SUPPLEMENTARY INFORMATION FOR "BEYOND THE AUDIOGRAM: USING PROMS AND AI MODELLING TO CHARACTERISE AGE- AND SEX-SPECIFIC HL NEEDS IN A NATIONWIDE STUDY"

Perrine Morvan[*]
Université Paris Cité
Institut Pasteur, AP-HP, INSERM, CNRS,
Fondation Pour l'Audition, Institut de l'Audition
IHU reConnect, F-75012, Paris, France
pmorvan@pasteur.fr

Marta Campi[*]
Université Paris Cité
Institut Pasteur, AP-HP, INSERM, CNRS,
Fondation Pour l'Audition, Institut de l'Audition
IHU reConnect, F-75012, Paris, France
mcampi@pasteur.fr

Gareth W. Peters
Department of Statistics and Applied Probability
University of California Santa Barbara
Santa Barbara, CA 93106, United States
garethpeters@ucsb.edu

Hung Thai-Van
Université Paris Cité
Institut Pasteur, AP-HP, INSERM, CNRS,
Fondation Pour l'Audition, Institut de l'Audition
IHU reConnect, F-75012, Paris, France
@pasteur.fr

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[*] These authors contributed equally to this work.

Contents

1 Introduction

This supplementary Information is in support of the paper "**Beyond the Audiogram: Using PROMs and AI Modelling to Characterise Age- and Sex-Specific Hearing Loss Needs in a Nationwide Study".** We provide all the results of our analyses described in the main body of the paper.

The structure is given as follows. In the first section acronyms and abbreviations used within this document as well as in the main paper are presented. We then provide the RECORD Checklist and data sharing statement, required for publication.

Afterwards, a section offering results of the descriptive statistics is given. The text classification procedure used for COSI responses is then presented, detailing how we employed advanced NLP techniques to systematically categorize patient-reported outcomes.

We then move to the statistical tests including the Chi-Squared, used to evaluate the association between categorical variables, specifically to determine how HL severity or sex relates to different COSI responses. Then, an ANOVA analysis is presented. Lastly, proportion tests are used to examine sex differences across age groups in COSI responses, providing insights into variations in experiences based on sex and age.

The multiple regression analysis is then described. This explores the relationships between PTA and the COSI responses considered individually, i.e. Q1.

To provide more rigorous and accurate understandings, we focus on a segmented regression [1, 2] analysis to detect potential age-related breakpoints by sex, focusing on PTA as the variable and examine how category needs might vary with age.

Several statistical tests (Wilcox, Kruskal-Wallis and Brown-Mood median) were then performed to understand whether the age partitions, identified using PTA as the variable, remain statistically significant when SNR and SRT distributions are considered.

Lastly, we present the results of multiple regression analysis using SMOGN (Synthetic Minority Over-sampling Technique for Regression with Gaussian Noise). This approach addresses imbalances in our dataset, particularly for less common HL categories, ensuring more robust results across the entire spectrum of hearing impairment.

2 Acronyms & Abbreviations

The following acronyms and abbreviations are used in this manuscript:
APSO : Audiology Practice Standards Organization
ASHA : American Speech-Hearing-Language Association
BERT : Bidirectional Encoder Representations from Transformers
COSI : Client-Oriented Scale of Improvement
CNIL : Commission Nationale de l'Informatique et des Libertés
CNRS : French National Center for Scientific Research
GAS : Goal Attainment Scaling
HA : Hearing Aid
HAS : French National Authority for Health
HL : Hearing Loss
NLP : Natural Language Processing
PCC : People-Centered Care
PROMs : Patient-Reported Outcome Measures
PTA : Pure-Tone Audiometry
RECORD : Reporting of Studies Conducted Using Observational Routinely Collected Data
SNR : Signal-to-Noise Ratio
SRT : Speech Reception Threshold
SI : Supplementary Information.

3 RECORD Statement

Table 1: The RECORD statement – checklist of items, extended from the STROBE statement, that should be reported in observational studies using routinely collected health data.

	Item No.	STROBE Items	Location in manuscript	RECORD Items	Location in manuscript
Title and abstract					
	1 1(b)	(a) Indicate the study's design with a commonly used term in the title or the abstract Provide in the abstract an informative and balanced summary of what was done and what was found	(a) and (b):p1 - (a) section:'methods'	RECORD 1.1: The type of data used should be specified in the title or abstract. When possible, the name of the databases used should be included. RECORD 1.2: If applicable, the geographic region and timeframe within which the study took place should be reported in the title or abstract. RECORD 1.3: If linkage between databases was conducted for the study, this should be clearly stated in the title or abstract.	
Introduction					
Background rationale	2	Explain the scientific background and rationale for the investigation being reported	p1-2		
Objectives	3	State specific objectives, including any prespecified hypotheses	p2		
Methods					
Study Design	4	Present key elements of study design early in the paper	p2, section 2.1		
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	p2, section 2.1		
Participants					

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Table 1 – continued from previous page

	Item No.	STROBE Items	Location in manuscript	RECORD Items	Location in manuscript
	6(a)	Cohort study- Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up Case-control study- Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls Cross-sectional study- Give the eligibility criteria, and the sources and methods of selection of participants p2, section 2.2		RECORD 6.1: The methods of study population selection (such as codes or algorithms used to identify subjects) should be listed in detail. If this is not possible, an explanation should be provided. RECORD 6.2: Any validation studies of the codes or algorithms used to select the population should be referenced. If validation was conducted for this study and not published elsewhere, detailed methods and results should be provided. RECORD 6.3: If the study involved linkage of databases, consider use of a flow diagram or other graphical display to demonstrate the data linkage process, including the number of individuals with linked data at each stage.	
	6(b)	Cohort study- For matched studies, give matching criteria and number of exposed and unexposed Case-control study- For matched studies, give matching criteria and the number of controls per case			
Variables					

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Table 1 – continued from previous page

	Item No.	STROBE Items	Location in manuscript	RECORD Items	Location in manuscript
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable.	p2, section 2.2	RECORD 7.1: A complete list of codes and algorithms used to classify exposures, outcomes, confounders, and effect modifiers should be provided. If these cannot be reported, an explanation should be provided.	
Data sources/measurement					
Data sources/ measurement	8	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	p2-3, section 2.3, 2.4		
Bias					
Bias	9	Describe any efforts to address potential sources of bias	SI, section 5-6		
Study size					
Study size	10	Explain how the study size was arrived at	p4, Figure 2		
Quantitative variables					
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen, and why	p3, Section 2.5		
Statistical methods					
Statistical methods	12(a)	Describe all statistical methods, including those used to control for confounding	(a)(b) p3, section 2.5		
	12(b)	Describe any methods used to examine subgroups and interactions			
	12(c)	Explain how missing data were addressed	(c) SI, sections 7-8-9- 10-11		
	12(d)	Cohort study- If applicable, explain how loss to follow-up was addressed Case-control study- If applicable, explain how matching of cases and controls was addressed Cross-sectional study- If applicable, describe analytical methods taking account of sampling strategy	(d) p3, section 2.5.2 and SI section 11.1		
	12(e)	Describe any sensitivity analyses			
Data access and cleaning methods					

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	Item No.	STROBE Items	Location in manuscript	RECORD Items	Location in manuscript
Data access and cleaning methods			p3, section 2.5.2	RECORD 12.1: Authors should describe the extent to which the investigators had access to the database population used to create the study population. RECORD 12.2: Authors should provide information on the data cleaning methods used in the study.	
Linkage					
Linkage				RECORD 12.3: State whether the study included person-level, institutional-level, or other data linkage across two or more databases. The methods of linkage and methods of linkage quality evaluation should be provided.	
Results					
Participants					
Participants	13(a)	Report the numbers of individuals at each stage of the study (e.g., numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed)	(a)(b)(c) p3,4 ; section 3.1		
	13(b)	Give reasons for non-participation at each stage			
	13(c)	Consider use of a flow diagram		RECORD 13.1: Describe in detail the selection of the persons included in the study (i.e., study population selection) including filtering based on data quality, data availability and linkage. The selection of included persons can be described in the text and/or by means of the study flow diagram.	
Descriptive data					
Descriptive data	14(a)	Give characteristics of study participants (e.g., demographic, clinical, social) and information on exposures and potential confounders	p3,4, section 3.1		

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Table 1 – continued from previous page

	Item No.	STROBE Items	Location in manuscript	RECORD Items	Location in manuscript
	14(b) 14(c)	Indicate the number of participants with missing data for each variable of interest Cohort study- summarise follow-up time (e.g., average and total amount)			
Outcome data					
Outcome data	15	Cohort study- Report numbers of outcome events or summary measures over time Case-control study- Report numbers in each exposure category, or summary measures of exposure Cross-sectional study- Report numbers of outcome events or summary measures	p 4-5-6		
Main results					
Main results	16(a) 16(b) 16(c)	Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (e.g., 95% confidence interval). Make clear which confounders were adjusted for and why they were included Report category boundaries when continuous variables were categorized If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	p4-5-6 sections 3.2 and 3.3		
Other analyses					
Other analyses	17	Report other analyses done—e.g., analyses of subgroups and interactions, and sensitivity analyses	SI, section 7-8-9-10-11		
Discussion					
Key results	18	Summarise key results with reference to study objectives	p 6,7,8		

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Table 1 – continued from previous page

	Item No.	STROBE Items	Location in manuscript	RECORD Items	Location in manuscript
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	p8, section 4.1	RECORD 19.1: Discuss the implications of using data that were not created or collected to answer the specific research question(s). Include discussion of misclassification bias, unmeasured confounding, missing data, and changing eligibility over time, as they pertain to the study being reported.	
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	p 6, 7, 8		
Generalisability	21	Discuss the generalisability (external validity) of the study results	p 8		
Other Information					
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	p8		
Accessibility of protocol, raw data, and programming code			p3	RECORD 22.1: Authors should provide information on how to access any supplemental information such as the study protocol, raw data, or programming code.	

**Reference: Benchimol EI, Smeeth L, Guttmann A, Harron K, Moher D, Petersen I, Sørensen HT, von Elm E, Langan SM, the RECORD Working Committee. The REporting of studies Conducted using Observational Routinely-collected health Data (RECORD) Statement. PLoS Medicine 2015; in press.*

4 Data Sharing Statement

In this subsection we provide Table 2, which outlines the data sharing information for the manuscript. The table consists of two columns: the first column contains the statement regarding data sharing, and the second column lists the data sharing options available.

Statements	Data sharing options.
Will individual participant data be available (including data dictionaries)?	Yes, upon demand
What data in particular will be shared?	Individual participant data that underlie the results reported in this article in line with GDPR (text, tables, figures, and appendices)
What other documents will be available?	Statistical analysis plan, analytic code
With whom?	Academic research
For what types of analyses?	No restriction
By what mechanism will data be made available?	GitHub repository and upon request

Table 2: Data sharing statements that fulfill the ICMJE requirements

5 Descriptive Statistics

In this section we report the main descriptive statistics for the considered dataset. Overall, the dataset comprises a total of 91,287 participants with varying degrees of HL, categorized from normal to profound. The distribution across HL levels shows the highest frequencies in the "Mild" and "Moderate" categories, with 33,924 and 40,749 participants, respectively. In contrast, "Profound" HL is the least common, with only 26 participants. Table 3 illustrates the distribution of HL levels among participants. Further disaggregation by sex is provided in Table 4, where it is evident that both males and females are similarly affected across all HL categories, although slight variations exist in counts.

Table 5 features distribution of responses across the COSI categories. For Q1, "Group conversation in noise" is the most common category, with 20,711 responses, followed by "Conversation with 1 or 2 in quiet" at 17,335. In contrast, "Increased social contact" has the fewest responses with 863. For Q2, the highest number of responses is in "Television/radio at normal volume" with 26,551, indicating a strong priority among participants for improving comprehension of media at normal volumes. "Conversation with 1 or 2 in quiet" also remains significant, with 8,779 responses. Q2 shows 3,261 "NAs". Instead, Q3 shows a marked increase in responses for "NAs" (47,899), suggesting that many participants either did not respond to this question or considered other categories less relevant. This distribution highlights varying priorities among individuals, with a notable emphasis on improving speech comprehension in noisy environments and understanding media. Table 6 presents the same settings but with the added variables of sex whose analysis indicates some differences in Qpatterns.

The summary statistics in Table 7 delve into demographic variables, presenting insights on age, PTA, SRT, and SNR overall. The mean age of participants is 72.1 years, with a standard deviation of 11.81 years, indicating a broad age range from 18 to 99 years. The average PTA is 42.87 dB HL, with a standard deviation of 11.25 dB HL, reflecting a wide variation in hearing levels across the sample. Summary statistics for SRT and SNR further illustrate the variability in hearing performance among participants, with mean SRT and SNR values of 45.36 dB and 4.24 dB, respectively.

When analyzed by sex, differences emerge in several key variables. The summary statistics are give in Table 8. For age, females have a slightly higher mean (72.92 years) compared to males (71.30 years), with both sexes exhibiting a wide age range. In terms of PTA, males show a marginally higher mean (43.22 dB HL) than females (42.47 dB HL), although the difference is relatively small. SRT values indicate that females have a higher mean threshold (46.38 dB) compared to males (44.31 dB), while SNR values are somewhat higher for males (4.37 dB) compared to females (4.09 dB). These statistics highlight subtle but notable differences in hearing characteristics between sexes, which could be relevant for tailoring audiological assessments and interventions. Figure 1 shows the repartition of the responses by sex.

Tables 10, **??**, **??** show distribution of COSI responses across various levels of HL for the three different questions, in each COSI category. Note that these tables are included in subsection 7.1, as they also present the Chi-Squared test results. It is possible to observe how the frequency of responses varies significantly. For example, the need to increase social contact is notably higher among individuals with moderate HL, reflecting a growing importance as HL intensifies. Similarly, the need for conversations in silence and group conversations in noisy environments is also prominent in moderate and severe HL groups, indicating how specific communication challenges evolve with the severity of hearing impairment. In contrast, needs such as group conversations in silence and interactions in church or meeting settings show less variation across HL levels. The need for understanding unfamiliar interlocutors on the phone and managing feelings of embarrassment or stupidity also becomes more pronounced as HL severity increases. Additionally, the demand for television and radio comprehension at normal volume is particularly high among those with moderate HL. These patterns highlight the diverse communication challenges faced by individuals with HL and underscore the necessity for targeted interventions based on the severity of their condition.

If one focuses on the participants with mild to moderate HL (average hearing level of 42.87 ± 11.25 dB HL and a mean age of 72.1 ± 11.81 years), the primary needs identified were improving speech comprehension in noisy environments and better understanding of television and/or radio. Sex differences reveal that women prioritize improving TV/radio comprehension less compared to men, who, in turn, place increasing social contacts as a lower priority. For understanding unfamiliar interlocutors, women rated phone conversations as a higher priority, while men focused more on comprehension in meetings or church settings.

The variability of COSI responses across sex, HL and age shows how COSI can be highly representative of the considered patient and carry a personalised value which can improve its caring from a PROM perspective.

HL Level	**Count**
Normal	667
Slight	4597
Mild	33924
Moderate	40749
Moderately severe	10430
Severe	894
Profound	26

Table 3: Counts of participants according to HL degree.

Category	**Male**	**Female**
Normal	246	421
Slight	2235	2362
Mild	17293	16631
Moderate	20668	20081
Moderately severe	5772	4658
Severe	534	360
Profound	14	12

Table 4: Counts of participants according to sex.

COSI Category	**Q1**	**Q2**	**Q3**
Conversation with one or two in quiet	17335	8779	2964
Conversation with group in quiet	6592	2850	1025
Conversation with group in noise	20711	16934	6275
Television/radio at normal volume	10929	26551	12222
Unfamiliar speaker on phone	1271	2990	3257
Increased social contact	863	1021	585
Feel embarrassed or stupid	8902	5558	2173
Listening in church or meeting	4163	3057	1305
Other	20521	20286	13582
NAs		3261	47899

Table 5: Counts of COSI responses across each question (Q1, Q2, Q3).

