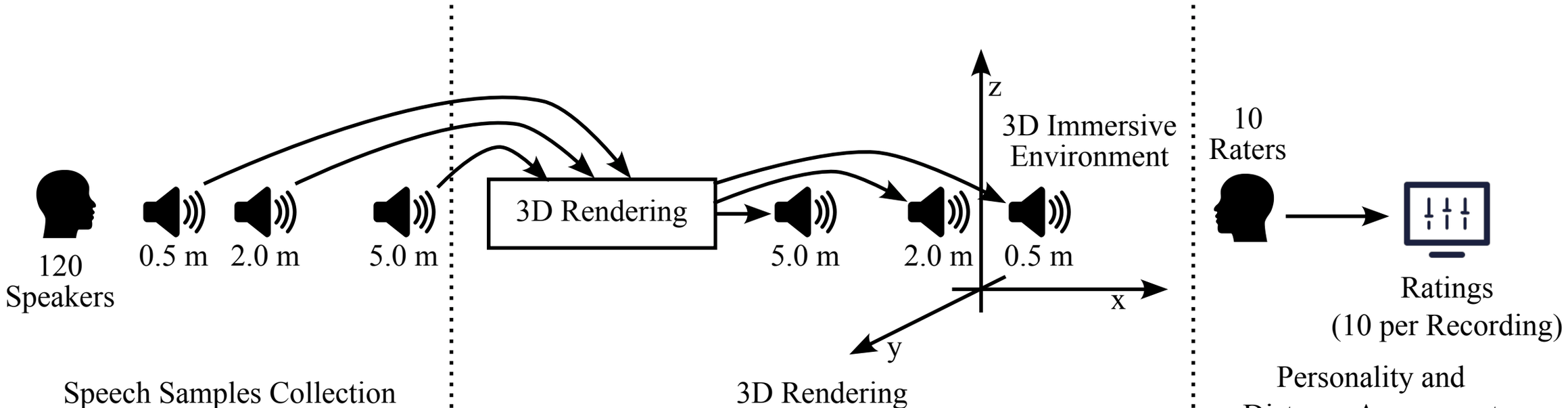
"We need to recognise that identification is often most consequential as the categorisation of others, rather than as self-identification."

Jenkins, "Social Identity", Routledge, Fourth Edition, 2014

Social AI

University of Glasgow

The Data



- Every speaker (60 female and 60 male) read three times the same text (The North Wind and the Sun), like speaking to listeners at different distances;
- The data are rendered in Audio Augmented Reality, an immersive environment that engages only with hearing.

Fringi, Alshubaily, Picinali, Brewster, Guha, Vinciarelli, “Is Distance a Modality? Multi-Task Learning for Speech-Based Joint Prediction of Attributed Traits and Perceived Distances in Virtual Immersive Audio Environments“, Proc. of the ACM International Conference on Multimodal Interaction, 2024.

Social AI

University of Glasgow

The Data

Gender	Male	Age	Nearfield	Midfield	Farfield	Length
Female	60	31.2±14.0	60	60	60	30 min.
Male	60	33.1±13.5	60	60	60	30 min.
Total	120	32.2±13.7	120	120	120	60 min.

- The recordings are stopped after 10 seconds;
- The total duration is 10x360 = 3600 seconds;
- No differences between female and male speakers.

Fringi, Alshubaily, Picinali, Brewster, Guha, Vinciarelli, “Is Distance a Modality? Multi-Task Learning for Speech-Based Joint Prediction of Attributed Traits and Perceived Distances in Virtual Immersive Audio Environments“, Proc. of the ACM International Conference on Multimodal Interaction, 2024.

Social AI

University of Glasgow

The Data

- The data design limits the range of factors that change from one clip to the other;
- The content is the same for all clips to avoid variance resulting from the content (what people say);
- The length is the same for all clips (10 seconds) to avoid variance resulting from duration;
- The perceived distance changes for every clip, the speakers target a specific distance (e.g., 50 cm), but speech production and perception are noisy;
- Nonverbal speech aspects (fundamental frequency, loudness, speed, etc.) change for every speaker.

Social AI

University of Glasgow

Personality

"The Big Five Personality Factors appear to provide a set of highly replicable dimensions that parsimoniously and comprehensively describe most phenotypic individual differences."

Saucier, Goldberg, "The Language of Personality: Lexical Perspectives on the Five-Factor Model", in "The Five-Factor Model of Personality", Wiggins (ed.), 21-50,1996

Social AI

University of Glasgow

The Big-Five

- Extraversion: tendency to be active, assertive, energetic, outgoing, etc.;
- Agreeableness: tendency to be appreciative, forgiving, generous, kind, sympathetic, trusting, etc.;
- Conscientiousness: tendency to be efficient, organised, planful, reliable, responsible, thorough, etc.;
- Neuroticism: tendency to be anxious, self-pitying, tense, touchy, unstable, worrying, etc.;
- Openness: tendency to be artistic, curious, imaginative, insightful, etc.

Social AI

University of Glasgow

The Judges

Gender	Male	Age
Female	10	30.0±8.2
Male	8	34.1±12.1
Total	18	31.8±10.0

- The 360 clips are randomly split in non-overlapping blocks of 90 clips (15 female and 15 male speakers);
- Every block is randomly assigned 10 judges (5 female and 5 male), some judges assess multiple blocks.

Fringi, Alshubaily, Picinali, Brewster, Guha, Vinciarelli, “Is Distance a Modality? Multi-Task Learning for Speech-Based Joint Prediction of Attributed Traits and Perceived Distances in Virtual Immersive Audio Environments“, Proc. of the ACM International Conference on Multimodal Interaction, 2024.