COSI Category	**Female**			**Male**		
	Q1	Q2	Q3	Q1	Q2	Q3
Conversation with one or two in quiet	8023	4082	1368	9312	4697	1596
Conversation with group in quiet	3414	1478	561	3178	1372	464
Conversation with group in noise	9121	7701	3028	11590	9233	3247
Television/radio at normal volume	5575	13043	5904	5354	13508	6318
Unfamiliar speaker on phone	873	1873	1900	398	1117	1357
Increased social contact	427	525	296	436	496	289
Feel embarrassed or stupid	4843	2889	1117	4059	2669	1056
Listening in church or meeting	1893	1419	625	2270	1638	680
Other	10356	10013	6584	10165	10273	6998
NAs		1502	23142		1759	24757

Table 6: Counts of COSI category responses by sex across questions Q1, Q2, and Q3.

Variable	Min	1st Q	Median	Mean	3rd Q	Max	Sd
Age	18.0	66.0	73.0	72.1	80.0	99.0	11.81
PTA	5.00	35.00	42.50	42.87	50.00	115.00	11.25
SRT	0.00	37.00	45.00	45.36	52.00	80.00	11.39
SNR	-10.00	2.00	4.00	4.24	6.00	20.00	3.74

Table 7: Summary statistics for variables including Age, PTA (Pure Tone Average), SRT (Speech Reception Threshold), and SNR (Signal-to-Noise Ratio) over the entire population.

Variable	Sex	Min	1st Q	Median	Mean	3rd Q	Max	Sd
Age	Female	18	66	74	72.92	82	99	12.59
	Male	18	65	72	71.30	79	99	10.96
PTA	Female	5	35	42.5	42.47	50	108.75	11.13
	Male	5	35	42.5	43.22	50	115.00	11.32
SRT	Female	0	39	46	46.38	54	80	11.17
	Male	0	36	43	44.31	51	80	11.47
SNR	Female	-10	2	4	4.09	6	20	3.65
	Male	-10	2	4	4.37	6	20	3.73

Table 8: Summary statistics for Age, PTA (Pure Tone Average), SRT (Speech Reception Threshold), and SNR (Signal-to-Noise Ratio) by sex.

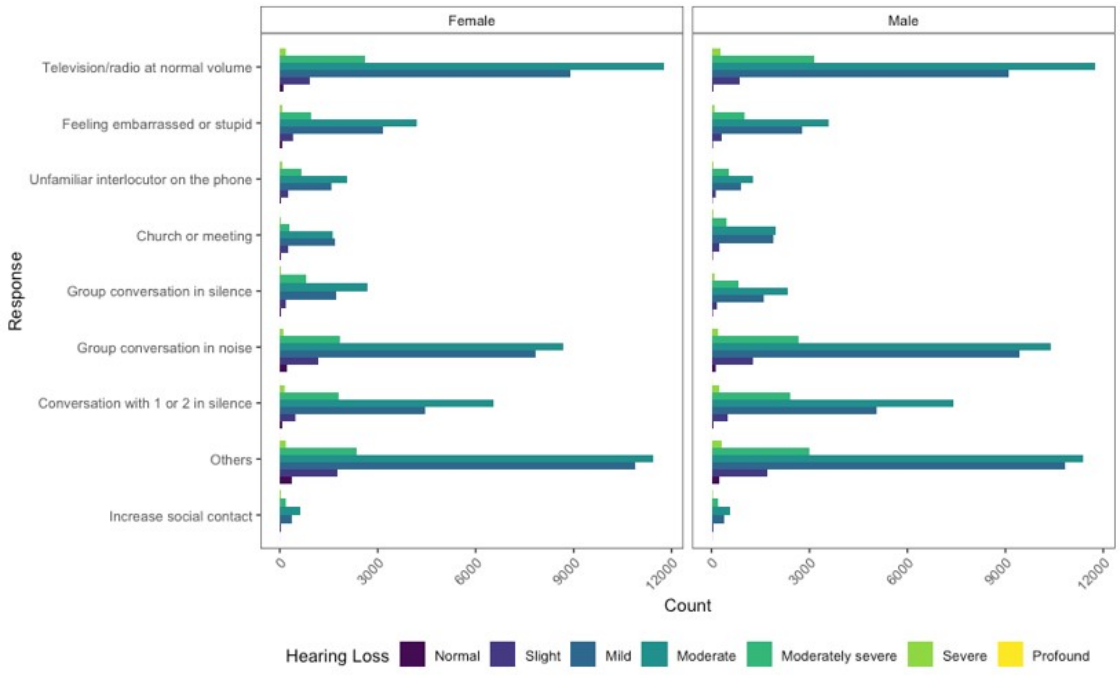


Figure 1: Counts of COSI Responses by sex and degree of HL.

6 Text Classification Procedure of COSI Responses

We began our analysis with a dataset of 723,255 COSI responses, all of which were initially unlabeled. To facilitate the classification process, we first labeled a random sample comprising 1% of the total dataset, which equated to 7,232 responses. This labeled subset was used to train our model and based on the initial categories defined by H.Dillon [3] (see Table 9). Following this, we employed a label projection technique to extend these labels to the remaining 714,255 responses. This projection allowed us to apply the learned labels from the initial sample to the vast majority of the dataset, significantly scaling our labeling efforts.

To classify the survey data, we employed the CamemBERT model[4] (remark that more details about the model are provided in the main body of the paper). The training process involved several key steps. Initially, we applied the

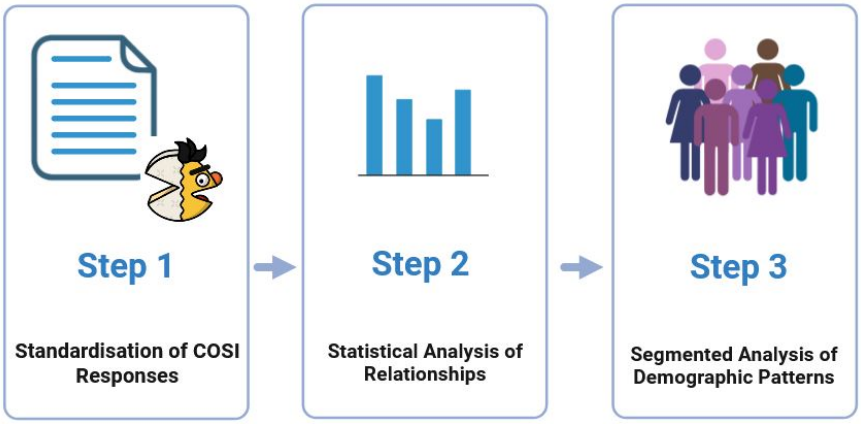


Figure 2: Analytical Framework for Integrating PROMs in Audiology.

deduplication technique described in the paper [5] to remove duplicate entries from the dataset, ensuring the model was trained on unique examples. This step was crucial in ensuring that the model was trained on unique examples, as duplicate entries can lead to overfitting and skewed performance metrics. The deduplication process involved identifying and eliminating exact and near-duplicate entries based on their textual similarity, which helped to enhance the quality of the dataset.

After deduplication, the text data was preprocessed through tokenization and padding for consistency. We then used a pre-trained CamemBERT model with a classification head, adding a linear layer on top for output predictions. The model was trained for a total of 3 to 5 epochs, with each epoch consisting of multiple steps where data was processed in batches. For instance, with a batch size of 16 or 32, the number of steps per epoch was determined by dividing the total number of training examples by the batch size (approximately 313 steps). The training utilized the AdamW optimizer with a learning rate schedule to fine-tune the model parameters, and Cross-Entropy Loss was used to evaluate performance. This approach, combined with the deduplication step, allowed us to achieve an accuracy of 98% on our data after rigorous training and validation, ensuring robust classification of all 723,255 responses. To validate the accuracy of the model, we assessed the classification results by applying expert knowledge to a random sample of 3% of the outputs. The results showed that 93% of this random sample was correctly classified.

Finally, to ensure the quality and accuracy of the label projection, we conducted a detailed review of 3% of the projected labels, which amounted to 21,427 responses. This meticulous checking process confirmed the validity of the label projection and further assured the reliability of the classification results.

Regarding performance metrics, the 98% accuracy achieved during training indicates how well the model performed on the training dataset, reflecting its learning and fitting capacity. However, this does not necessarily guarantee similar performance on unseen data due to potential overfitting. The 93% accuracy on the validation sample reflects a more realistic performance measure, as it was assessed on a random subset and cross-validated by multiple experts, providing a more reliable estimate of the model's generalization capability.

Figure 2 illustrates this analytical framework, demonstrating how each step addresses specific aspects of our research questions.

6.1 COSI Responses Screening

After the label projection and initial classification, we conducted a thorough data screening to further refine the dataset. We began with 723,255 COSI responses. First, we excluded entries related to screening procedures, resulting in 453,709 responses from 190,213 patients. We then applied additional filters: removing patients outside the age range of 18 to 99 years, which reduced the dataset to 185,540 patients; excluding entries with missing PTA data, defined in accordance with the American Speech-Language-Hearing Association (ASHA) classification [6], bringing the number of patients to 177,098; and eliminating those with an SNR smaller than -10 or larger than 20, extreme values that can be tested with a loudspeaker and are realistic for the speech-in-noise test, resulting in 113,363 patients. We also removed entries with missing Q1 responses, leaving 112,599 patients. Further exclusions were made for individuals who use hearing aids (HA), reducing the dataset to 104,731 patients. Finally, we removed those with asymmetric HL, defined by more than 15 dB difference in PTA between both ears [7], resulting in a final dataset of 91,297 patients and 222,701 COSI responses.

Category Number	Category Description	Percentage of Subjects Mentioning
1	Conversation with one or two in quiet	47.4
2	Conversation with one or two in noise	24.1
3	Group conversation in quiet	31.9
4	Group conversation in noise	23.5
5	Television/radio at normal volume	74.8
6	Familiar interlocutor on phone	10.9
7	Unfamiliar interlocutor on the phone	5.0
8	Hear telephone ring from another room	9.3
9	Hear front doorbell or knock	1.8
10	Hear traffic	1.5
11	Increased social contact	1.8
12	Feel embarrassed or stupid	2.4
13	Feel left out	0.4
14	Feel upset or angry	0.6
15	Listening in church or meeting	19.8
16	Other	21.2

Table 9: Number of Times Each of the 16 Standard COSI Needs Categories was Mentioned at the Initial Appointment as a Percentage of the Number of Subjects.

7 Results of Statistical Tests

To comprehensively analyze the relationship between sex or HL severity and the COSI responses, we employed a series of statistical tests to evaluate these associations. Note that, the significance of the tests was determined using p-values. We adhered to conventional thresholds for significance: coefficients with p-values less than 0.05 are considered statistically significant and marked with one asterisk ($*$), indicating moderate evidence against the null hypothesis. Those with p-values below 0.01 are denoted with two asterisks ($**$), representing strong evidence, while p-values under 0.001 are marked with three asterisks ($***$), indicating very strong evidence of a statistically significant effect. P-values above 0.05 are not considered statistically significant and are left unmarked.

7.1 Chi-Squared

We employed the Chi-Squared test of independence to examine whether there is a significant association between either sex or the severity of HL and categorical COSI responses. Results for Q1 (highest priority needs) are given in table 10 for sex and in table 11 for HL. While we conducted descriptive statistics for all three COSI needs (Q1, Q2, and Q3), we focus on presenting detailed results for Q1 here, as it represents patients' most critical priorities.

More formally, denote the categorical variables—sex (S) and severity of HL (HL) and categorical COSI responses (R). The hypotheses for the Chi-Squared test of independence with respect to one categorical variable are as follows:

- Null Hypothesis (H_0): There is no significant association between the categorical variable (e.g., sex) and the categorical COSI responses R. Formally, H_0 posits that the distribution of R is independent of S. Mathematically:
$$H_0 : \mathrm{P}(R|S) = \mathrm{P}(R)$$
- Alternative Hypothesis (H_1): There is a significant association between the categorical variable (e.g., sex) and the categorical COSI responses R. Formally, H_1 asserts that the distribution of R depends on S. Mathematically:
$$H_1 : \mathrm{P}(R|S) \neq \mathrm{P}(R)$$

Equivalently, the same hypotheses are tested with respect to the severity of HL HL replacing sex S.

The results indicate significant associations in all cases ($p < 0.001$), suggesting that both sex and HL severity substantially influence the distribution of COSI responses. These findings highlight a strong relationship between these factors and the reported social and communication challenges.

By evaluating the independence of these categorical variables, the Chi-Squared test helps determine if variations in patterns are systematically related to different sex or levels of HL severity. The results reveal significant associations in all cases ($p<0.001$), indicating that sex and HL severity notably impact the distribution of COSI responses across

various social and communication scenarios. These findings highlight that as the severity of HL changes, the pattern of responses also changes, demonstrating a strong relationship between HL severity and the reported social and communication challenges. An equivalent reasoning can be applied for sex.

Category	**Female**	**Male**
Conversation with one or two in quiet	8,023	9,312
Conversation with group in quiet	3,414	3,178
Conversation with group in noise	9,121	11,590
Television/radio at normal volume	5,575	5,354
Unfamiliar speaker on phone	873	398
Increased social contact	427	436
Feel embarrassed or stupid	4,843	4,059
Listening in church or meeting	1,893	2,270
Other	10,356	10,165
X-squared = 631.24, df = 8, p-value <0.001***		

Table 10: Q1: Counts for Female and Male & Chi-Squared

Q1	**Normal**	**Slight**	**Mild**	**Moderate**	**Moderately severe**	**Severe**	**Profound**	**p-value**
Conversation with one or two in quiet	50	494	5375	8486	2666	253	11	
Conversation with group in quiet	28	198	2060	3182	1030	94	0	
Conversation with group in noise	184	1284	8438	8645	2011	146	3	
Television/radio at normal volume	41	427	4234	5138	1026	61	2	
Unfamiliar speaker on phone	14	84	469	501	184	19	0	
Increased social contact	3	22	262	430	130	16	0	<0.001***
Feel embarrassed or stupid	48	363	3115	4239	1056	80	1	
Listening in church or meeting	32	273	1832	1674	322	28	2	
Other	267	1452	8139	8454	2005	197	7	
X-squared				2050				df=48

Table 11: Q1 Counts by Category and Chi-Squared Value

7.2 ANOVA

To assess the differences in means across various COSI categories, ANOVA was performed on variables such as age, PTA, SNR, and SRT. This analysis helps identify whether these metrics vary significantly with different categories, shedding light on how hearing impairments influence social and communication experiences. Results are given in table 12. As above, we conducted this analysis by considering each individual COSI need, i.e. Q1 only. The hypotheses for the One-Way ANOVA tests with respect to one categorical variable are as follows :

- Null Hypothesis (H_0): There are no significant differences in the means of the continuous variable (e.g., age) across different categories of the COSI responses. Formally:

$$H_0 : \mu_1 = \mu_2 = \cdots = \mu_k$$

  where μ_i represents the mean of the continuous variable for category i, and k is the number of categories.

- Alternative Hypothesis (H_1): There are significant differences in the means of the continuous variable across different categories of the COSI responses. Formally:

$$H_1 : \text{At least one } \mu_i \text{ is different from the others}$$

The ANOVA analysis revealed significant differences in the means across various categories for different variables including age, PTA, SNR, and SRT for Q1, Q2, and Q3. For age means, the differences were statistically significant ($p¡0.001$) across all categories for each response, indicating that the age distribution varied significantly with different categories. Similarly, the PTA means, SNR means, and SRT means also showed significant differences ($p¡0.001$ for all of them) across all categories. This suggests that different levels of hearing impairments (as measured by PTA, SNR, and SRT) are associated with varying responses to social and communication situations. The F-values for these analyses further support the significant differences observed, with notable values such as $F = 435$ for age means in Q1, $F = 259.6$ for PTA means in Q1, $F = 187.4$ for SNR means in Q1, and $F = 154.2$ for SRT means in Q1, among others. Table 12 shows the detailed results for Q1; complete results for Q2 and Q3 are available upon request from the

corresponding author. These results underscore the varying impacts of HL severity on individuals' social interactions and communication experiences.

Q1				
Category	Age Means	PTA Means	SNR Means	SRT Means
Conversation with one or two in quiet	73.94	45.37	4.93	48.00
Conversation with group in quiet	72.91	45.25	4.95	47.92
Conversation with group in noise	71.53	41.53	3.93	43.80
Television/radio at normal volume	75.26	42.65	4.06	45.37
Unfamiliar speaker on phone	72.19	42.98	4.37	45.55
Increased social contact	72.20	45.48	4.89	46.71
Feel embarrassed or stupid	71.90	43.53	4.29	45.77
Listening in church or meeting	64.32	40.67	3.34	42.74
Other	70.76	41.42	3.89	43.96
ANOVA Results	F=435***	F=259.6***	F=187.4***	F=154.2***

Table 12: Comparison of Age, PTA, SNR, and SRT Means with ANOVA Results for Q1.

7.3 Proportion Tests

A two-proportion test[8, 9] was used to explore sex differences in responses, segmented by age in ten-year intervals. By comparing proportions of COSI responses between sexs across different age groups, the provide insights into how sex-related variations in social and communication experiences evolve with age. Significant differences, particularly in older age groups, highlight potential sex disparities in experiencing and responding to social and communication challenges as people age. Results are given in table 13 for Q1. The hypotheses for the two-proportion test, applied to each COSI category, are as follows

- Null Hypothesis (H_0): There is no significant difference between the proportions of individuals selecting each COSI category between sexes in each age group. Formally:

  $$H_0 : p_{1,i} = p_{2,i}$$

  where:
  - $p_{1,i}$ represents the proportion of individuals of the male sex who answered the i-th COSI category.
  - $p_{2,i}$ represents the proportion of individuals of the female sex who answered the i-th COSI category.
- Alternative Hypothesis (H_1): There is a significant difference between the proportions of individuals selecting each COSI category between sexes in each age group. Formally:

  $$H_1 : p_{1,i} \neq p_{2,i}$$

Q1								
Response	18-29	30-39	40-49	50-59	60-69	70-79	80-89	90-99
Conversation with one or two in quiet	1.000	0.016*	0.850	0.964	<0.001***	<0.001***	<0.001***	0.036
Conversation with group in quiet	0.190	0.984	0.855	0.946	0.063	0.009**	0.008**	0.700
Conversation with group in noise	0.883	0.714	0.158	<0.001***	<0.001***	<0.001***	<0.001***	0.490
Television/radio at normal volume	1.000	0.708	0.031*	0.016*	0.658	<0.001***	0.029*	0.184
Unfamiliar speaker on phone	0.406	0.411	<0.001***	<0.001***	<0.001***	<0.001***	<0.001***	0.120
Increased social contact	1.000	0.931	0.808	0.066	0.043*	0.161	0.502	0.363
Feel embarrassed or stupid	0.524	0.683	0.053	0.006**	<0.001***	<0.001***	<0.001***	0.106
Listening in church or meeting	0.301	0.029*	0.058	0.003**	<0.001***	<0.001***	0.424	0.696
Other	0.717	0.580	0.149	0.454	<0.001***	<0.001***	0.080	0.871

Table 13: P-values for Responses Across Different Age Groups (Q1)

The two-proportion test, implemented using the `prop.test` function in R, assesses whether the observed proportions of individuals selecting each COSI category differ significantly between males and females. Focusing on Q1 (highest priority needs), notable statistical significance is observed predominantly in the older age groups (50-99) across different social situations and communication settings. For the age group 50-59, significant differences ($p < 0.05$) are found in Q1 responses related to group conversation in noise, church meetings, unfamiliar interlocutor on the phone, feeling embarrassed or stupid, and television/radio at normal volume. In the age group 60-69, highly significant differences ($p < 0.001$) appear in Q1 responses for conversations with 1 or 2 in silence, group conversations in noise, church meetings, unfamiliar interlocutor on the phone, and feeling embarrassed or stupid. The 70-79 age group shows

significant differences in multiple Q1 responses including conversations with 1 or 2 in silence, group conversations in noise, group conversations in silence, church meetings, unfamiliar interlocutor on the phone, and feeling embarrassed or stupid. For the 80-89 age group, significant results are seen in Q1 responses related to conversations with 1 or 2 in silence, group conversations in noise, group conversations in silence, unfamiliar interlocutor on the phone, and feeling embarrassed or stupid. The age group 90-99 shows fewer significant differences, with notable significance only in conversations with 1 or 2 in silence. While we conducted the same analyses for Q2 and Q3, detailed results for these secondary and tertiary priority needs are available upon request from the corresponding author.

8 Multiple Regression Analysis

We performed a multiple regression with PTA as the response variable, using SNR, SRT, and patient responses ordered by priority (Q1 only) as explanatory variables, each assessed relative to a reference category ("Others"). The regression analysis was conducted across four different scenarios: the entire dataset (overall), by degree of HL, by sex, and by 10-year age categories. This approach allows us to observe variations in the significance of the variables across different settings, providing insights into how the relationships between audiological tests and the needs of hearing-impaired participants differ. The significance of the regression coefficients was determined using p-values derived from partial t-tests. The partial t-test is applied in the context of multiple regression analysis to assess the significance of individual predictors while controlling for the influence of other variables in the model. Specifically, it tests whether the coefficient for a particular variable is significantly different from zero, indicating that the variable has a meaningful impact on the dependent variable. The regression models for each COSI category can be expressed as follows:

- For Q1 (with k levels corresponding to the COSI categories):

$$\text{PTA}_i = \beta_{0,Q1} + \beta_{1,Q1}\text{SNR}_i + \beta_{2,Q1}\text{SRT}_i + \sum_{j=1}^{k-1} \gamma_{j,Q1}\text{Q1}_{j,i} + \epsilon_i \tag{1}$$

where:

- PTA_i is the pure-tone average for the i-th individual.
- SNR_i is the signal-to-noise ratio for the i-th individual.
- SRT_i is the speech reception threshold for the i-th individual.
- $\text{Q1}_{j,i}$ are binary indicator variables representing whether the i-th individual falls into each level j of Q1, respectively.
- $\beta_{0,Q1}$ is the intercept for the models corresponding to Q1.
- $\beta_{1,Q1}$ is the coefficients for SNR in the models for Q1.
- $\beta_{2,Q1}$ is the coefficients for SRT in the models for Q1.
- $\gamma_{j,Q1}$ is the coefficients for the indicator variables representing the different levels j within each COSI category, i.e. Q1 in here.
- ϵ_i is the error term for the i-th individual, assumed to be normally distributed with mean 0 and constant variance.

It is crucial to understand that "Others" is set as the reference category for the COSI responses. This means that the coefficients for other response categories are compared relative to this baseline. Each coefficient for the COSI responses represents the effect on PTA in comparison to the reference category. This approach allows for a clear understanding of how different responses influence PTA relative to the baseline category. Furthermore, remark that the regression analyses were performed both on the entire population, as described earlier, and on various subpopulations, including splits by sex, age categories, and degrees of HL. For simplicity and without loss of generality, we do not formalize these scenarios in detail, as they follow the same methodology as the overall analysis but are indexed by different subpopulation indices. By conducting these analyses across different subpopulations, we can observe variations in the significance of the predictors and how the relationships between audiological measures and COSI responses might differ based on these demographic and clinical factors. This stratification enhances our understanding of the nuanced impacts of HL and response categories across diverse groups within the study population.

8.1 Overall Results

Results of the overall regressions for Q1 are given in Table 14. Both SNR and SRT are consistently significant in the model, indicating their strong association with improved PTA scores. Key patient needs such as increasing social contact, having conversations with one or two people in silence, and participating in group conversations in noise all show significant relationships with PTA scores. Addressing feelings of embarrassment is also highly significant in the Q1 analysis, highlighting its importance as a primary need. Similarly, normalizing television/radio volume shows significance in the regression model. These findings underscore the critical nature of these priority needs for patients managing their HL. Further analysis by the degree of HL will provide additional insights into these trends. Complete results for Q2 and Q3 regression analyses are available upon request from the corresponding author.

Q1				
Variable	**Estimate**	**Std. Error**	**t value**	**P-value**
Intercept	14.951	0.167	89.566	<0.001***
SNR	0.634	0.012	53.275	<0.001***
SRT	0.550	0.004	139.550	<0.001***
Increase social contact	1.587	0.382	4.149	<0.001***
conv. with 1 or 2 in silence	1.215	0.109	11.175	<0.001***
Group conv. in noise	0.334	0.105	3.183	0.001**
Group conv. in silence	0.975	0.157	6.197	<0.001***
Church or meeting	0.267	0.185	1.445	0.148
Unfamiliar interlocutor on the phone	0.347	0.311	1.114	0.265
Feeling embarrassed or stupid	1.003	0.134	7.488	<0.001***
Television/radio at normal volume	0.373	0.126	2.952	0.003**

Table 14: Regression Overall - Reference Category: Others

8.2 Results by Degree of HL

Results of the regressions by degree of HL for Q1 are given in Tables 15, 17, 18, 19 and 20 for Normal, Mild, Moderate, Moderately Severe and Profound. The results for Slight and Severe are provided in the main body of the paper.

The regression analysis tables reveal that intercepts are significant across all degrees of HL, establishing a consistent baseline effect. The Speech Recognition Threshold (SRT) is significant in most degrees of HL, underscoring its critical role in outcomes. The Signal-to-Noise Ratio (SNR) becomes increasingly significant as the degree of HL progresses, notably in the Mild to Severe categories. For Moderate HL, SNR ($p<0.001$), SRT ($p<0.001$), Conversation with 1 or 2 in silence ($p<0.001$), and Feeling embarrassed or stupid ($p = 0.004$) are significant in Q1.

As the degree of HL increases, the significance of various variables, particularly SNR and SRT, becomes more pronounced, indicating greater challenges. For individuals with normal hearing, fewer variables are significant, suggesting fewer difficulties. Slight HL sees more variables, including SNR and SRT, becoming significant, indicating increased difficulty in social and conversational settings. Mild HL highlights substantial challenges across various settings, with almost all variables, especially SNR and SRT, being significant. For Moderate to Severe HL, a broader range of variables, including conversational settings and social factors, become significant, indicating significant challenges in everyday interactions.

For Q1, the significance of conversational settings (e.g., conversation with 1 or 2 in silence, group conversation in noise) increases with the degree of HL. This analysis underscores the heightened needs and challenges in both social and personal contexts as the degree of HL intensifies. While similar analyses were conducted for Q2 and Q3, these detailed results are available upon request from the corresponding author.

Q1				
Variable	**Estimate**	**Std. Error**	**t value**	**P-value**
Intercept	10.556	0.591	17.864	<0.001***
SNR	0.010	0.058	0.176	0.861
SRT	0.067	0.021	3.197	0.043*
Increase social contact	-0.953	1.747	-0.546	0.586
Conversation with 1 or 2 in silence	-0.142	0.494	-0.288	0.774
Group conversation in noise	-0.005	0.347	-0.014	0.989
Group conversation in silence	1.441	0.697	2.066	0.054
Church or meeting	-1.022	0.667	-1.532	0.127
Unfamiliar interlocutor on the phone	0.994	0.893	1.114	0.266
Feeling embarrassed or stupid	0.070	0.519	0.135	0.893
Television/radio at normal volume	0.187	0.591	0.317	0.752

Table 15: Regressions with Q1, Q2, Q3 - Reference Category: Others (Normal Hearing)

Q1				
Variable	**Estimate**	**Std. Error**	**t value**	**P-value**
Intercept	19.765	0.262	75.580	¡0.001***
SNR	0.088	0.027	3.280	0.001**
SRT	0.062	0.008	7.596	0.019*
Increase social contact	-0.584	0.811	-0.720	0.013*
Conversation with 1 or 2 in silence	0.520	0.187	2.773	0.214
Group conversation in noise	0.172	0.138	1.243	0.006**
Group conversation in silence	0.035	0.283	0.124	0.902
Church or meeting	0.092	0.237	0.390	0.697
Unfamiliar interlocutor on the phone	-0.127	0.400	-0.318	0.751
Feeling embarrassed or stupid	0.167	0.204	0.817	0.414
Television/radio at normal volume	0.455	0.205	2.221	0.026*

Table 16: Regression with Q1. Reference Category: Others. Slight HL.

Q1				
Variable	**Estimate**	**Std. Error**	**t value**	**P-value**
Intercept	27.443	0.153	179.828	<0.001***
SNR	0.126	0.012	10.325	<0.001***
SRT	0.172	0.004	44.724	<0.001***
Increase social contact	0.474	0.333	1.422	0.155
Conversation with 1 or 2 in silence	0.386	0.089	4.347	<0.001***
Group conversation in noise	0.104	0.079	1.317	<0.001***
Group conversation in silence	0.328	0.132	2.489	0.017*
Church or meeting	0.125	0.136	0.913	0.361
Unfamiliar interlocutor on the phone	0.027	0.249	0.110	0.912
Feeling embarrassed or stupid	0.218	0.107	2.032	0.042*
Television/radio at normal volume	0.269	0.097	2.780	0.004**

Table 17: Regressions with Q1 - Reference Category: Others (Mild HL)

Q1				
Variable	**Estimate**	**Std. Error**	**t value**	**P-value**
Intercept	39.598	0.147	269.043	<0.001***
SNR	0.190	0.009	21.889	<0.001***
SRT	0.138	0.003	44.084	<0.001***
Increase social contact	0.039	0.260	0.149	0.882
Conversation with 1 or 2 in silence	0.321	0.077	4.146	<0.001***
Group conversation in noise	0.141	0.078	1.811	0.007**
Group conversation in silence	0.202	0.112	1.807	0.071
Church or meeting	-0.022	0.137	-0.163	0.018*
Unfamiliar interlocutor on the phone	0.149	0.236	0.632	0.528
Feeling embarrassed or stupid	0.258	0.096	2.688	0.004**
Television/radio at normal volume	-0.053	0.090	-0.583	0.560

Table 18: Regressions with Q1- Reference Category: Others (Moderate HL)

Q1				
Variable	**Estimate**	**Std. Error**	**t value**	**P-value**
Intercept	56.488	0.297	190.282	<0.001***
SNR	0.156	0.012	12.677	0.032*
SRT	0.049	0.005	8.972	<0.001***
Increase social contact	0.373	0.466	0.801	0.423
Conversation with 1 or 2 in silence	0.205	0.142	1.441	0.015*
Group conversation in noise	-0.174	0.153	-1.136	0.256
Group conversation in silence	0.035	0.191	0.185	0.853
Church or meeting	-0.337	0.310	-1.088	0.276
Unfamiliar interlocutor on the phone	0.180	0.387	0.465	0.642
Feeling embarrassed or stupid	0.085	0.180	0.472	0.637
Television/radio at normal volume	-0.371	0.186	-1.994	0.046*

Table 19: Regression with Q1 - Reference Category: Others (Moderately Severe HL)

Response1				
Variable	**Estimate**	**Std. Error**	**t value**	**P-value**
Intercept	94.741	12.564	7.541	<0.001***
SNR	0.055	0.644	0.085	0.934
SRT	0.052	0.268	0.195	0.850
Increase social contact	NA	NA	NA	NA
Conversation with 1 or 2 in silence	-6.021	4.679	-1.287	0.230
Group conversation in noise	-2.477	8.286	-0.299	0.772
Group conversation in silence	NA	NA	NA	NA
Church or meeting	3.442	7.071	0.487	0.638
Unfamiliar interlocutor on the phone	NA	NA	NA	NA
Feeling embarrassed or stupid	-5.222	8.037	-0.650	0.532
Television/radio at normal volume	-8.458	8.144	-1.038	0.326

Table 20: Regression with Q1 - Reference Category: Others (Profound HL)

8.3 Results by sex

Results of the regressions by sex for Q1 are given in Tables 21 and 22. The regression analysis of PTA with explanatory variables SNR and SRT, using "Others" as the reference category, reveals significant patterns differentiated by sex. For both females and males, SNR and SRT exhibit significant positive effects on PTA, indicating that improvements in these auditory metrics are associated with better PTA outcomes. Males generally display higher intercept values and coefficients in the Q1 analysis, suggesting a greater sensitivity to these factors.