Social AI

University of Glasgow

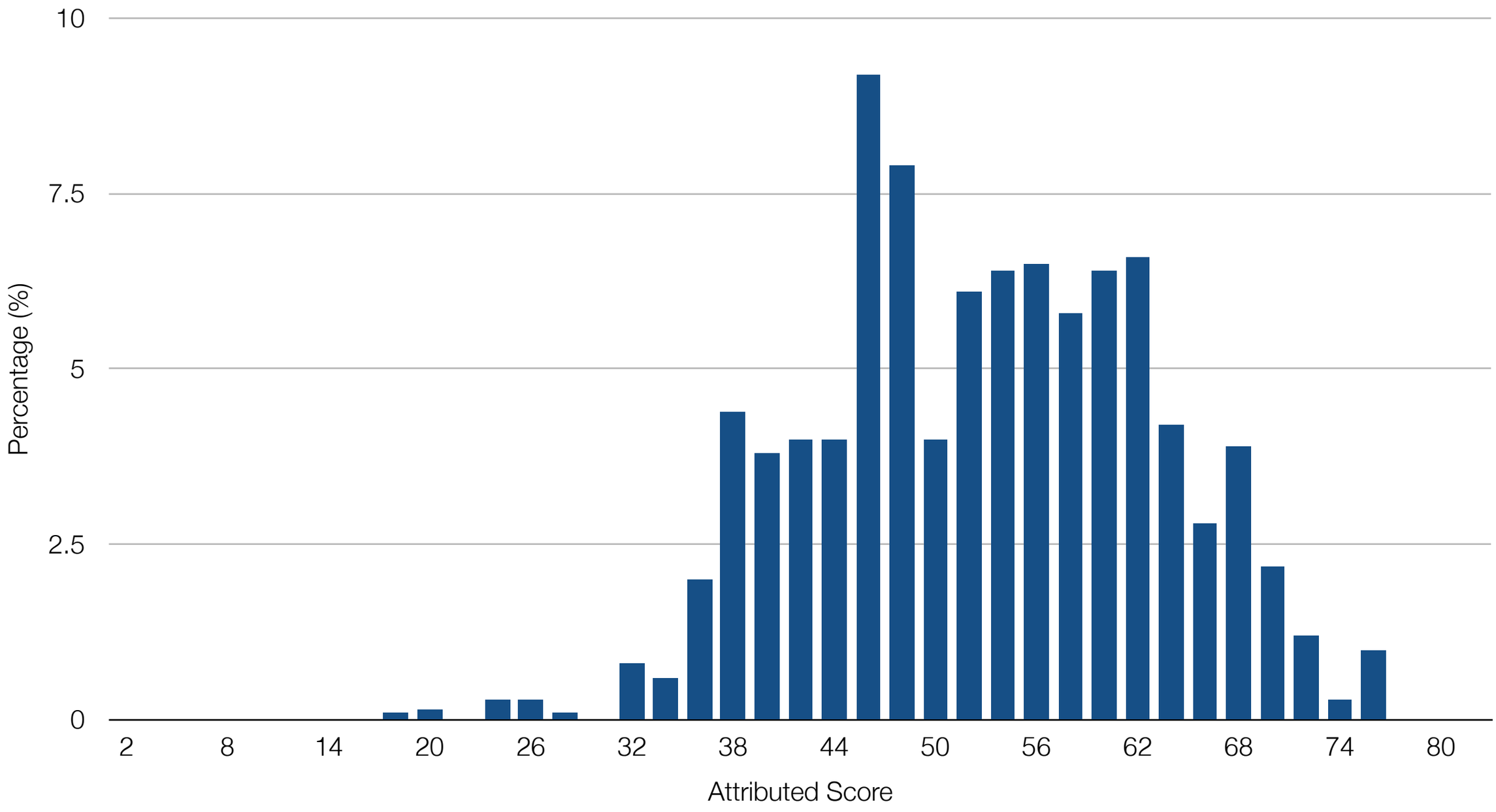
The Task

- The judges were asked to assess every speaker in terms of the Big-Five traits and the perceived distance;
- For the Big-Five, the judges are given a definition of every trait and are asked to give a score between 1 and 100;
- The distance must range between 0 and 10 meters;
- The data were randomly split in four blocks (15 female and 15 male speakers) and every block is randomly assigned 10 judges (5 female and 5 male), some judges assess multiple blocks.

Social AI

University of Glasgow

Openness

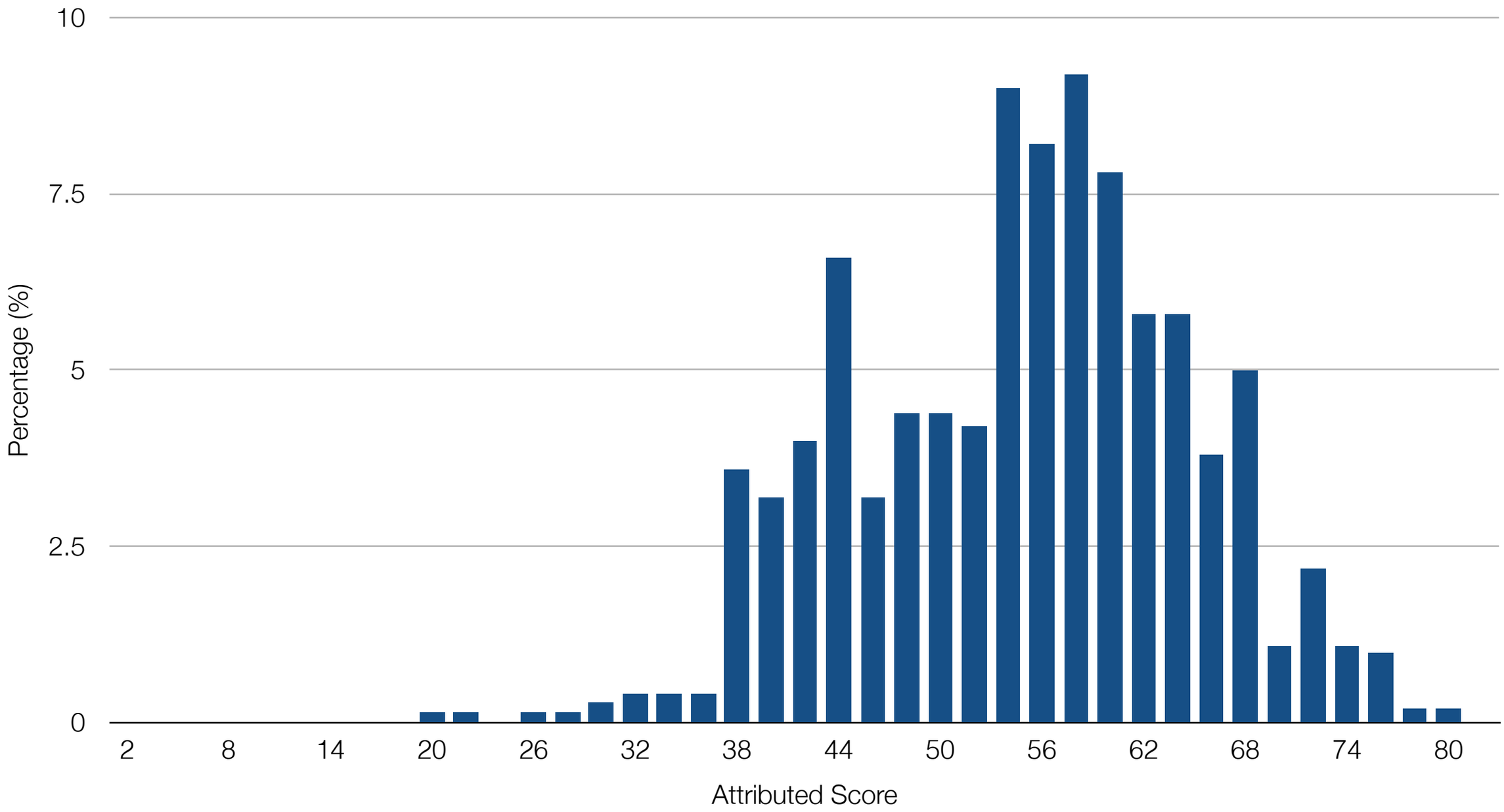


Fringi, Alshubaily, Picinali, Brewster, Guha, Vinciarelli, “Is Distance a Modality? Multi-Task Learning for Speech-Based Joint Prediction of Attributed Traits and Perceived Distances in Virtual Immersive Audio Environments“, Proc. of the ACM International Conference on Multimodal Interaction, 2024.