Examining the Q1 COSI needs, increased social contact significantly influences PTA for females, while males show a more variable response to this factor. Additionally, females consistently show a positive correlation with feelings of embarrassment or being stupid in their highest priority needs, whereas males demonstrate some marginal significance in this regard. These findings underscore the importance of considering sex differences in auditory interventions, as males and females respond distinctly to various social and auditory environments when addressing their primary hearing needs. This insight is crucial for designing tailored rehabilitation strategies and highlights the need for further research to explore the broader applicability of these trends in diverse populations. Complete results for Q2 and Q3 regression analyses by sex are available upon request from the corresponding author.

Response1				
Variable	**Estimate**	**Std. Error**	**t value**	**P-value**
Intercept	12.95	0.242	53.488	<0.001***
SNR	0.542	0.017	31.883	<0.001***
SRT	0.586	0.006	103.513	<0.001***
Increase social contact	1.421	0.508	2.799	0.005**
Conversation with 1 or 2 in silence	0.99	0.151	6.546	<0.001***
Group conversation in noise	0.146	0.148	0.986	<0.001***
Group conversation in silence	0.872	0.212	4.121	0.324
Church or meeting	-0.097	0.264	-0.367	0.713
Unfamiliar interlocutor on the phone	0.568	0.368	1.54	0.123
Feeling embarrassed or stupid	0.998	0.179	5.569	<0.001***
Television/radio at normal volume	0.295	0.172	1.718	0.086

Table 21: Regression with Q1 - Reference category: Others. Female.

Response1				
Variable	**Estimate**	**Std. Error**	**t value**	**P-value**
Intercept	15.889	0.231	68.92	<0.001***
SNR	0.65	0.017	38.841	<0.001***
SRT	0.546	0.006	98.34	<0.001***
Increase social contact	1.87	0.57	3.284	0.071
Conversation with 1 or 2 in silence	1.258	0.155	8.14	<0.001***
Group conversation in noise	0.303	0.148	2.053	<0.001***
Group conversation in silence	1.093	0.231	4.731	0.04*
Church or meeting	0.427	0.257	1.662	0.027*
Unfamiliar interlocutor on the phone	0.769	0.56	1.372	0.005**
Feeling embarrassed or stupid	1.074	0.198	5.434	0.071
Television/radio at normal volume	0.428	0.183	2.337	0.019*

Table 22: Regression with Q1 - Reference category: Others. Male.

8.4 Results by Age Category

Results of the regressions by age category for Q1 are given in Tables 23, 24, 25, 26, 27, 28, 29 and 30. The regression analysis assessing PTA across various age groups highlights the influence of SNR, SRT, and social interaction scenarios, using "Others" as the reference category.

Generally, younger age groups (18-29) show significant positive coefficients for SNR and SRT in the Q1 analysis, indicating strong relationships with PTA outcomes, although other variables like "Increase social contact" and specific social interaction scenarios yield mixed significance. The significance and impact of different variables in Q1 reflect the priority and immediate factors affecting individuals' auditory experiences.

As age groups progress to older populations, the intercept values and coefficients for SNR and SRT typically increase in the Q1 models, revealing that age correlates positively with PTA improvements in these metrics. Older age groups also demonstrate significant impacts for variables such as "Group conversation in silence" and feelings of embarrassment, indicating that social dynamics and emotional responses are critical in shaping these individuals' primary auditory experiences.

The differences in results by age suggest that, as individuals mature, the importance of various social factors and auditory performance may shift, necessitating targeted approaches in auditory interventions tailored to each age group's unique characteristics and prioritized needs. Overall, these insights from the Q1 analysis can guide personalized hearing rehabilitation strategies and enhance our understanding of how age-related changes influence communication and

hearing performance. Complete results for Q2 and Q3 regression analyses by age category are available upon request from the corresponding author.

Response1				
Variable	**Estimate**	**Std. Error**	**t value**	**P-value**
Intercept	3.65	2.647	1.379	0.169
SNR	0.662	0.204	3.251	0.001**
SRT	0.77	0.065	11.833	<0.001***
Increase social contact	6.606	6.148	1.075	0.284
Conversation with 1 or 2 in silence	5.997	2.355	2.547	0.011*
Group conversation in noise	-0.849	1.836	-0.462	0.644
Group conversation in silence	1.424	2.511	0.567	0.571
Church or meeting	0.046	2.095	0.022	0.983
Unfamiliar interlocutor on the phone	8.412	6.115	1.376	0.17*
Feeling embarrassed or stupid	4.332	2.724	1.59	0.013*
Television/radio at normal volume	-2.899	3.14	-0.923	0.357

Table 23: Regression with Q1 - Reference category: Others. 18-29

Response1				
Variable	**Estimate**	**Std. Error**	**t value**	**P-value**
Intercept	5.09	1.792	2.841	0.005**
SNR	0.693	0.145	4.767	<0.001***
SRT	0.719	0.046	15.752	<0.001***
Increase social contact	3.92	4.995	0.785	0.433
Conversation with 1 or 2 in silence	2.601	1.364	1.906	0.057
Group conversation in noise	0.205	1.213	0.169	0.866
Group conversation in silence	2.478	1.837	1.349	0.178
Church or meeting	0.655	1.372	0.477	0.633
Unfamiliar interlocutor on the phone	4.912	2.806	1.751	0.081
Feeling embarrassed or stupid	1.143	1.556	0.734	0.463
Television/radio at normal volume	4.617	2.423	1.905	0.057

Table 24: Regression with Q1 - Reference category: Others. 30-39

Response1				
Variable	**Estimate**	**Std. Error**	**t value**	**P-value**
Intercept	7.822	0.976	8.014	<0.001***
SNR	0.933	0.079	11.809	<0.001***
SRT	0.675	0.025	26.96	<0.001***
Increase social contact	-1.037	2.563	-0.405	0.686
Conversation with 1 or 2 in silence	0.299	0.744	0.402	0.688
Group conversation in noise	-1.181	0.653	-1.81	0.041*
Group conversation in silence	-0.226	0.984	-0.23	0.819
Church or meeting	1.263	0.749	1.686	0.092
Unfamiliar interlocutor on the phone	0.273	1.605	0.17	0.865
Feeling embarrassed or stupid	-0.618	0.767	-0.806	0.042*
Television/radio at normal volume	1.242	1.31	0.948	0.343

Table 25: Regression with Q1 - Reference category: Others. 40-49.

Response1				
Variable	**Estimate**	**Std. Error**	**t value**	**P-value**
Intercept	11.235	0.547	20.527	<0.001***
SNR	0.759	0.047	16.191	<0.001***
SRT	0.605	0.014	43.344	<0.001***
Increase social contact	3.865	1.306	2.96	0.003**
Conversation with 1 or 2 in silence	0.828	0.402	2.06	0.039*
Group conversation in noise	0.393	0.349	1.125	0.26
Group conversation in silence	1.362	0.539	2.528	0.012*
Church or meeting	1.009	0.427	2.363	0.018*
Unfamiliar interlocutor on the phone	-0.421	0.919	-0.458	0.647
Feeling embarrassed or stupid	0.984	0.452	2.176	0.03*
Television/radio at normal volume	1.008	0.579	1.742	0.082

Table 26: Regression with Q1 - Reference category: Others. 50-59.

Response1				
Variable	**Estimate**	**Std. Error**	**t value**	**P-value**
Intercept	13.762	0.335	41.079	<0.001***
SNR	0.74	0.028	26.784	<0.001***
SRT	0.559	0.008	67.59	<0.001***
Increase social contact	1.312	0.777	1.689	0.091
Conversation with 1 or 2 in silence	1.428	0.224	6.372	<0.001***
Group conversation in noise	0.155	0.205	0.759	0.448
Group conversation in silence	1.044	0.337	3.092	0.002**
Church or meeting	0.667	0.39	1.711	0.087
Unfamiliar interlocutor on the phone	0.81	0.726	1.116	0.264
Feeling embarrassed or stupid	0.783	0.269	2.918	0.004**
Television/radio at normal volume	0.091	0.263	0.347	0.729

Table 27: Regression with Q1 - Reference category: Others. 60-69

Response1				
Variable	**Estimate**	**Std. Error**	**t value**	**P-value**
Intercept	16.705	0.284	58.787	<0.001***
SNR	0.656	0.02	32.79	<0.001***
SRT	0.514	0.007	78.122	<0.001***
Increase social contact	2.136	0.635	3.364	0.001**
Conversation with 1 or 2 in silence	1.265	0.173	7.319	<0.001***
Group conversation in noise	0.637	0.169	3.776	<0.001***
Group conversation in silence	0.943	0.256	3.683	<0.001***
Church or meeting	1.024	0.352	2.913	0.004**
Unfamiliar interlocutor on the phone	0.355	0.562	0.632	0.528
Feeling embarrassed or stupid	1.358	0.22	6.179	<0.001***
Television/radio at normal volume	0.193	0.197	0.976	0.329

Table 28: Regression with Q1 - Reference category: Others. 70-79

Response1				
Variable	**Estimate**	**Std. Error**	**t value**	**P-value**
Intercept	22.13	0.383	57.794	<0.001***
SNR	0.508	0.021	24.039	0.031*
SRT	0.451	0.008	55.807	0.021*
Increase social contact	-0.182	0.736	-0.247	0.805
Conversation with 1 or 2 in silence	0.682	0.213	3.2	0.001**
Group conversation in noise	-0.062	0.221	-0.279	0.78
Group conversation in silence	0.568	0.301	1.886	0.059
Church or meeting	-0.564	0.497	-1.134	0.257
Unfamiliar interlocutor on the phone	-0.439	0.546	-0.804	0.421
Feeling embarrassed or stupid	0.562	0.267	2.104	0.035*
Television/radio at normal volume	-0.622	0.237	-2.631	0.009**

Table 29: Regression with Q1 - Reference category: Others. 80-89

Response1				
Variable	**Estimate**	**Std. Error**	**t value**	**P-value**
Intercept	25.238	1.184	21.31	<0.001***
SNR	0.443	0.052	8.508	0.099
SRT	0.415	0.024	17.615	0.041*
Increase social contact	2.076	1.801	1.153	0.249
Conversation with 1 or 2 in silence	0.299	0.579	0.517	0.605
Group conversation in noise	0.828	0.624	1.326	0.185
Group conversation in silence	0.998	0.760	1.313	0.189
Church or meeting	-1.054	1.361	-0.775	0.439
Unfamiliar interlocutor on the phone	1.050	1.517	0.692	0.489
Feeling embarrassed or stupid	1.991	0.743	2.677	0.307
Television/radio at normal volume	-0.257	0.675	-0.381	0.704

Table 30: Regression with Q1 - Reference category: Others. 90-99.

9 Segmented Regression Analysis

Segmented regression, also known as piecewise regression, is a statistical method used to identify changes in the relationship between a variable and one or more explanatory variables at certain points along the range of the explanatory variables, known as breakpoints. This method is particularly useful when the data shows different linear relationships in different ranges of the explanatory variable. One of the key references for segmented regression is the work by Muggeo [1, 2], who developed an efficient algorithm for estimating the breakpoints and the associated regression coefficients. We consider such a method in this work.

In segmented regression, the data is divided into segments based on the identified breakpoints, and separate linear regressions are fitted to each segment. This allows for the detection of shifts in trends or behaviors that are not

captured by a single linear model. Muggeo's method involves an iterative procedure that alternates between estimating the breakpoints and fitting the linear models until convergence is achieved. The procedure is computationally efficient and provides robust estimates of the breakpoints and regression coefficients.

Focusing on Q1, both males and females show a trend towards prioritizing social dynamics and effective communication as they age, though the specific age-related breakpoints and priorities differ. For females, managing feelings of embarrassment and effective communication in noisy environments become more pronounced around ages 49, 67, 65, and 75. In contrast, males increasingly prioritize social interactions and emotional concerns, with significant breakpoints observed at ages 63, 76, 65, and 74. The evolving concern with television and radio at normal volume is evident for both sexes, with notable shifts in priorities around the early 60s and mid-70s. By focusing on these distinct patterns, auditory interventions can be more effectively designed to enhance communication and manage social and emotional factors, ultimately improving the quality of life for individuals with HL.

Results for Q1 breakpoints are provided, with detailed tables for males and females (Tables 31 and 32 and Figure 3, respectively). While similar analyses were conducted for Q2 and Q3, these detailed results are available upon request from the corresponding author.

Formally, the segmented regression model is given by:

$$PTA_{jk} = \beta_{0jk} + \beta_{1jk} \cdot \text{SNR} + \beta_{2jk} \cdot \text{SRT} + \gamma_{1jk} \cdot I(\text{Age} > \psi_{1jk}) + \gamma_{2jk} \cdot I(\text{Age} > \psi_{2jk}) + \epsilon_{jk}$$

where:

- PTA_{jk}: The response variable (PTA) for sex j and COSI response category k.
- β_{0jk}: Intercept for sex j and category k.
- β_{1jk}: Coefficient for SNR for sex j and category k.
- β_{2jk}: Coefficient for SRT for sex j and category k.
- γ_{1jk} and γ_{2jk}: Slopes in different segments for sex j and category k.
- ψ_{1jk} and ψ_{2jk}: Breakpoints for age in sex j and category k.
- $I(\text{Age} > \psi_{1jk})$ and $I(\text{Age} > \psi_{2jk})$: Indicator functions that are 1 if Age is greater than the breakpoints ψ_{1jk} and ψ_{2jk}, respectively, and 0 otherwise.
- ϵ_{jk}: Error term for sex j and category k.

To account for the effects of SNR and SRT, we first remove these influences from the PTA values using partial regression. This involves calculating the residuals after regressing PTA on SNR and SRT. Formally, the residuals $\tilde{PTA}_{jk}$ are given by:

$$\tilde{PTA}_{jk} = PTA_{jk} - \left(\hat{\beta}_{1jk} \cdot \text{SNR} + \hat{\beta}_{2jk} \cdot \text{SRT}\right)$$

The segmented regression model is then applied to these residuals $\tilde{PTA}_{jk}$, focusing solely on the effect of age and the COSI categories. This approach allows for examining how PTA is influenced by age, segmented by breakpoints ψ_{1jk} and ψ_{2jk}, while controlling for the effects of SNR and SRT.

By estimating the breakpoints ψ_{1jk} and ψ_{2jk}, this model captures shifts in the relationship between age and the residual PTA, thus providing a more nuanced understanding of how age impacts PTA when the effects of SNR and SRT are accounted for. For simplicity and due to the nature of the data spanning ages 18 to 99, we fix two breakpoints in the segmented regression model. This approach assumes that significant changes in the relationship between age and PTA occur at two distinct points within this wide age range. Fixing two breakpoints helps to avoid overfitting the model and ensures that we capture major shifts in the relationship while maintaining model simplicity. The model is applied separately for each sex and COSI response category, ensuring that the model remains interpretable and relevant across the extensive age range of the data.

9.1 Male Results

The segmented regression analysis of age-related preferences among males identifies clear patterns for the highest priority needs (Q1). Significant breakpoints occur at ages 63 and 76 for feelings of embarrassment, highlighting the increasing sensitivity to social interactions and the potential for embarrassment as men age. Breakpoints at ages 65 and 74 for group conversations, both in noise and silence, underscore the growing importance of effective communication in social settings. "Television/radio at normal volume," shows breakpoints at ages 62 and 76, indicating that familiar environments and the ability to hear in these settings become increasingly crucial with age. The analysis also reveals

important breakpoints for church or meeting settings (ages 52 and 63), conversations with one or two people in silence (ages 58 and 76), unfamiliar interlocutors on the phone (ages 64 and 85), and increased social contact (ages 58 and 60).

Question	COSI Response	Age
Q1	Feeling embarrassed or stupid	63
Q1	Feeling embarrassed or stupid	76
Q1	Group conversation in noise	65
Q1	Group conversation in noise	74
Q1	Group conversation in silence	65
Q1	Group conversation in silence	74
Q1	Conversation with 1 or 2 in silence	58
Q1	Conversation with 1 or 2 in silence	76
Q1	Television/radio at normal volume	62
Q1	Television/radio at normal volume	76
Q1	Church or meeting	52
Q1	Church or meeting	63
Q1	Unfamiliar interlocutor on the phone	64
Q1	Unfamiliar interlocutor on the phone	85
Q1	Increase social contact	58
Q1	Increase social contact	60

Table 31: Q1 Results by Age and Level (Males).

Similar analyses were conducted for Q2 and Q3, with detailed results available upon request from the corresponding author.

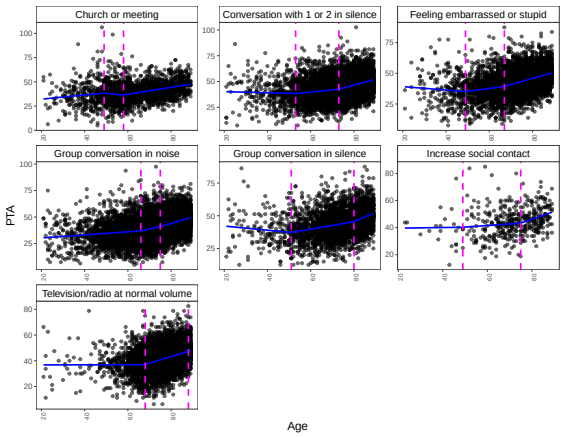
9.2 Female Results

For females, the analysis of Q1, which represents the highest priority needs, shows significant turning points at ages 49 and 67 for feelings of embarrassment or stupidity. This suggests that as women reach their late 40s and into their 60s, they become more sensitive to social dynamics, particularly concerns about embarrassment and social interactions. In group conversations, particularly in noisy environments, notable changes occur at ages 66 and 75, indicating that as women age, they increasingly prioritize environments where they can communicate effectively. The analysis also reveals important breakpoints for group conversations in silence (ages 51 and 80), conversations with one or two people in silence (ages 53 and 73), television/radio at normal volume (ages 68 and 88), church or meeting settings (ages 49 and 58), and increased social contact (ages 49 and 75).

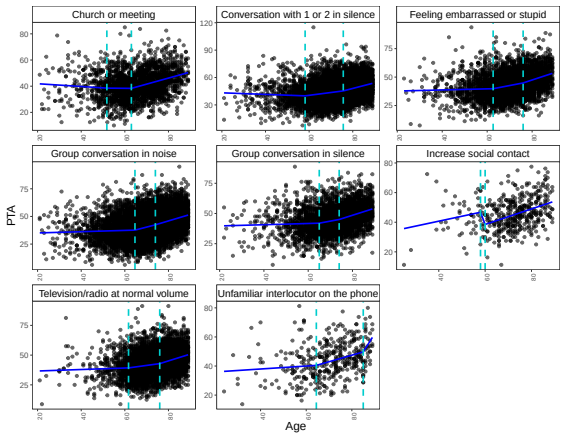
Question	COSI Response	Age
Q1	Feeling embarrassed or stupid	49
Q1	Feeling embarrassed or stupid	67
Q1	Group conversation in noise	66
Q1	Group conversation in noise	75
Q1	Group conversation in silence	51
Q1	Group conversation in silence	80
Q1	Conversation with 1 or 2 in silence	53
Q1	Conversation with 1 or 2 in silence	73
Q1	Television/radio at normal volume	68
Q1	Television/radio at normal volume	88
Q1	Church or meeting	49
Q1	Church or meeting	58
Q1	Increase social contact	49
Q1	Increase social contact	75

Table 32: Q1 Results by Age and Level (Females).

Similar analyses were conducted for Q2 and Q3, with detailed results available upon request from the corresponding author.



(a) Female Segmented Regressions Q1.



(b) Male Segmented Regressions Q1.

Figure 3: Segmented regression results by sex.

10 Cross-Measure Validation of PTA Breakpoints with SNR and SRT Results

In this section, we present the results of non-parametric statistical tests used to explore SNR and SRT distributions across sex and age segments. After identifying age-related breakpoints through a segmented regression with PTA as the response variable, we aimed to understand whether the differences in PTA were also reflected in SRT and SNR performances. To assess this, we conducted three non-parametric statistical tests. Specifically, we used the Wilcoxon test [10] to examine overall sex differences, followed by the Kruskal-Wallis Rank Sum Test [11] and the Brown-Mood median test [12] to analyze SNR and SRT differences across age segments and sex.

10.1 Wilcox Test for Overall SRT and SNR Differences by sex

In our examination of COSI needs through the Wilcoxon test, we assessed sex differences across various scenarios as captured in the COSI survey, focusing on SNR and SRT. Specifically, we tested if there is a difference between a specific COSI need of Q1 in the overall distribution of SRT (or SNR) between males and females. The hypotheses are formulated as follows:

Null Hypothesis (H_0): The null hypothesis states that there is no significant difference in the distribution of SRT (or SNR) between males and females for a given COSI response category. Mathematically, this can be expressed as:

$$H_0 : F_{\text{SRT,male}}(x) = F_{\text{SRT,female}}(x) \text{ for all } x$$
$$H_0 : F_{\text{SNR,male}}(x) = F_{\text{SNR,female}}(x) \text{ for all } x$$

where:

- $F_{\text{SRT,male}}(x)$ denotes the cumulative distribution function (CDF) of SRT for males.
- $F_{\text{SRT,female}}(x)$ denotes the CDF of SRT for females.
- $F_{\text{SNR,male}}(x)$ denotes the CDF of SNR for males.
- $F_{\text{SNR,female}}(x)$ denotes the CDF of SNR for females.

Alternative Hypothesis (H_1): The alternative hypothesis posits that there is a significant difference in the distribution of SRT (or SNR) between males and females for a given COSI response category. This can be written as:

$$H_1 : F_{\text{SRT,male}}(x) \neq F_{\text{SRT,female}}(x) \text{ for some } x$$
$$H_1 : F_{\text{SNR,male}}(x) \neq F_{\text{SNR,female}}(x) \text{ for some } x$$

In these equations, F represents the cumulative distribution function (CDF) of the given variable. The CDF $F(x)$ provides the probability that the variable will take a value less than or equal to x. By comparing the CDFs of SRT and SNR between males and females, we can assess whether there are significant differences in their distributions.

The results for Q1, summarized in Table 33, revealed several significant p-values, particularly in contexts involving conversation dynamics. For instance, a strong distinction was observed in responses related to one-on-one conversations in silence ($p = 0.001$) and group conversations in noisy environments ($p < 0.001$) where sex differences were prominent. Similarly, both SNR and SRT figures showcased significant disparities in contexts such as group discussions in silence (SNR: $p = 0.002$; SRT: $p < 0.001$) and situations involving unfamiliar interlocutors on the phone (SNR: $p < 0.001$; SRT: $p < 0.001$). These findings underscore the critical influence of sex on individual communication preferences and challenges, particularly in noisy or unfamiliar settings. Similar analyses were conducted for Q2 and Q3, with detailed results available upon request from the corresponding author.

Response	p-value	Question	Variable
Increase social contact	0.063	Q1	SNR
Conversation with 1 or 2 in silence	0.001	Q1	SNR
Group conversation in noise	0.000	Q1	SNR
Group conversation in silence	0.002	Q1	SNR
Church or meeting	0.032	Q1	SNR
Unfamiliar interlocutor on the phone	0.000	Q1	SNR
Feeling embarrassed or stupid	0.012	Q1	SNR
Television/radio at normal volume	0.000	Q1	SNR
Increase social contact	0.384	Q1	SRT
Conversation with 1 or 2 in silence	0.000	Q1	SRT
Group conversation in noise	0.000	Q1	SRT
Group conversation in silence	0.000	Q1	SRT
Church or meeting	0.001	Q1	SRT
Unfamiliar interlocutor on the phone	0.505	Q1	SRT
Feeling embarrassed or stupid	0.000	Q1	SRT
Television/radio at normal volume	0.000	Q1	SRT

Table 33: Results for Wilcox Test for Q1 sex differences.

10.2 Kruskal-Wallis Rank Sum Test for Differences in SNR and SRT by Sex & Age Segments

The results from the Kruskal-Wallis test, presented in Table 34, highlight significant sex differences across various communication scenarios for Q1 (highest priority needs).

We aim to assess whether there are significant differences in the distributions of SRT and SNR across age segments defined by breakpoints from a segmented regression model. Specifically, the hypotheses are formulated as follows:

Null Hypothesis (H_0): The null hypothesis posits that there are no significant differences in the distributions of SRT or SNR across the age segments induced by the breakpoints ψ_{1jk} and ψ_{2jk} for each sex and each COSI response category. Mathematically, this is expressed as:

$$H_0 : F_{\text{SRT,female}}(x, \psi_{1jk}, \psi_{2jk}) = F_{\text{SRT,female}}(x, \psi_{1jk}, \psi_{2jk}) \text{ for all } x \text{ within each COSI category } k \quad (2)$$

$$H_0 : F_{\text{SRT,male}}(x, \psi_{1jk}, \psi_{2jk}) = F_{\text{SRT,male}}(x, \psi_{1jk}, \psi_{2jk}) \text{ for all } x \text{ within each COSI category } k \quad (3)$$

$$H_0 : F_{\text{SNR,female}}(x, \psi_{1jk}, \psi_{2jk}) = F_{\text{SNR,female}}(x, \psi_{1jk}, \psi_{2jk}) \text{ for all } x \text{ within each COSI category } k \quad (4)$$

$$H_0 : F_{\text{SNR,male}}(x, \psi_{1jk}, \psi_{2jk}) = F_{\text{SNR,male}}(x, \psi_{1jk}, \psi_{2jk}) \text{ for all } x \text{ within each COSI category } k \quad (5)$$

where:

- $F_{\text{SRT,female}}(x, \psi_{1jk}, \psi_{2jk})$ and $F_{\text{SRT,male}}(x, \psi_{1jk}, \psi_{2jk})$ denote the cumulative distribution functions (CDFs) of SRT for females and males, respectively, adjusted for age segments defined by breakpoints ψ_{1jk} and ψ_{2jk}.
- $F_{\text{SNR,female}}(x, \psi_{1jk}, \psi_{2jk})$ and $F_{\text{SNR,male}}(x, \psi_{1jk}, \psi_{2jk})$ denote the CDFs of SNR for females and males, respectively, adjusted for age segments defined by breakpoints ψ_{1jk} and ψ_{2jk}.
- j denotes sex ($j = 1$ for males and $j = 2$ for females).
- k denotes the COSI response category.

Alternative Hypothesis (H_1): The alternative hypothesis asserts that there are significant differences in the distributions of SRT or SNR across the age segments induced by the breakpoints ψ_{1jk} and ψ_{2jk} for at least one COSI response category. Formally:

$$H_1 : F_{\text{SRT,female}}(x, \psi_{1jk}, \psi_{2jk}) \neq F_{\text{SRT,female}}(x, \psi_{1jk}, \psi_{2jk}) \text{ for some } x \text{ within each COSI category } k \quad (6)$$

$$H_1 : F_{\text{SRT,male}}(x, \psi_{1jk}, \psi_{2jk}) \neq F_{\text{SRT,male}}(x, \psi_{1jk}, \psi_{2jk}) \text{ for some } x \text{ within each COSI category } k \quad (7)$$

$$H_1 : F_{\text{SNR,female}}(x, \psi_{1jk}, \psi_{2jk}) \neq F_{\text{SNR,female}}(x, \psi_{1jk}, \psi_{2jk}) \text{ for some } x \text{ within each COSI category } k \quad (8)$$

$$H_1 : F_{\text{SNR,male}}(x, \psi_{1jk}, \psi_{2jk}) \neq F_{\text{SNR,male}}(x, \psi_{1jk}, \psi_{2jk}) \text{ for some } x \text{ within each COSI category } k \quad (9)$$

Here, F represents the cumulative distribution function (CDF), which provides the probability that the variable (SRT or SNR) takes a value less than or equal to x, given the age segments defined by the breakpoints ψ_{1jk} and ψ_{2jk}. This framework ensures that any observed differences are attributable to the effects of age, segmented according to the breakpoints, rather than overall differences across the entire range of SRT or SNR.

Examining Q1 results, both males and females were found to exhibit significant challenges with communication in silence and during group conversations in noise, as indicated by consistently low p-values (all $p < 0.001$) for scenarios such as "Conversation with 1 or 2 in silence" and "Group conversation in noise." The scenarios involving church or meeting settings, group conversations in silence, television/radio at normal volume, and feelings of embarrassment all showed significant differences ($p < 0.001$) across age segments for both males and females. Interestingly, for the "Increase social contact" category, females showed significant differences (SNR: p = 0.001; SRT: p = 0.000) while males did not (SNR: p = 0.267; SRT: p = 0.250), suggesting this need varies more by age for females than for males. Similar analyses were conducted for Q2 and Q3, with detailed results available upon request from the corresponding author.

Sex	Level	p-value	Value Col
Female	Conversation with 1 or 2 in silence	0.000	SNR
Female	Conversation with 1 or 2 in silence	0.000	SRT
Male	Conversation with 1 or 2 in silence	0.000	SNR
Male	Conversation with 1 or 2 in silence	0.000	SRT
Female	Group conversation in noise	0.000	SNR
Female	Group conversation in noise	0.000	SRT
Male	Group conversation in noise	0.000	SNR
Male	Group conversation in noise	0.000	SRT
Female	Church or meeting	0.000	SNR
Female	Church or meeting	0.000	SRT
Male	Church or meeting	0.000	SNR
Male	Church or meeting	0.000	SRT
Female	Group conversation in silence	0.000	SNR
Female	Group conversation in silence	0.000	SRT
Male	Group conversation in silence	0.000	SNR
Male	Group conversation in silence	0.000	SRT
Female	Television/radio at normal volume	0.000	SNR
Female	Television/radio at normal volume	0.000	SRT
Male	Television/radio at normal volume	0.000	SNR
Male	Television/radio at normal volume	0.000	SRT
Female	Feeling embarrassed or stupid	0.000	SNR
Female	Feeling embarrassed or stupid	0.000	SRT
Male	Feeling embarrassed or stupid	0.000	SNR
Male	Feeling embarrassed or stupid	0.000	SRT
Female	Increase social contact	0.001	SNR
Female	Increase social contact	0.000	SRT
Male	Increase social contact	0.267	SNR
Male	Increase social contact	0.250	SRT
Male	Unfamiliar interlocutor on the phone	0.003	SNR
Male	Unfamiliar interlocutor on the phone	0.000	SRT

Table 34: Results for Kruskal-Wallis Q1 by Sex, Level, and Value Column.