Social AI

University of Glasgow

Conscientiousness

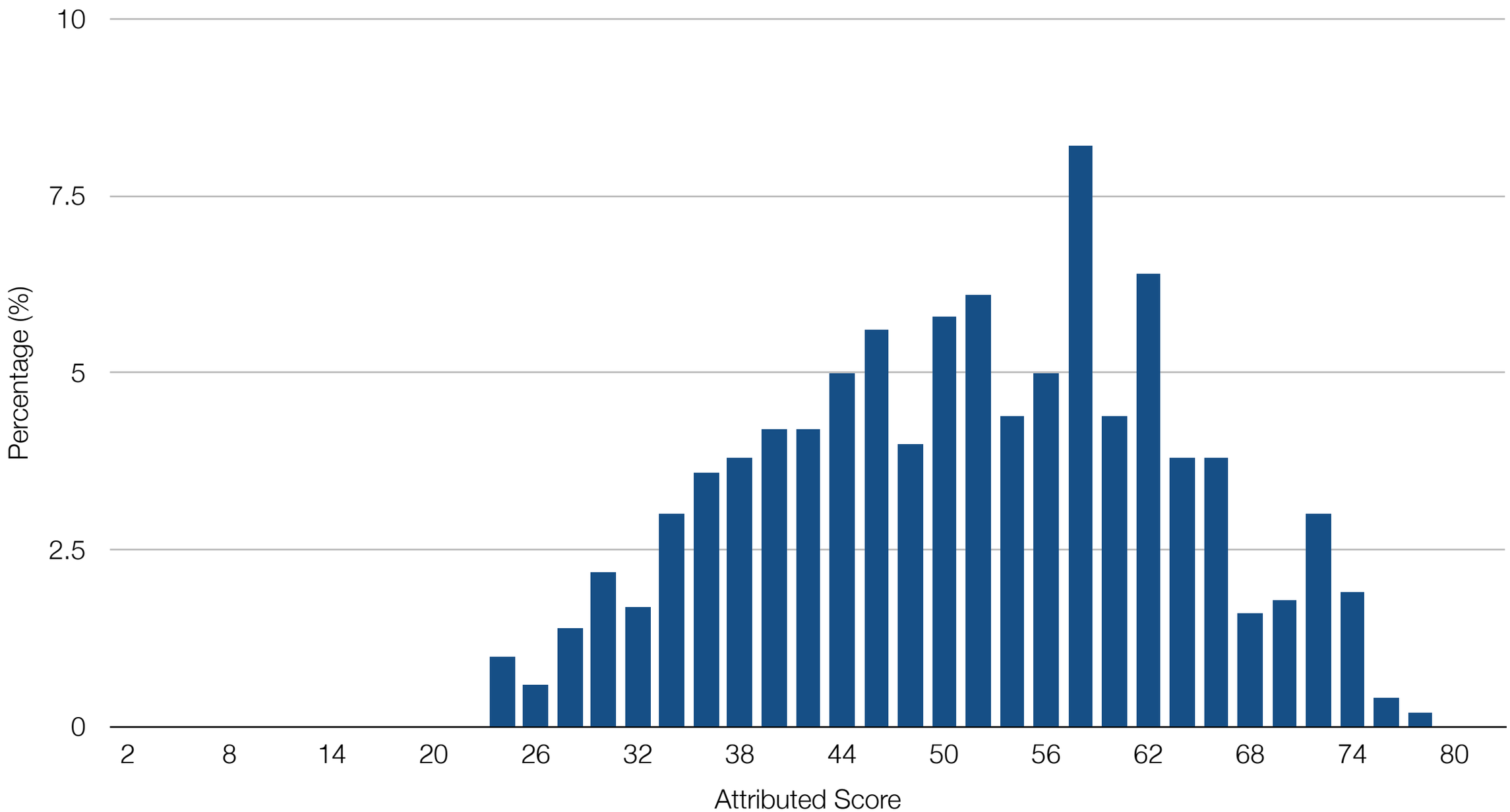


Fringi, Alshubaily, Picinali, Brewster, Guha, Vinciarelli, “Is Distance a Modality? Multi-Task Learning for Speech-Based Joint Prediction of Attributed Traits and Perceived Distances in Virtual Immersive Audio Environments“, Proc. of the ACM International Conference on Multimodal Interaction, 2024.

Social AI

University of Glasgow

Extraversion

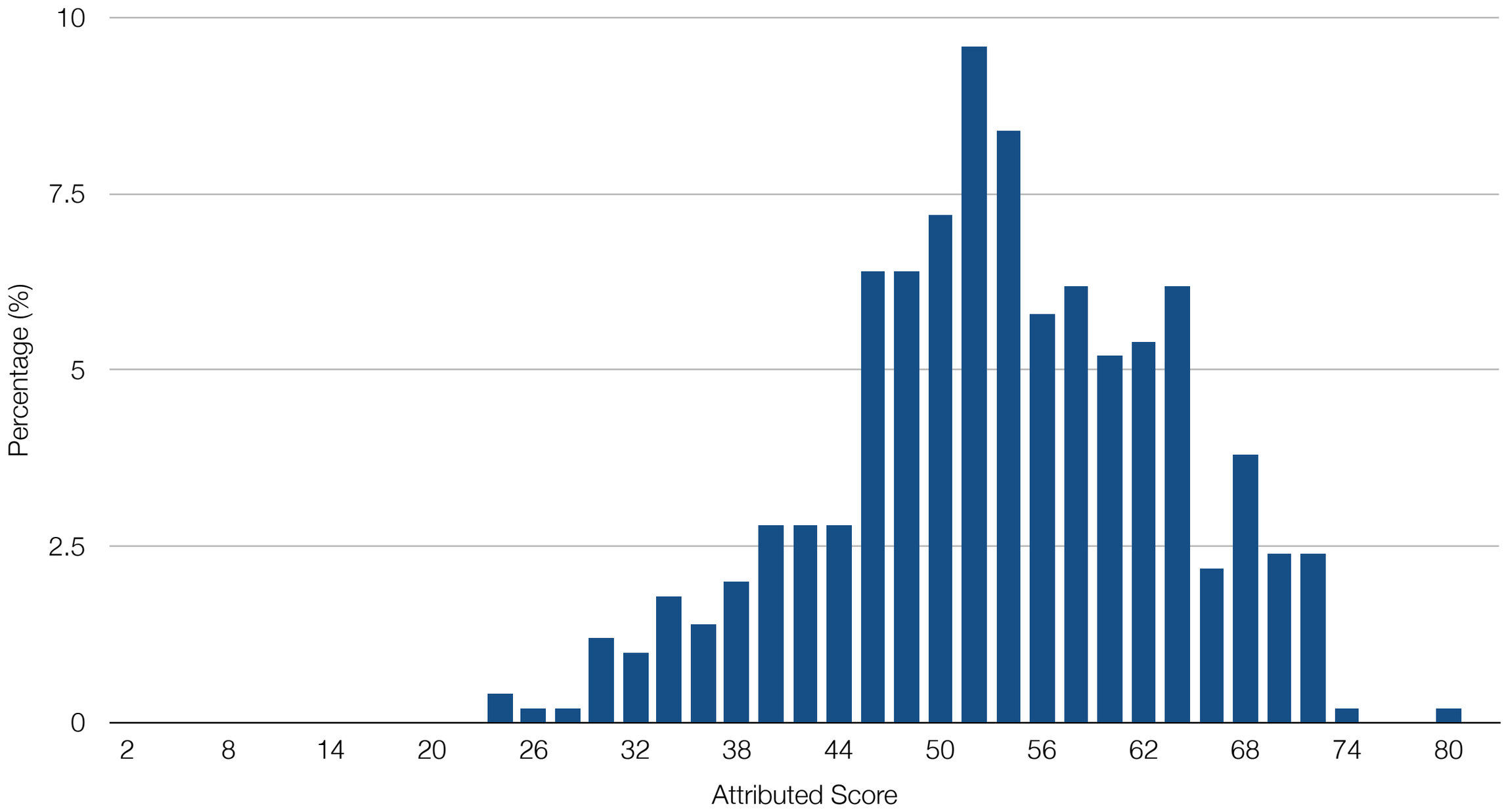


Fringi, Alshubaily, Picinali, Brewster, Guha, Vinciarelli, “Is Distance a Modality? Multi-Task Learning for Speech-Based Joint Prediction of Attributed Traits and Perceived Distances in Virtual Immersive Audio Environments“, Proc. of the ACM International Conference on Multimodal Interaction, 2024.