10.3 The Brown-Mood median for Differences in SNR and SRT by Sex & Age Segments

The results from the Brown-Mood median analysis, displayed in Table 35, further elucidate the communication challenges experienced by different sexes for Q1 (highest priority needs). Formally, the test is given as follows:

Null Hypothesis (H_0): The null hypothesis posits that the median values of SRT or SNR are equal across the age segments defined by breakpoints ψ_{1jk} and ψ_{2jk} for each sex and each COSI response category. Mathematically, this is expressed as:

$$H_0 : \text{Median}_{\text{SRT,female}}(\psi_{1jk}, \psi_{2jk}) = \text{Median}_{\text{SRT,female}}(\psi_{1jk}, \psi_{2jk}) \text{ for each } k \text{ and for all age segments} \quad (10)$$

$$H_0 : \text{Median}_{\text{SRT,male}}(\psi_{1jk}, \psi_{2jk}) = \text{Median}_{\text{SRT,male}}(\psi_{1jk}, \psi_{2jk}) \text{ for each } k \text{ and for all age segments} \quad (11)$$

$$H_0 : \text{Median}_{\text{SNR,female}}(\psi_{1jk}, \psi_{2jk}) = \text{Median}_{\text{SNR,female}}(\psi_{1jk}, \psi_{2jk}) \text{ for each } k \text{ and for all age segments} \quad (12)$$

$$H_0 : \text{Median}_{\text{SNR,male}}(\psi_{1jk}, \psi_{2jk}) = \text{Median}_{\text{SNR,male}}(\psi_{1jk}, \psi_{2jk}) \text{ for each } k \text{ and for all age segments} \quad (13)$$

where:

- $\text{Median}_{\text{SRT,female}}(\psi_{1jk}, \psi_{2jk})$ and $\text{Median}_{\text{SRT,male}}(\psi_{1jk}, \psi_{2jk})$ denote the median values of SRT for females and males, respectively, adjusted for age segments defined by breakpoints ψ_{1jk} and ψ_{2jk}.
- $\text{Median}_{\text{SNR,female}}(\psi_{1jk}, \psi_{2jk})$ and $\text{Median}_{\text{SNR,male}}(\psi_{1jk}, \psi_{2jk})$ denote the median values of SNR for females and males, respectively, adjusted for age segments defined by breakpoints ψ_{1jk} and ψ_{2jk}.
- j denotes sex ($j = 1$ for males and $j = 2$ for females).
- k denotes the COSI response category.

Alternative Hypothesis (H_1): The alternative hypothesis asserts that there are significant differences in the median values of SRT or SNR across the age segments induced by the breakpoints ψ_{1jk} and ψ_{2jk} for at least one COSI response category. Formally:

$$H_1 : \text{Median}_{\text{SRT,female}}(\psi_{1jk}, \psi_{2jk}) \neq \text{Median}_{\text{SRT,female}}(\psi_{1jk}, \psi_{2jk}) \text{ for some age segments and for each} k \quad (14)$$

$$H_1 : \text{Median}_{\text{SRT,male}}(\psi_{1jk}, \psi_{2jk}) \neq \text{Median}_{\text{SRT,male}}(\psi_{1jk}, \psi_{2jk}) \text{ for some age segments and for each} k \quad (15)$$

$$H_1 : \text{Median}_{\text{SNR,female}}(\psi_{1jk}, \psi_{2jk}) \neq \text{Median}_{\text{SNR,female}}(\psi_{1jk}, \psi_{2jk}) \text{ for some age segments and for each} k \quad (16)$$

$$H_1 : \text{Median}_{\text{SNR,male}}(\psi_{1jk}, \psi_{2jk}) \neq \text{Median}_{\text{SNR,male}}(\psi_{1jk}, \psi_{2jk}) \text{ for some age segments and for each} k \quad (17)$$

Here, the median is used to compare central tendencies of SRT and SNR across age segments defined by the breakpoints for each sex and COSI category. The Brown-Mood median test checks whether the medians are equal across age segments within each COSI category.

For Q1, both male and female participants reported significant difficulties in multiple scenarios, especially in quiet settings such as "Conversation with 1 or 2 in silence" and environments with background noise, like "Group conversation in noise," with all p-values registering at 0.000. This trend suggests a universal struggle with these communication contexts, highlighting their importance in social interactions. Additionally, feelings of embarrassment and the need for increased social contact were also prominent, with p-values of 0.005 for females in both SNR and SRT measures, while males exhibited non-significant values for "Increase social contact" (p = 0.720, SNR; p = 0.213, SRT).

This analysis of Q1 responses underscores the need for targeted approaches tailored to address sex-specific communication issues across varying contexts, with a focus on enhancing support and interventions for overcoming barriers related to embarrassment, social interaction, and navigating noisy environments. Similar analyses were conducted for Q2 and Q3, with detailed results available upon request from the corresponding author.

Sex	Level	p-value	Value Col
Female	Conversation with 1 or 2 in silence	0.000	SNR
Female	Conversation with 1 or 2 in silence	0.000	SRT
Male	Conversation with 1 or 2 in silence	0.000	SNR
Male	Conversation with 1 or 2 in silence	0.000	SRT
Female	Group conversation in noise	0.000	SNR
Female	Group conversation in noise	0.000	SRT
Male	Group conversation in noise	0.000	SNR
Male	Group conversation in noise	0.000	SRT
Female	Church or meeting	0.000	SNR
Female	Church or meeting	0.000	SRT
Male	Church or meeting	0.000	SNR
Male	Church or meeting	0.002	SRT
Female	Group conversation in silence	0.000	SNR
Female	Group conversation in silence	0.000	SRT
Male	Group conversation in silence	0.000	SNR
Male	Group conversation in silence	0.000	SRT
Female	Television/radio at normal volume	0.000	SNR
Female	Television/radio at normal volume	0.000	SRT
Male	Television/radio at normal volume	0.000	SNR
Male	Television/radio at normal volume	0.000	SRT
Female	Feeling embarrassed or stupid	0.000	SNR
Female	Feeling embarrassed or stupid	0.000	SRT
Male	Feeling embarrassed or stupid	0.000	SNR
Male	Feeling embarrassed or stupid	0.000	SRT
Female	Increase social contact	0.005	SNR
Female	Increase social contact	0.002	SRT
Male	Increase social contact	0.720	SNR
Male	Increase social contact	0.213	SRT
Male	Unfamiliar interlocutor on the phone	0.018	SNR
Male	Unfamiliar interlocutor on the phone	0.000	SRT

Table 35: Results for Brown-Mood Median Test for Q1 by Sex, Level, and Value Column.

10.4 Additional Plot for SNR & SRT Distributions by Age Break Points

To further support the findings from the Kruskal-Wallis test and the Brown-Mood median analysis, we present a series of heatmaps in Figure 4. These plots provide heatmaps of the average SNR and SRT by sex and degree of HL for each of the COSI responses, organized by each question (i.e., Q1). The variability across these heatmaps illustrates how these quantities differ across the categories and further reinforces our statistical test findings.

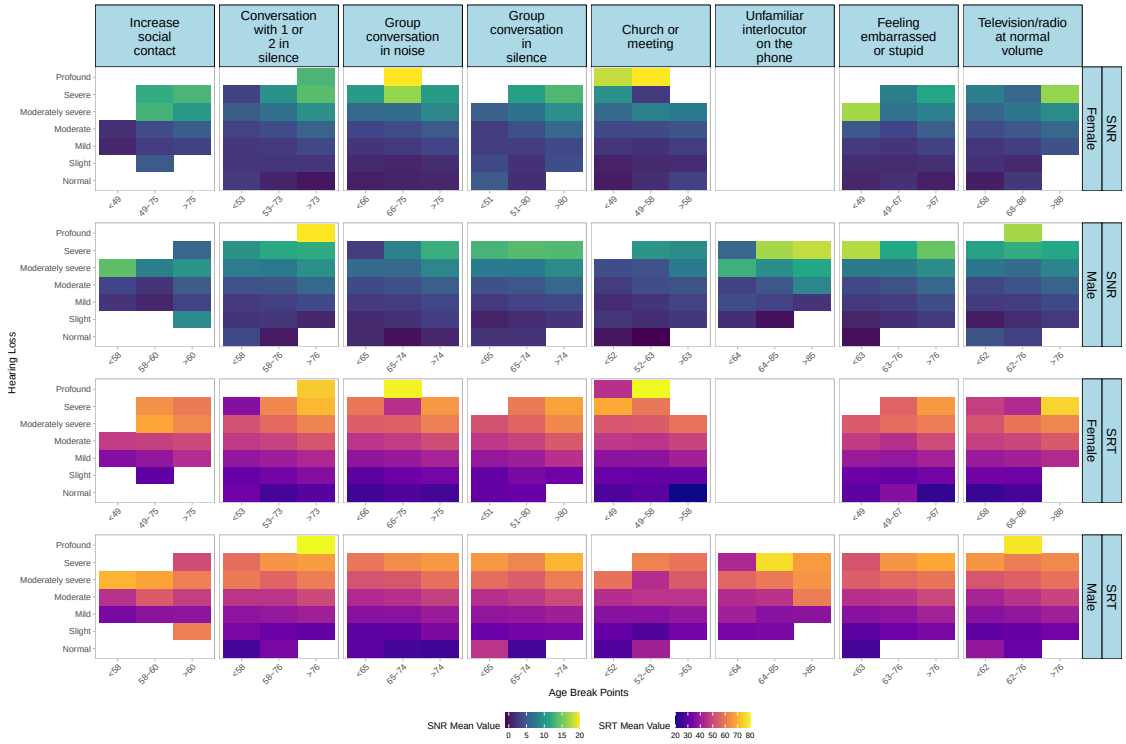


Figure 4: Heatmaps SNR, SRT Q1 by degree of HL.

11 Multiple Regression Results with SMOGN

11.1 Oversampling Techniques and SMOGN

In regression problems with imbalanced data, where certain regions of the target variable distribution are underrepresented, standard modeling approaches may fail to capture important patterns in these rare regions. Synthetic Minority Over-sampling Technique for Regression with Gaussian Noise (SMOGN) is an extension of the SMOTE algorithm specifically designed for regression tasks [13, 14].

SMOGN addresses imbalanced distributions by generating synthetic examples for underrepresented regions of the response variable. Unlike classification-focused techniques, SMOGN carefully preserves the continuous nature of the target variable while enriching regions with sparse observations. This is particularly relevant for our HL dataset, where certain degrees of hearing impairment (especially profound cases) have fewer observations compared to mild and moderate cases.

The method works by:

1. Identifying rare and normal regions in the target variable distribution using relevance functions
2. Applying Gaussian noise to create synthetic observations in rare regions
3. Using a combination of oversampling rare values and undersampling normal values to achieve better balance

In our analysis, we employed SMOGN to enhance the representation of severe and profound HL cases, ensuring that our regression models could accurately capture the relationships between audiological metrics and COSI responses

(specifically focusing on Q1 highest priority needs) across the entire spectrum of HL. This approach allows for more robust estimation of coefficients for population segments that would otherwise have insufficient statistical power.

11.2 Results with SMOGN

The tables presented in this section display the results of our multiple regression analysis using SMOGN for Q1. Table 36 shows the regression results without age binning, highlighting the significant influence of SNR and SRT on PTA, along with several key COSI needs including conversations with 1 or 2 people in silence, feelings of embarrassment, group conversations in both noisy and quiet settings, and television/radio at normal volume.

When examining the age-binned results in Table 37, we observe that the effects of SNR and SRT vary across age groups, with generally decreasing coefficients for SRT as age increases (from 0.82 in the 18-29 age group to 0.42 in the 90-99 age group). This suggests that the relationship between speech reception and pure tone audiometry changes with age. Similarly, the significance of various COSI needs varies across age groups, with conversations with 1 or 2 people in silence showing particular importance in younger (18-29) and middle-aged (60-79) groups.

The sex-specific analysis (Tables 38 and 39) reveals notable differences between males and females in their Q1 priorities. For females, SNR coefficients are generally more stable across age groups, while males show greater variability. Additionally, the significance of specific COSI needs differs between sexes, with males showing stronger associations between PTA and church/meeting needs in middle age (40-59), while females demonstrate stronger associations with social contact in their 50s.

When examining results by HL severity (Tables 40 through 49), we observe that the significance of SNR and SRT varies systematically with HL degree. For mild HL, SRT consistently shows stronger associations with PTA than SNR across most age groups, while for moderate HL, the pattern reverses with SNR showing stronger associations in many age ranges. This suggests that the mechanisms of hearing impairment and their relationship to communication needs may differ qualitatively across degrees of HL.

These findings, enhanced by the SMOGN technique to ensure appropriate representation of all HL severities, provide valuable insights into how audiological measures relate to Q1 priority needs across different demographic and clinical segments. Such nuanced understanding can guide more personalized interventions for individuals with HL. Detailed results for Q2 and Q3 regression analyses with SMOGN are available upon request from the corresponding author.

When examining the combined effect of sex and HL severity (Tables 44 through 49), we observe distinct patterns that would not be apparent from analyzing either factor in isolation. For females with slight HL, SNR often shows negative coefficients in younger age groups (18-29: -0.43, p=0.033), while SRT maintains positive associations (0.47, p=0.000), suggesting different compensatory mechanisms. Conversely, males with slight HL show different patterns, with significant positive associations for group conversation in silence at younger ages (18-29: 4.79, p=0.000).

For mild HL, the sex differences become more pronounced with age. Female patients show stronger associations between PTA and church/meeting settings in younger groups (18-29: -3.15, p=0.001), while males demonstrate stronger relationships with conversation needs (18-29: 1.35, p=0.053). In the moderate HL category, males show significant associations between group conversations in noise and PTA in the youngest age group (18-29: 2.72, p=0.000), a relationship not observed in females of the same age and HL category.

These intersectional findings highlight how sex and HL severity interact to produce unique patterns of association between audiological measures and communication priorities. Such complex relationships underscore the importance of personalized approaches to hearing care that consider multiple demographic and clinical factors simultaneously.

Table 36: Regression Results - Overall (No Age Binning)

Variable	All Ages
SNR	0.63 (0.01, p=0.000)
SRT	0.57 (0.00, p=0.000)
Church Meeting	0.13 (0.17, p=0.440)
Conversation 1-2	1.12 (0.11, p=0.000)
Feeling embarrassed or stupid	0.83 (0.13, p=0.000)
Group Noise	0.34 (0.10, p=0.001)
Group Silence	0.62 (0.15, p=0.000)
Social Contact	-0.09 (0.26, p=0.717)
TV Radio	0.41 (0.13, p=0.001)
Phone Interlocutor	0.39 (0.31, p=0.214)

Table 37: Regression Results - Overall

Variable	18-29	30 - 39	40 - 49	50 - 59	60 - 69	70 - 79	80 - 89	90 - 99
SNR	0.49 (0.08, p=0.000)	0.73 (0.08, p=0.000)	0.93 (0.06, p=0.000)	0.76 (0.05, p=0.000)	0.74 (0.03, p=0.000)	0.66 (0.02, p=0.000)	0.51 (0.02, p=0.000)	0.42 (0.04, p=0.000)
SRT	0.82 (0.02, p=0.000)	0.73 (0.03, p=0.000)	0.69 (0.02, p=0.000)	0.60 (0.01, p=0.000)	0.56 (0.01, p=0.000)	0.51 (0.01, p=0.000)	0.45 (0.01, p=0.000)	0.42 (0.02, p=0.000)
Church Meeting	0.20 (0.80, p=0.804)	0.52 (0.77, p=0.498)	1.55 (0.60, p=0.010)	1.01 (0.43, p=0.018)	0.67 (0.39, p=0.087)	1.02 (0.35, p=0.004)	-0.56 (0.50, p=0.257)	-2.11 (1.01, p=0.036)
Conversation 1-2	2.97 (0.80, p=0.000)	1.36 (0.71, p=0.055)	0.56 (0.57, p=0.324)	0.83 (0.40, p=0.039)	1.43 (0.22, p=0.000)	1.26 (0.17, p=0.000)	0.68 (0.21, p=0.001)	0.13 (0.44, p=0.770)
Embarrassed	1.85 (0.78, p=0.018)	0.66 (0.74, p=0.377)	-0.44 (0.57, p=0.440)	0.98 (0.45, p=0.030)	0.78 (0.27, p=0.004)	1.36 (0.22, p=0.000)	0.56 (0.27, p=0.035)	1.14 (0.51, p=0.024)
Group Noise	0.17 (0.69, p=0.806)	0.94 (0.67, p=0.160)	-0.69 (0.52, p=0.184)	0.39 (0.35, p=0.260)	0.15 (0.20, p=0.448)	0.64 (0.17, p=0.000)	-0.06 (0.22, p=0.780)	1.16 (0.46, p=0.013)
Group Silence	0.40 (0.75, p=0.595)	0.10 (0.80, p=0.904)	-0.36 (0.66, p=0.589)	1.36 (0.54, p=0.012)	1.04 (0.34, p=0.002)	0.94 (0.26, p=0.000)	0.57 (0.30, p=0.059)	0.69 (0.53, p=0.190)
Social Contact	0.04 (0.80, p=0.960)	-0.43 (0.83, p=0.607)	0.53 (0.84, p=0.531)	3.87 (1.31, p=0.003)	1.31 (0.78, p=0.091)	2.14 (0.64, p=0.001)	-0.18 (0.74, p=0.805)	0.06 (0.65, p=0.921)
TV Radio	-3.61 (1.88, p=0.054)	4.26 (1.40, p=0.002)	1.28 (1.17, p=0.275)	1.01 (0.58, p=0.082)	0.09 (0.26, p=0.729)	0.19 (0.20, p=0.329)	-0.62 (0.24, p=0.009)	-0.54 (0.57, p=0.347)
Phone Interlocutor	8.15 (5.03, p=0.105)	3.88 (2.23, p=0.083)	0.47 (1.48, p=0.752)	-0.42 (0.92, p=0.647)	0.81 (0.73, p=0.264)	0.35 (0.56, p=0.528)	-0.44 (0.55, p=0.421)	0.77 (1.38, p=0.580)

Table 38: Regression Results - Female

Variable	18-29	30 - 39	40 - 49	50 - 59	60 - 69	70 - 79	80 - 89	90 - 99
SNR	0.71 (0.11, p=0.000)	0.65 (0.12, p=0.000)	0.94 (0.09, p=0.000)	0.66 (0.07, p=0.000)	0.58 (0.04, p=0.000)	0.57 (0.03, p=0.000)	0.43 (0.03, p=0.000)	0.55 (0.06, p=0.000)
SRT	0.86 (0.04, p=0.000)	0.76 (0.04, p=0.000)	0.70 (0.03, p=0.000)	0.67 (0.02, p=0.000)	0.61 (0.01, p=0.000)	0.55 (0.01, p=0.000)	0.46 (0.01, p=0.000)	0.41 (0.03, p=0.000)
Church Meeting	-3.02 (1.30, p=0.021)	0.79 (1.09, p=0.471)	0.38 (0.81, p=0.641)	0.66 (0.61, p=0.277)	0.65 (0.62, p=0.296)	0.61 (0.56, p=0.283)	-0.91 (0.64, p=0.158)	-0.97 (1.43, p=0.498)
Conversation 1-2	1.81 (1.15, p=0.117)	2.76 (1.00, p=0.006)	-0.57 (0.79, p=0.476)	1.08 (0.60, p=0.069)	0.87 (0.34, p=0.010)	0.99 (0.24, p=0.000)	0.85 (0.27, p=0.002)	0.65 (0.60, p=0.281)
Embarrassed	1.32 (1.15, p=0.249)	1.74 (1.05, p=0.097)	-1.29 (0.79, p=0.105)	0.84 (0.66, p=0.202)	0.74 (0.38, p=0.052)	1.22 (0.30, p=0.000)	0.71 (0.32, p=0.027)	2.27 (0.72, p=0.002)
Group Noise	-0.55 (1.00, p=0.579)	0.48 (0.94, p=0.611)	-1.68 (0.74, p=0.023)	0.04 (0.53, p=0.932)	0.01 (0.31, p=0.976)	0.46 (0.24, p=0.058)	-0.01 (0.28, p=0.986)	0.91 (0.63, p=0.153)
Group Silence	-0.72 (1.08, p=0.502)	-0.64 (1.12, p=0.570)	-1.34 (0.92, p=0.144)	0.64 (0.82, p=0.434)	1.19 (0.48, p=0.014)	1.01 (0.35, p=0.004)	0.52 (0.37, p=0.159)	0.77 (0.74, p=0.299)
Social Contact	-0.75 (1.20, p=0.533)	-1.05 (1.29, p=0.415)	-0.80 (1.25, p=0.521)	3.84 (1.66, p=0.021)	0.91 (1.02, p=0.373)	2.10 (0.91, p=0.021)	-0.02 (0.90, p=0.981)	0.75 (1.02, p=0.462)
TV Radio	-1.20 (2.44, p=0.624)	2.69 (2.15, p=0.211)	2.32 (1.91, p=0.225)	0.26 (0.91, p=0.772)	-0.47 (0.39, p=0.227)	0.23 (0.27, p=0.383)	-0.46 (0.29, p=0.117)	-0.30 (0.72, p=0.681)
Phone Interlocutor	11.19 (6.40, p=0.081)	4.40 (3.51, p=0.211)	1.01 (1.69, p=0.549)	-0.13 (1.18, p=0.910)	0.83 (0.91, p=0.363)	0.56 (0.65, p=0.389)	-0.07 (0.61, p=0.906)	1.58 (1.64, p=0.335)

Table 39: Regression Results - Male

Variable	18-29	30 - 39	40 - 49	50 - 59	60 - 69	70 - 79	80 - 89	90 - 99
SNR	0.28 (0.12, p=0.022)	0.82 (0.11, p=0.000)	0.89 (0.09, p=0.000)	0.77 (0.06, p=0.000)	0.76 (0.04, p=0.000)	0.63 (0.03, p=0.000)	0.52 (0.03, p=0.000)	0.24 (0.06, p=0.000)
SRT	0.79 (0.03, p=0.000)	0.69 (0.04, p=0.000)	0.68 (0.03, p=0.000)	0.57 (0.02, p=0.000)	0.55 (0.01, p=0.000)	0.51 (0.01, p=0.000)	0.47 (0.01, p=0.000)	0.45 (0.03, p=0.000)
Church Meeting	1.90 (1.03, p=0.065)	-0.12 (1.08, p=0.915)	3.23 (0.89, p=0.000)	1.48 (0.60, p=0.014)	0.41 (0.50, p=0.411)	0.81 (0.45, p=0.071)	-0.46 (0.77, p=0.551)	-3.51 (1.40, p=0.012)
Conversation 1-2	3.65 (1.10, p=0.001)	-0.21 (1.01, p=0.838)	1.88 (0.81, p=0.020)	0.59 (0.54, p=0.272)	1.58 (0.30, p=0.000)	1.27 (0.24, p=0.000)	0.24 (0.34, p=0.484)	-0.56 (0.64, p=0.385)
Embarrassed	1.96 (1.05, p=0.062)	-0.60 (1.05, p=0.568)	0.60 (0.81, p=0.457)	1.17 (0.62, p=0.057)	0.90 (0.37, p=0.015)	1.52 (0.32, p=0.000)	0.49 (0.45, p=0.279)	0.06 (0.71, p=0.936)
Group Noise	1.05 (0.95, p=0.268)	0.94 (0.95, p=0.323)	0.38 (0.73, p=0.603)	0.60 (0.46, p=0.190)	0.05 (0.27, p=0.864)	0.54 (0.23, p=0.022)	-0.45 (0.35, p=0.207)	1.47 (0.68, p=0.029)
Group Silence	1.45 (1.04, p=0.165)	0.47 (1.14, p=0.683)	0.89 (0.96, p=0.353)	1.89 (0.71, p=0.008)	0.90 (0.46, p=0.051)	0.86 (0.37, p=0.019)	0.66 (0.50, p=0.187)	0.48 (0.75, p=0.523)
Social Contact	0.74 (1.06, p=0.487)	-0.73 (1.11, p=0.510)	1.69 (1.12, p=0.133)	4.49 (2.10, p=0.032)	2.27 (1.17, p=0.052)	2.08 (0.88, p=0.018)	-0.48 (1.22, p=0.692)	-0.97 (0.84, p=0.250)
TV Radio	-8.12 (2.99, p=0.007)	4.85 (1.83, p=0.008)	0.68 (1.47, p=0.643)	1.43 (0.75, p=0.055)	0.36 (0.35, p=0.304)	0.13 (0.28, p=0.643)	-0.95 (0.39, p=0.015)	-0.25 (0.94, p=0.792)
Phone Interlocutor	0.83 (8.29, p=0.921)	3.09 (2.88, p=0.284)	-1.97 (3.28, p=0.548)	-0.28 (1.46, p=0.845)	1.70 (1.17, p=0.146)	1.28 (1.07, p=0.233)	-0.45 (1.08, p=0.674)	-0.32 (2.62, p=0.903)
NA	3.50 (1.35, p=0.010)	7.86 (1.45, p=0.000)	7.34 (1.05, p=0.000)	13.01 (0.71, p=0.000)	14.86 (0.43, p=0.000)	17.82 (0.39, p=0.000)	22.58 (0.58, p=0.000)	25.94 (1.30, p=0.000)

Table 40: Regression Results - Slight

Variable	18-29	30 - 39	40 - 49	50 - 59	60 - 69	70 - 79	80 - 89
SNR	-0.67 (0.13, p=0.000)	-0.26 (0.15, p=0.093)	0.22 (0.13, p=0.080)	0.08 (0.08, p=0.352)	0.13 (0.05, p=0.016)	0.14 (0.07, p=0.069)	0.16 (0.16, p=0.318)
SRT	0.35 (0.04, p=0.000)	0.23 (0.04, p=0.000)	0.12 (0.03, p=0.000)	0.18 (0.03, p=0.000)	0.12 (0.02, p=0.000)	0.08 (0.02, p=0.000)	0.03 (0.05, p=0.522)
Church Meeting	1.25 (0.98, p=0.202)	2.70 (1.14, p=0.018)	0.23 (0.84, p=0.784)	-0.05 (0.64, p=0.942)	2.02 (0.62, p=0.001)	0.18 (0.91, p=0.845)	-0.77 (2.29, p=0.737)
Conversation 1-2	-0.86 (0.98, p=0.378)	2.01 (0.98, p=0.041)	0.42 (0.84, p=0.613)	0.01 (0.64, p=0.992)	1.08 (0.40, p=0.007)	0.72 (0.45, p=0.115)	-0.61 (1.43, p=0.672)
Embarrassed	-0.78 (0.97, p=0.423)	3.90 (1.11, p=0.001)	0.29 (0.73, p=0.695)	0.18 (0.64, p=0.782)	0.22 (0.43, p=0.608)	0.60 (0.61, p=0.324)	-0.61 (1.20, p=0.610)
Group Noise	-0.16 (0.80, p=0.845)	2.59 (0.91, p=0.005)	0.46 (0.64, p=0.473)	0.41 (0.45, p=0.359)	0.67 (0.28, p=0.017)	-0.35 (0.37, p=0.343)	-0.44 (0.95, p=0.646)
Group Silence	2.78 (0.88, p=0.002)	3.15 (1.20, p=0.009)	-0.40 (1.12, p=0.723)	-0.03 (0.95, p=0.975)	0.04 (0.59, p=0.950)	-0.22 (0.76, p=0.775)	1.40 (1.61, p=0.386)
Social Contact	-0.51 (0.97, p=0.599)	1.62 (1.04, p=0.120)	-3.34 (1.52, p=0.029)	4.27 (2.96, p=0.149)	-4.14 (1.73, p=0.017)	0.10 (1.98, p=0.961)	0.44 (3.20, p=0.890)
TV Radio	-0.98 (1.55, p=0.526)	3.34 (3.28, p=0.310)	0.70 (1.85, p=0.706)	1.68 (1.11, p=0.132)	0.50 (0.40, p=0.205)	0.11 (0.47, p=0.818)	0.52 (0.93, p=0.576)
Phone Interlocutor	2.90 (4.53, p=0.521)	NA	2.00 (1.62, p=0.217)	-0.02 (1.19, p=0.987)	-0.57 (0.88, p=0.519)	-1.98 (1.10, p=0.073)	0.89 (1.77, p=0.619)

Table 41: Regression Results - Mild

Variable	18-29	30 - 39	40 - 49	50 - 59	60 - 69	70 - 79	80 - 89	90 - 99
SNR	0.04 (0.05, p=0.488)	0.00 (0.07, p=0.968)	0.10 (0.05, p=0.051)	0.10 (0.04, p=0.008)	0.15 (0.02, p=0.000)	0.12 (0.02, p=0.000)	0.03 (0.03, p=0.238)	0.03 (0.10, p=0.749)
SRT	0.31 (0.02, p=0.000)	0.20 (0.02, p=0.000)	0.21 (0.02, p=0.000)	0.18 (0.01, p=0.000)	0.16 (0.01, p=0.000)	0.16 (0.01, p=0.000)	0.15 (0.01, p=0.000)	0.09 (0.03, p=0.012)
Church Meeting	-1.14 (0.53, p=0.031)	-0.69 (0.53, p=0.196)	0.68 (0.41, p=0.093)	0.25 (0.28, p=0.378)	0.49 (0.28, p=0.072)	0.54 (0.28, p=0.057)	0.20 (0.49, p=0.687)	-2.12 (1.01, p=0.037)
Conversation 1-2	0.78 (0.54, p=0.151)	-0.07 (0.49, p=0.885)	-0.28 (0.39, p=0.468)	0.62 (0.28, p=0.025)	0.34 (0.16, p=0.036)	0.52 (0.14, p=0.000)	0.05 (0.23, p=0.828)	-0.14 (0.74, p=0.848)
Embarrassed	0.26 (0.53, p=0.623)	-0.14 (0.49, p=0.770)	0.23 (0.38, p=0.537)	0.19 (0.30, p=0.538)	-0.04 (0.19, p=0.825)	0.59 (0.18, p=0.001)	0.09 (0.28, p=0.755)	0.04 (0.93, p=0.966)
Group Noise	-0.97 (0.46, p=0.036)	-0.23 (0.45, p=0.608)	-0.05 (0.35, p=0.877)	0.10 (0.24, p=0.677)	0.06 (0.14, p=0.681)	0.34 (0.13, p=0.009)	-0.20 (0.21, p=0.355)	-0.14 (0.74, p=0.846)
Group Silence	-0.29 (0.50, p=0.566)	-0.89 (0.55, p=0.108)	-0.23 (0.42, p=0.585)	0.66 (0.38, p=0.085)	0.21 (0.25, p=0.414)	0.61 (0.21, p=0.004)	-0.24 (0.33, p=0.454)	1.54 (1.18, p=0.194)
Social Contact	-0.01 (0.51, p=0.991)	-0.46 (0.61, p=0.444)	0.37 (0.54, p=0.495)	0.27 (0.92, p=0.773)	0.62 (0.56, p=0.269)	0.73 (0.60, p=0.223)	-0.05 (0.81, p=0.951)	1.39 (1.42, p=0.330)
TV Radio	0.14 (1.26, p=0.913)	0.97 (0.99, p=0.328)	-0.32 (0.78, p=0.682)	0.47 (0.38, p=0.214)	-0.06 (0.18, p=0.743)	0.40 (0.15, p=0.007)	-0.14 (0.22, p=0.536)	0.07 (0.82, p=0.932)
Phone Interlocutor	NA	0.07 (1.44, p=0.958)	0.47 (1.03, p=0.647)	0.08 (0.59, p=0.891)	-0.14 (0.54, p=0.797)	0.32 (0.45, p=0.478)	-0.57 (0.52, p=0.273)	2.11 (2.17, p=0.332)