Social AI

University of Glasgow

Agreeableness

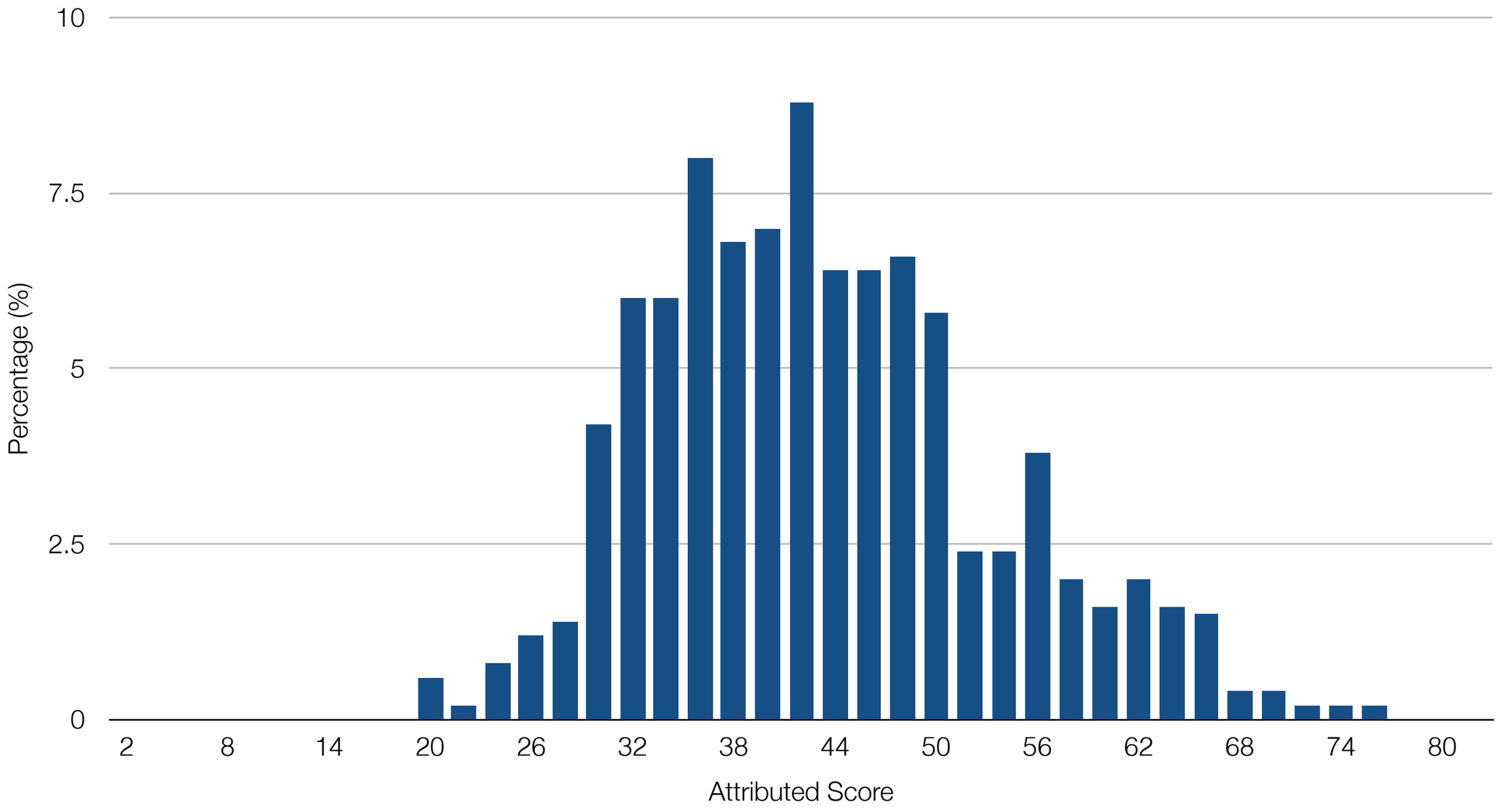


Fringi, Alshubaily, Picinali, Brewster, Guha, Vinciarelli, “Is Distance a Modality? Multi-Task Learning for Speech-Based Joint Prediction of Attributed Traits and Perceived Distances in Virtual Immersive Audio Environments“, Proc. of the ACM International Conference on Multimodal Interaction, 2024.

Social AI

University of Glasgow

Neuroticism

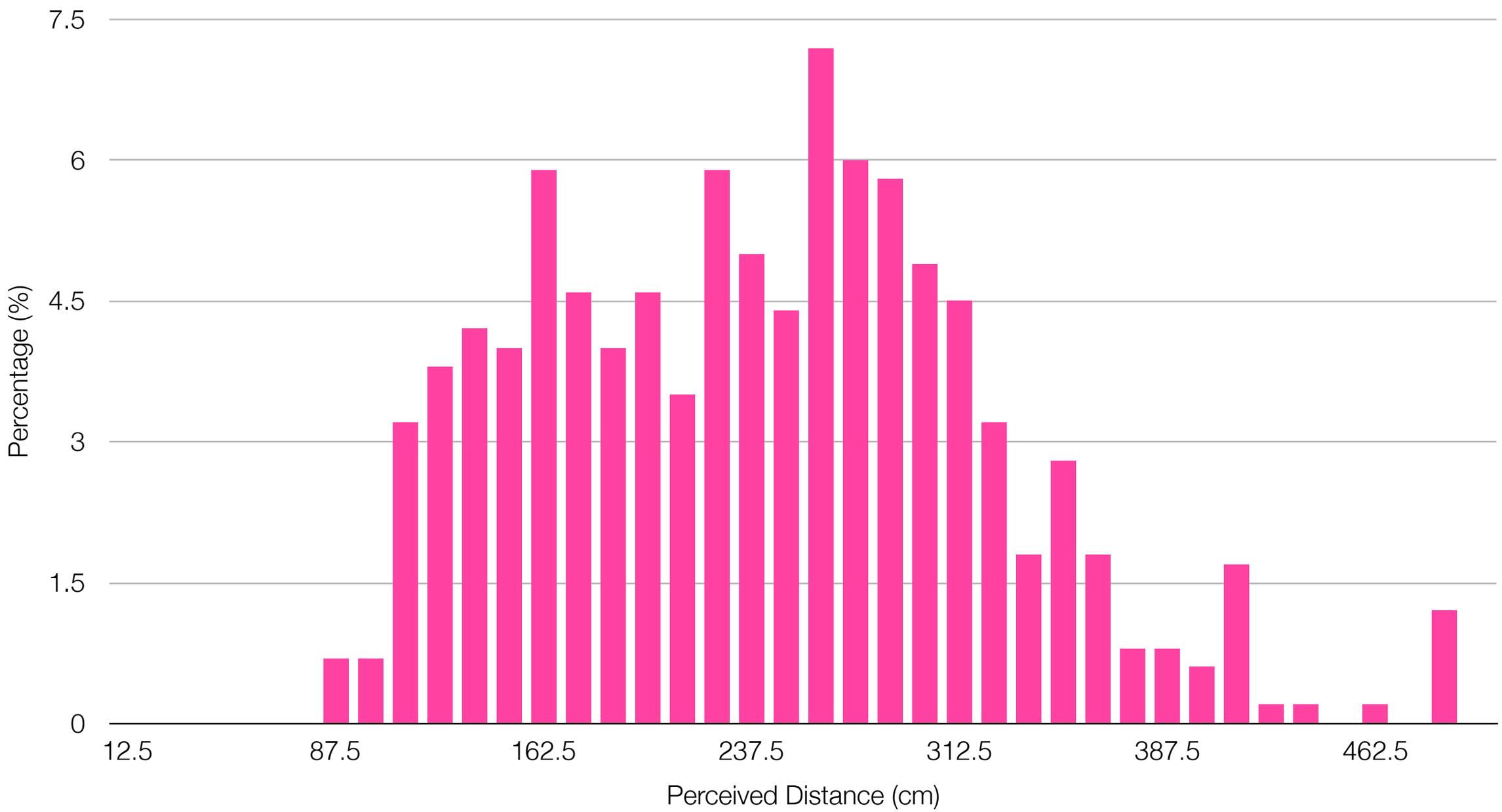


Fringi, Alshubaily, Picinali, Brewster, Guha, Vinciarelli, “Is Distance a Modality? Multi-Task Learning for Speech-Based Joint Prediction of Attributed Traits and Perceived Distances in Virtual Immersive Audio Environments“, Proc. of the ACM International Conference on Multimodal Interaction, 2024.

Social AI

University of Glasgow

Perceived Distance



Fringi, Alshubaily, Picinali, Brewster, Guha, Vinciarelli, “Is Distance a Modality? Multi-Task Learning for Speech-Based Joint Prediction of Attributed Traits and Perceived Distances in Virtual Immersive Audio Environments“, Proc. of the ACM International Conference on Multimodal Interaction, 2024.

Social AI

University of Glasgow

Reliability

Trait / Distance	Reliability
Openness	0.72
Conscientiousness	0.76
Extraversion	0.84
Agreeableness	0.78
Neuroticism	0.68
Distance	0.87

- The minimum reliability for considering the ratings acceptable is conventionally 0.7.

Fringi, Alshubaily, Picinali, Brewster, Guha, Vinciarelli, “Is Distance a Modality? Multi-Task Learning for Speech-Based Joint Prediction of Attributed Traits and Perceived Distances in Virtual Immersive Audio Environments“, Proc. of the ACM International Conference on Multimodal Interaction, 2024.

Relative Entropy (I)

$$\sum_{k=1}^{N} p_k = 1$$

- Consider a probability distribution over N mutually exclusive events;
- The value of p_k is the probability of event k taking place.

Social AI

University of Glasgow

Relative Entropy (II)

$$H = -\frac{\sum_{k=1}^{N} p_k \log(p_k)}{\log(N)}$$

- H is the relative entropy of the distribution and its value is bound between 0 (one of the p_k is equal to one) and 1 ($p_k = 1/N \, \forall k \in \{1,\ldots,N\}$);
- $H = 0$ means maximum certainty, $H = 1$ means maximum uncertainty.

Social AI

University of Glasgow

Is the Distribution Uniform?

$$H = -\frac{\sum_{k=1}^{N} p_k \log(p_k)}{\log(N)}$$

- H can be thought of as the expectation of the random variable $\log(p)/\log(N)$;
- It is possible to apply a t-test and to verify whether the distributions differ to a statistically significant extent from the uniform distribution.

Social AI

University of Glasgow

Relative Entropy

Trait / Distance	Relative Entropy
Openness	0.77
Conscientiousness	0.77
Extraversion	0.80
Agreeableness	0.77
Neuroticism	0.77
Distance	0.73

- According to a t-test, the entropy is never distinguishable from the one of the uniform distribution.

Fringi, Alshubaily, Picinali, Brewster, Guha, Vinciarelli, “Is Distance a Modality? Multi-Task Learning for Speech-Based Joint Prediction of Attributed Traits and Perceived Distances in Virtual Immersive Audio Environments“, Proc. of the ACM International Conference on Multimodal Interaction, 2024.

The Spearman Correlation Coefficient

Difference between rank of trait and rank of GS score for the same stimulus

$$r = 1 - \frac{6 \sum_{k=1}^{M} d(t_k, g_k)}{M(M^2 - 1)}$$

- The Spearman Correlation Coefficient is more robust to outliers than the most common Pearson Correlation.

Social AI

University of Glasgow

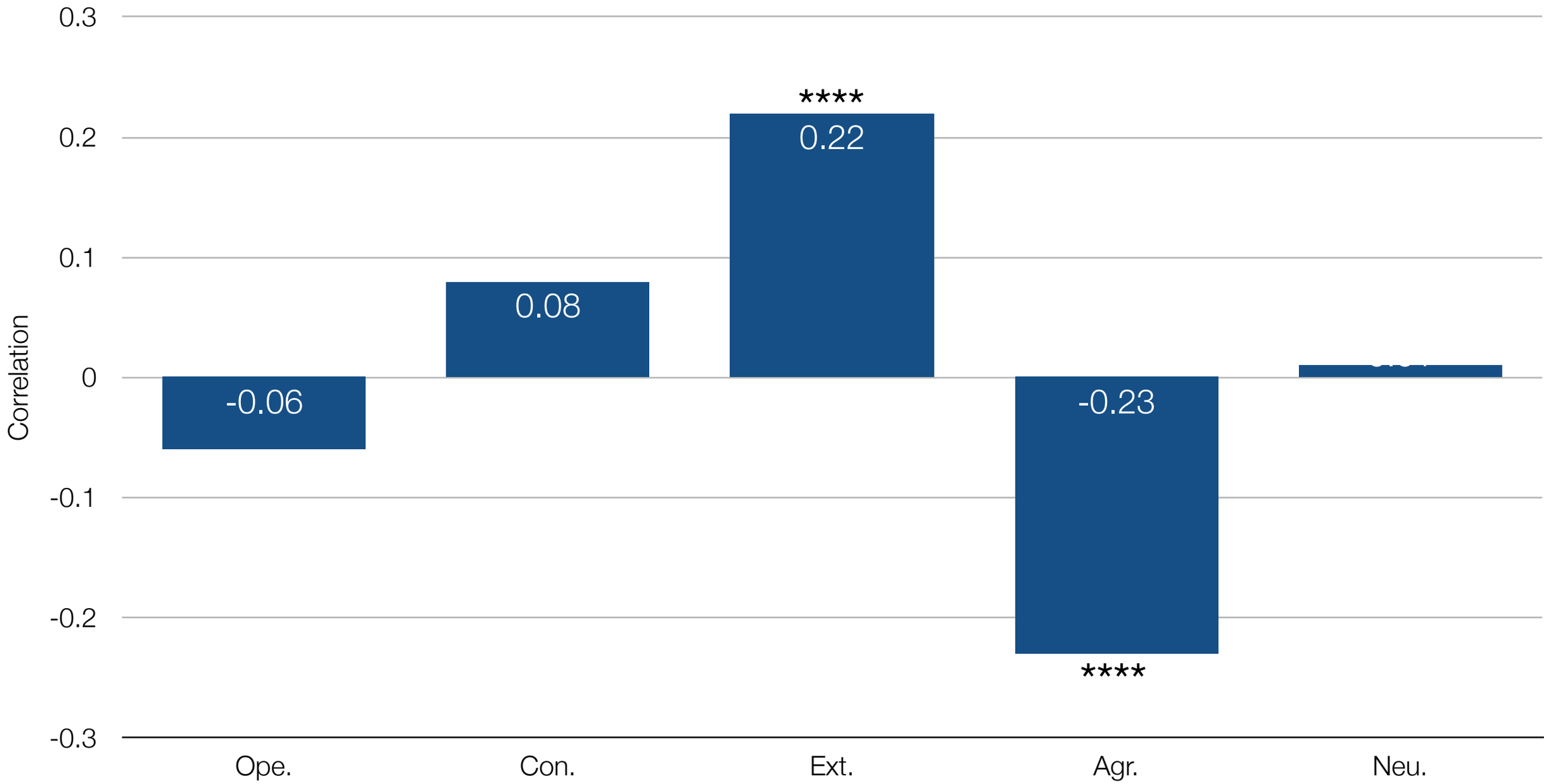
Correlation Distance-Traits

- The correlation between attributed traits and perceived distance can show whether there is a relationship between the two variables;
- The main advantage of the correlation is that it is associated to a t variable and, therefore, it is possible to test whether it is statistically significant;
- The Spearman Correlation Coefficient is less sensitive to outliers than the most commonly used Pearson Correlation Coefficient.

Social AI

University of Glasgow

Correlation Distance-Traits



Fringi, Picinali, Brewster and Vinciarelli, “The interplay between interpersonal distance and personality perception in virtual immersive audio environments”, under review, 2026

Social AI

University of Glasgow

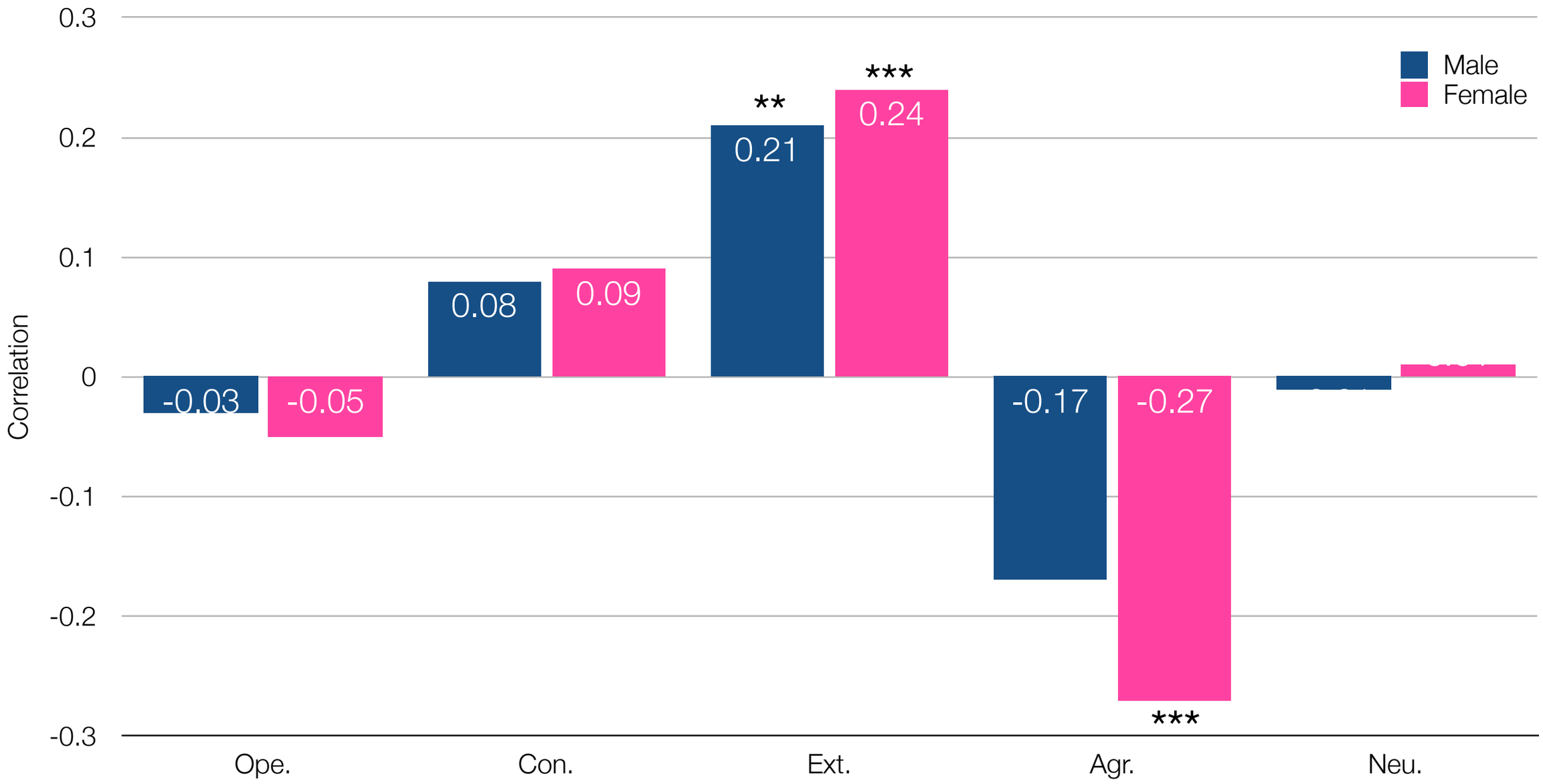
Correlation Distance-Traits

- The correlation is weak, but statistically significant and positive for Extraversion: speakers sound extravert when they speak from far away;
- The correlation is weak, but statistically significant and negative for Agreeableness: speakers sound agreeable when they speak close;
- Increasing Extraversion reduces Agreeableness, a tradeoff must be found between the two opposite tendencies.

Social AI

University of Glasgow

Gender Effects



Fringi, Picinali, Brewster and Vinciarelli, “The interplay between interpersonal distance and personality perception in virtual immersive audio environments”, under review, 2026

Social AI

University of Glasgow

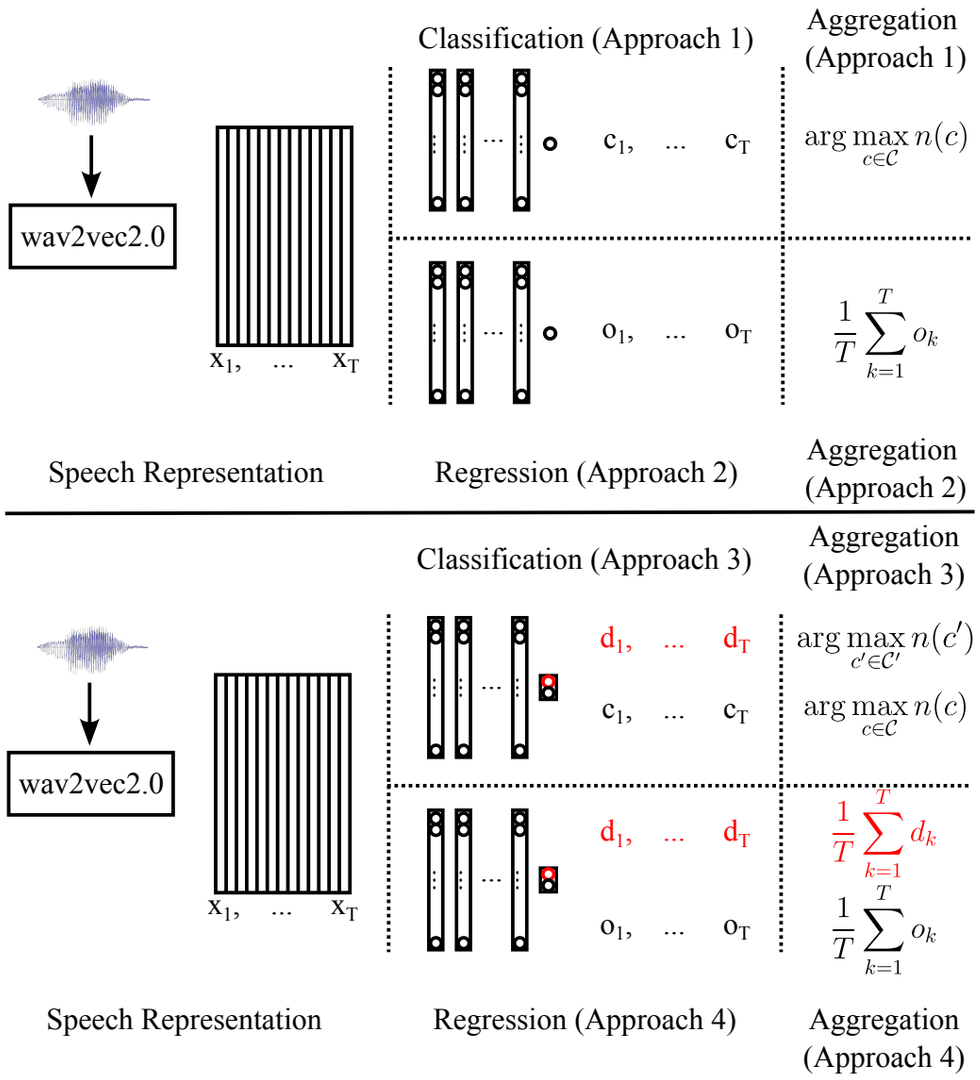
Gender Effects

- The correlation is weak, but statistically significant and positive for Extraversion, irrespective of gender;
- The correlation is weak, but statistically significant and negative for Agreeableness, but the effect applies to female speakers only.
- The problem of the tradeoff seems to apply to female speakers only, but this might depend on the reduction in the number of speakers.

Social AI

University of Glasgow

Predicting Attributed Traits



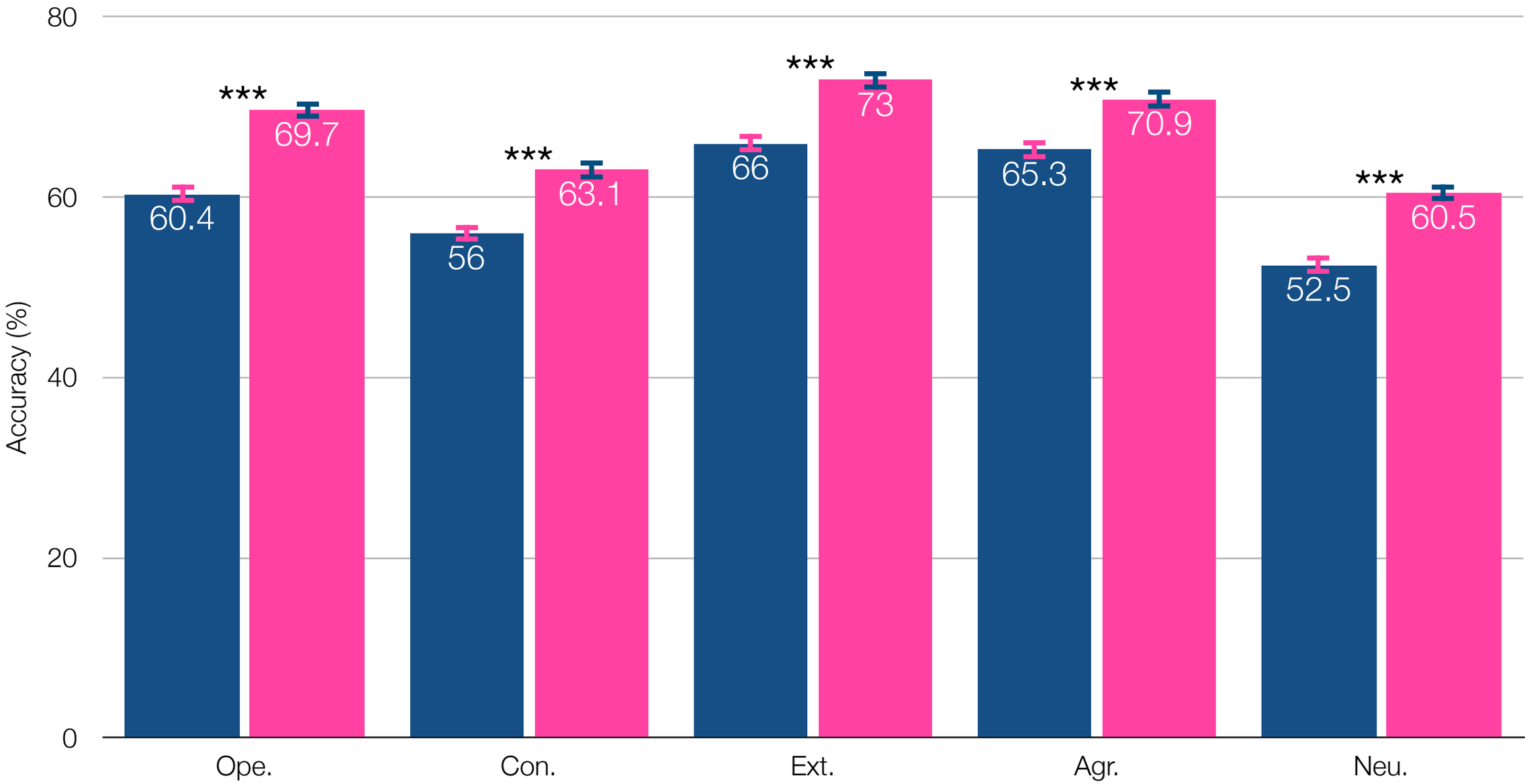
- Predicting whether the speaker is perceived to be above or below median;
- The previous results suggest there is a relationship traits-distance (in some cases);
- Jointly predicting distance and traits should improve the performance.

Fringi, Alshubaily, Picinali, Brewster, Guha, Vinciarelli, “Is Distance a Modality? Multi-Task Learning for Speech-Based Joint Prediction of Attributed Traits and Perceived Distances in Virtual Immersive Audio Environments“, Proc. of the ACM International Conference on Multimodal Interaction, 2024.

Social AI

University of Glasgow

Prediction Results (Accuracy)

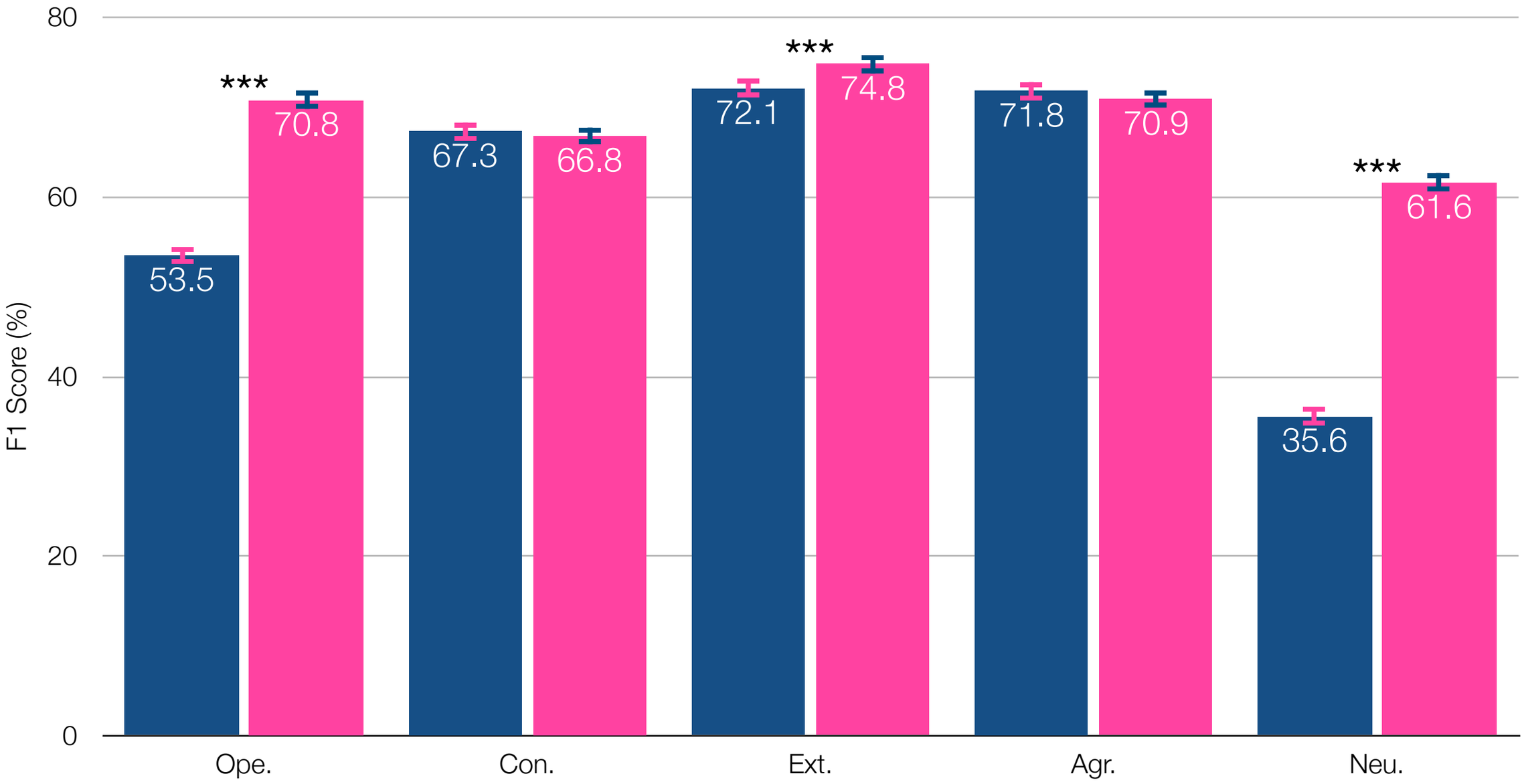


Fringi, Alshubaily, Picinali, Brewster, Guha, Vinciarelli, “Is Distance a Modality? Multi-Task Learning for Speech-Based Joint Prediction of Attributed Traits and Perceived Distances in Virtual Immersive Audio Environments“, Proc. of the ACM International Conference on Multimodal Interaction, 2024.

Social AI

University of Glasgow

Prediction Results (F1 Score)

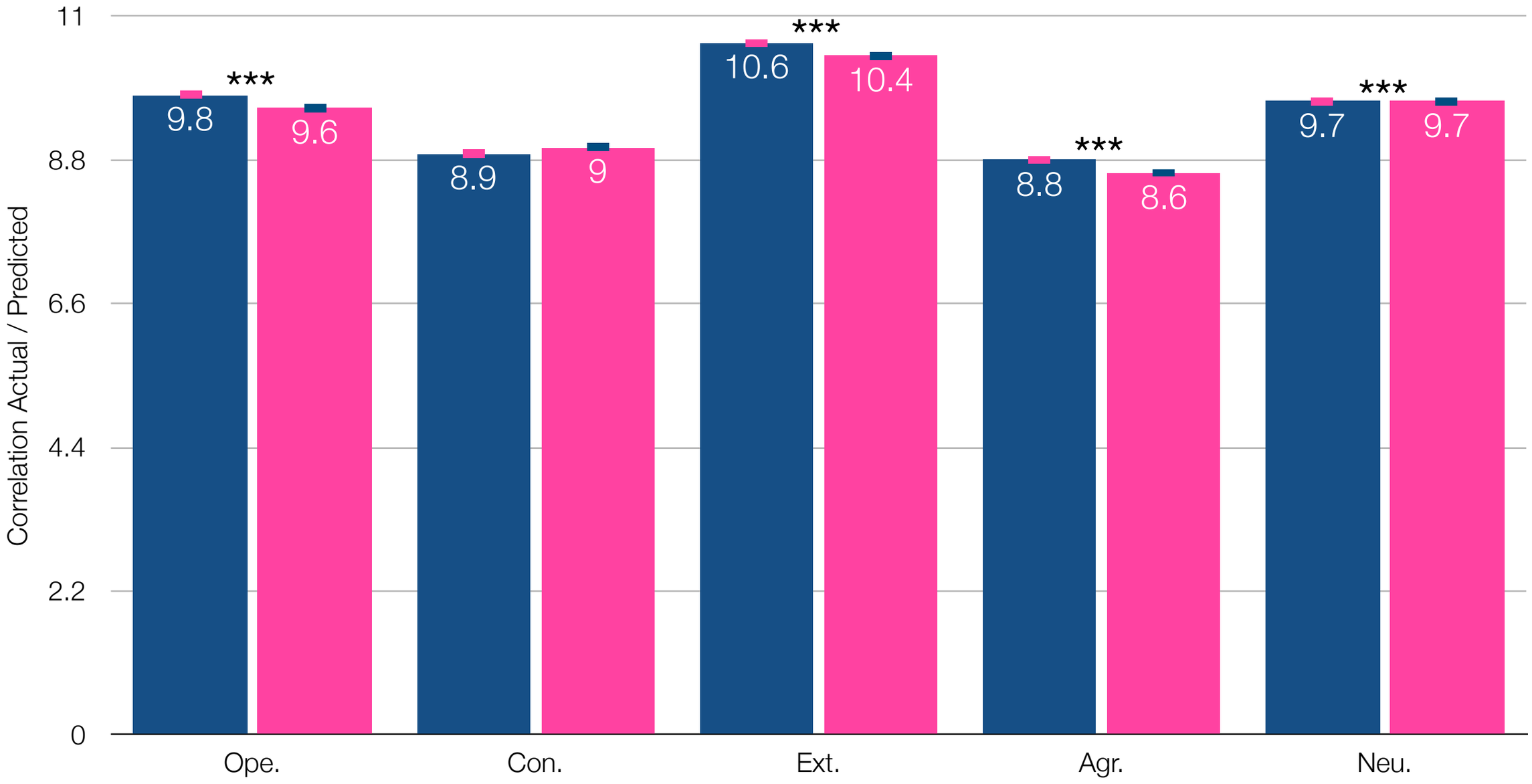


Fringi, Alshubaily, Picinali, Brewster, Guha, Vinciarelli, “Is Distance a Modality? Multi-Task Learning for Speech-Based Joint Prediction of Attributed Traits and Perceived Distances in Virtual Immersive Audio Environments“, Proc. of the ACM International Conference on Multimodal Interaction, 2024.

Social AI

University of Glasgow

Prediction Results (Regression)



Fringi, Alshubaily, Picinali, Brewster, Guha, Vinciarelli, “Is Distance a Modality? Multi-Task Learning for Speech-Based Joint Prediction of Attributed Traits and Perceived Distances in Virtual Immersive Audio Environments“, Proc. of the ACM International Conference on Multimodal Interaction, 2024.

Social AI

University of Glasgow

Prediction

- All traits can be predicted well beyond chance;
- When jointly predicting traits and distance, the accuracy increases for all traits, the F1 Score for Openness, Conscientiousness and Neuroticism;
- The classification improvement seems to confirm that there is a relationship distance-traits, including traits for which the correlation is not significant;
- The improvement suggests relationships distance-traits in cases for which the correlation is not significant;
- An alternative to Psychology?

Social AI

University of Glasgow

Outline

- Judgment Studies
- Example: Personality Perception in AAR
- Conclusions

Social AI

University of Glasgow

Conclusions

- There is an interplay between perceived distance and attribution of personality traits;
- In Audio Augmented Reality, distance is one of the key-perception modalities;
- Humans struggle in assessing the distance of a speaker in absence of visual stimuli and distance perception is a challenging problem;
- Uncertainty in predicting the perceived distance results into uncertainty in predicting the attributed traits.

Social AI

University of Glasgow

Thank You!

Social AI

University of Glasgow