Table 42: Regression Results - Moderate

Variable	18-29	30 - 39	40 - 49	50 - 59	60 - 69	70 - 79	80 - 89	90 - 99
SNR	0.38 (0.06, p=0.000)	0.31 (0.06, p=0.000)	0.26 (0.06, p=0.000)	0.25 (0.04, p=0.000)	0.21 (0.02, p=0.000)	0.20 (0.01, p=0.000)	0.13 (0.01, p=0.000)	0.13 (0.03, p=0.000)
SRT	0.05 (0.02, p=0.013)	0.17 (0.02, p=0.000)	0.17 (0.02, p=0.000)	0.11 (0.01, p=0.000)	0.12 (0.01, p=0.000)	0.13 (0.01, p=0.000)	0.15 (0.01, p=0.000)	0.16 (0.01, p=0.000)
Church Meeting	1.83 (0.62, p=0.003)	-0.72 (0.60, p=0.234)	0.19 (0.52, p=0.707)	0.39 (0.34, p=0.247)	-0.11 (0.30, p=0.714)	-0.05 (0.25, p=0.836)	-0.28 (0.33, p=0.397)	0.09 (0.72, p=0.904)
Conversation 1-2	0.66 (0.61, p=0.279)	1.06 (0.56, p=0.058)	0.04 (0.49, p=0.938)	0.50 (0.31, p=0.108)	0.47 (0.17, p=0.007)	0.29 (0.13, p=0.020)	0.22 (0.14, p=0.134)	0.09 (0.30, p=0.773)
Embarrassed	0.65 (0.59, p=0.274)	-0.11 (0.62, p=0.861)	-0.40 (0.53, p=0.447)	0.26 (0.36, p=0.477)	0.30 (0.21, p=0.157)	0.17 (0.16, p=0.294)	0.29 (0.18, p=0.102)	0.90 (0.35, p=0.012)
Group Noise	1.64 (0.54, p=0.002)	-0.96 (0.53, p=0.072)	-0.57 (0.48, p=0.238)	0.16 (0.28, p=0.569)	0.23 (0.17, p=0.170)	0.16 (0.13, p=0.214)	0.10 (0.15, p=0.505)	0.62 (0.32, p=0.053)
Group Silence	0.64 (0.58, p=0.268)	-0.82 (0.61, p=0.180)	-0.33 (0.63, p=0.606)	0.22 (0.40, p=0.584)	0.35 (0.26, p=0.168)	0.19 (0.18, p=0.306)	0.08 (0.21, p=0.705)	0.35 (0.37, p=0.346)
Social Contact	-0.70 (0.63, p=0.267)	-0.14 (0.64, p=0.827)	-1.35 (0.71, p=0.060)	0.60 (1.01, p=0.554)	-0.19 (0.58, p=0.742)	0.21 (0.42, p=0.621)	-0.23 (0.49, p=0.639)	0.12 (0.43, p=0.789)
TV Radio	2.22 (2.74, p=0.418)	-0.71 (1.07, p=0.508)	-1.63 (0.97, p=0.093)	-0.42 (0.46, p=0.360)	0.27 (0.21, p=0.199)	0.03 (0.15, p=0.838)	-0.34 (0.16, p=0.033)	0.20 (0.38, p=0.605)
Phone Interlocutor	2.80 (3.84, p=0.466)	1.26 (1.65, p=0.443)	2.82 (1.57, p=0.073)	0.36 (0.92, p=0.699)	0.41 (0.58, p=0.479)	0.06 (0.42, p=0.880)	-0.24 (0.38, p=0.534)	0.17 (1.07, p=0.877)

Table 43: Regression Results - Moderately severe

Variable	18-29	30 - 39	40 - 49	50 - 59	60 - 69	70 - 79	80 - 89	90 - 99
SNR	0.05 (0.07, p=0.461)	0.35 (0.10, p=0.001)	0.17 (0.11, p=0.115)	0.17 (0.06, p=0.006)	0.20 (0.04, p=0.000)	0.12 (0.02, p=0.000)	0.18 (0.02, p=0.000)	0.08 (0.03, p=0.012)
SRT	-0.10 (0.04, p=0.006)	0.03 (0.05, p=0.528)	0.13 (0.04, p=0.006)	0.04 (0.02, p=0.054)	0.04 (0.01, p=0.009)	0.07 (0.01, p=0.000)	0.05 (0.01, p=0.000)	0.09 (0.02, p=0.000)
Church Meeting	0.07 (0.93, p=0.940)	-0.24 (1.41, p=0.863)	-1.44 (1.37, p=0.296)	0.29 (0.80, p=0.717)	-2.20 (0.85, p=0.010)	-0.34 (0.56, p=0.544)	-0.31 (0.61, p=0.618)	0.82 (1.13, p=0.468)
Conversation 1-2	-0.89 (0.87, p=0.310)	0.29 (1.21, p=0.812)	-0.17 (1.14, p=0.885)	0.07 (0.66, p=0.911)	0.36 (0.38, p=0.340)	0.38 (0.24, p=0.119)	0.02 (0.23, p=0.930)	0.13 (0.40, p=0.751)
Embarrassed	-1.11 (0.84, p=0.190)	0.68 (1.34, p=0.612)	-2.56 (1.24, p=0.041)	0.57 (0.87, p=0.508)	0.43 (0.48, p=0.376)	0.23 (0.31, p=0.453)	-0.18 (0.29, p=0.538)	-0.21 (0.45, p=0.646)
Group Noise	-1.79 (0.94, p=0.059)	1.14 (1.29, p=0.376)	-1.65 (1.26, p=0.194)	-0.12 (0.71, p=0.862)	-0.32 (0.41, p=0.437)	0.01 (0.26, p=0.974)	-0.21 (0.25, p=0.401)	-0.46 (0.43, p=0.286)
Group Silence	-2.65 (1.04, p=0.013)	1.60 (1.42, p=0.262)	-1.02 (1.35, p=0.452)	-0.37 (0.84, p=0.657)	0.36 (0.52, p=0.487)	-0.11 (0.34, p=0.758)	0.11 (0.31, p=0.726)	-0.24 (0.46, p=0.604)
Social Contact	1.99 (1.16, p=0.088)	-1.38 (1.55, p=0.376)	-2.83 (2.08, p=0.176)	-0.27 (1.64, p=0.870)	1.21 (1.25, p=0.337)	-0.74 (0.83, p=0.377)	0.11 (0.80, p=0.887)	-1.43 (0.58, p=0.015)
TV Radio	2.03 (2.05, p=0.324)	3.00 (1.62, p=0.066)	2.81 (2.82, p=0.321)	-1.49 (0.99, p=0.133)	-0.34 (0.55, p=0.530)	-0.08 (0.34, p=0.813)	-0.43 (0.28, p=0.131)	-0.68 (0.59, p=0.245)
Phone Interlocutor	5.97 (2.78, p=0.034)	8.32 (2.91, p=0.005)	-1.78 (2.34, p=0.447)	1.58 (1.34, p=0.238)	-0.81 (1.20, p=0.497)	0.57 (0.78, p=0.462)	-0.36 (0.63, p=0.566)	-0.07 (1.09, p=0.952)

Table 44: Regression Results - Female Slight

Variable	18-29	30 - 39	40 - 49	50 - 59	60 - 69	70 - 79	80 - 89
SNR	-0.43 (0.20, p=0.033)	-0.28 (0.22, p=0.203)	0.10 (0.19, p=0.588)	0.11 (0.13, p=0.411)	0.14 (0.08, p=0.077)	0.17 (0.10, p=0.103)	0.13 (0.20, p=0.510)
SRT	0.47 (0.06, p=0.000)	0.31 (0.06, p=0.000)	0.10 (0.05, p=0.052)	0.19 (0.04, p=0.000)	0.15 (0.03, p=0.000)	0.13 (0.03, p=0.000)	0.08 (0.05, p=0.154)
Church Meeting	-0.81 (1.33, p=0.545)	3.80 (1.57, p=0.017)	-0.61 (1.08, p=0.570)	0.10 (0.85, p=0.902)	1.63 (1.09, p=0.135)	2.88 (2.51, p=0.253)	0.22 (3.10, p=0.943)
Conversation 1-2	-3.27 (1.20, p=0.007)	2.84 (1.41, p=0.046)	0.51 (1.08, p=0.635)	0.06 (0.92, p=0.952)	1.61 (0.59, p=0.007)	0.53 (0.68, p=0.437)	-1.65 (1.46, p=0.265)
Embarrassed	-3.50 (1.30, p=0.008)	4.72 (1.51, p=0.002)	0.01 (0.97, p=0.994)	-0.22 (0.89, p=0.804)	-0.11 (0.59, p=0.846)	0.18 (0.78, p=0.816)	-1.01 (1.48, p=0.499)
Group Noise	-2.18 (1.00, p=0.031)	1.95 (1.21, p=0.110)	-0.04 (0.92, p=0.970)	0.65 (0.64, p=0.311)	0.32 (0.44, p=0.462)	-0.69 (0.53, p=0.193)	-1.81 (1.14, p=0.121)
Group Silence	0.65 (1.17, p=0.582)	3.28 (1.47, p=0.028)	-0.59 (1.49, p=0.694)	0.35 (1.20, p=0.769)	0.23 (0.85, p=0.782)	0.19 (1.08, p=0.863)	1.36 (2.16, p=0.534)
Social Contact	-0.60 (1.40, p=0.669)	-0.70 (1.64, p=0.671)	-4.52 (2.33, p=0.054)	4.59 (2.99, p=0.126)	-1.41 (2.59, p=0.586)	0.33 (2.08, p=0.873)	NA
TV Radio	-0.48 (1.68, p=0.775)	-1.12 (4.64, p=0.810)	3.96 (4.51, p=0.380)	1.31 (1.54, p=0.395)	0.66 (0.55, p=0.230)	-0.28 (0.61, p=0.644)	-1.03 (1.16, p=0.382)
Phone Interlocutor	0.94 (4.29, p=0.826)	NA	1.00 (1.83, p=0.585)	-0.56 (1.54, p=0.719)	-0.92 (1.05, p=0.380)	-2.68 (1.38, p=0.054)	-0.23 (1.79, p=0.900)

Table 45: Regression Results - Female Mild

Variable	18-29	30 - 39	40 - 49	50 - 59	60 - 69	70 - 79	80 - 89	90 - 99
SNR	0.13 (0.08, p=0.106)	-0.02 (0.10, p=0.857)	0.06 (0.07, p=0.431)	0.16 (0.06, p=0.009)	0.10 (0.04, p=0.005)	0.12 (0.03, p=0.000)	0.03 (0.04, p=0.420)	0.11 (0.15, p=0.439)
SRT	0.31 (0.03, p=0.000)	0.20 (0.03, p=0.000)	0.25 (0.02, p=0.000)	0.18 (0.02, p=0.000)	0.18 (0.01, p=0.000)	0.16 (0.01, p=0.000)	0.16 (0.01, p=0.000)	0.10 (0.05, p=0.056)
Church Meeting	-3.15 (0.92, p=0.001)	-1.01 (0.69, p=0.144)	0.67 (0.54, p=0.213)	0.52 (0.40, p=0.191)	0.27 (0.43, p=0.533)	-0.05 (0.47, p=0.916)	0.21 (0.63, p=0.734)	1.60 (1.63, p=0.329)
Conversation 1-2	-0.34 (0.85, p=0.691)	0.23 (0.66, p=0.723)	-0.39 (0.53, p=0.460)	0.24 (0.41, p=0.554)	0.05 (0.24, p=0.836)	0.39 (0.20, p=0.053)	-0.14 (0.30, p=0.643)	0.36 (0.92, p=0.696)
Embarrassed	0.38 (0.78, p=0.629)	-0.27 (0.67, p=0.684)	0.28 (0.53, p=0.591)	0.55 (0.44, p=0.211)	-0.16 (0.28, p=0.560)	0.58 (0.24, p=0.016)	-0.02 (0.34, p=0.949)	2.18 (1.61, p=0.181)
Group Noise	-0.24 (0.64, p=0.712)	-1.28 (0.61, p=0.036)	0.08 (0.48, p=0.862)	0.37 (0.36, p=0.302)	-0.08 (0.21, p=0.690)	0.25 (0.18, p=0.177)	-0.28 (0.28, p=0.313)	-0.38 (0.92, p=0.678)
Group Silence	-0.61 (0.71, p=0.391)	-0.94 (0.73, p=0.195)	-0.74 (0.57, p=0.195)	0.54 (0.57, p=0.348)	-0.41 (0.37, p=0.269)	0.43 (0.30, p=0.152)	-0.56 (0.40, p=0.160)	1.16 (1.39, p=0.408)
Social Contact	-0.15 (0.71, p=0.829)	-0.59 (0.89, p=0.505)	0.03 (0.76, p=0.968)	-0.07 (1.11, p=0.947)	-0.17 (0.75, p=0.818)	0.85 (0.86, p=0.321)	0.09 (0.94, p=0.922)	NA
TV Radio	-1.61 (1.77, p=0.365)	0.94 (1.29, p=0.467)	-0.00 (1.22, p=1.000)	0.48 (0.57, p=0.402)	-0.24 (0.27, p=0.364)	0.03 (0.21, p=0.904)	-0.29 (0.28, p=0.291)	0.71 (0.95, p=0.456)
Phone Interlocutor	NA	0.09 (1.76, p=0.959)	0.84 (1.22, p=0.490)	0.47 (0.73, p=0.522)	-0.34 (0.66, p=0.602)	0.51 (0.50, p=0.312)	-0.73 (0.59, p=0.220)	2.06 (3.07, p=0.504)

Table 46: Regression Results - Female Moderate

Variable	18-29	30 - 39	40 - 49	50 - 59	60 - 69	70 - 79	80 - 89	90 - 99
SNR	0.31 (0.09, p=0.001)	0.31 (0.09, p=0.001)	0.37 (0.08, p=0.000)	0.20 (0.06, p=0.000)	0.24 (0.04, p=0.000)	0.18 (0.02, p=0.000)	0.12 (0.02, p=0.000)	0.09 (0.04, p=0.038)
SRT	0.05 (0.03, p=0.134)	0.14 (0.04, p=0.000)	0.16 (0.03, p=0.000)	0.12 (0.02, p=0.000)	0.13 (0.01, p=0.000)	0.14 (0.01, p=0.000)	0.17 (0.01, p=0.000)	0.17 (0.02, p=0.000)
Church Meeting	1.20 (1.03, p=0.248)	-0.84 (1.01, p=0.406)	0.60 (0.73, p=0.408)	0.04 (0.51, p=0.937)	-0.56 (0.47, p=0.232)	-0.65 (0.40, p=0.107)	0.00 (0.43, p=0.999)	-0.06 (0.96, p=0.954)
Conversation 1-2	0.20 (0.89, p=0.819)	1.21 (0.83, p=0.149)	0.76 (0.69, p=0.266)	0.29 (0.47, p=0.531)	0.36 (0.27, p=0.185)	0.23 (0.18, p=0.198)	0.36 (0.18, p=0.051)	-0.18 (0.39, p=0.643)
Embarrassed	-0.34 (0.88, p=0.694)	-0.80 (0.92, p=0.387)	0.11 (0.73, p=0.884)	-0.31 (0.54, p=0.564)	0.03 (0.30, p=0.926)	-0.04 (0.23, p=0.848)	0.52 (0.22, p=0.018)	1.08 (0.47, p=0.022)
Group Noise	0.06 (0.82, p=0.941)	-0.75 (0.81, p=0.354)	0.22 (0.71, p=0.752)	0.03 (0.44, p=0.953)	0.24 (0.26, p=0.345)	0.08 (0.19, p=0.678)	0.12 (0.19, p=0.547)	0.43 (0.41, p=0.293)
Group Silence	-0.50 (0.83, p=0.550)	-1.21 (0.94, p=0.199)	-0.01 (0.86, p=0.991)	-0.05 (0.62, p=0.931)	0.25 (0.36, p=0.501)	0.02 (0.25, p=0.924)	-0.13 (0.26, p=0.613)	0.27 (0.49, p=0.577)
Social Contact	-2.63 (0.98, p=0.008)	-1.01 (1.04, p=0.331)	-0.96 (1.15, p=0.405)	0.19 (1.43, p=0.896)	-1.18 (0.74, p=0.112)	-0.15 (0.66, p=0.818)	0.02 (0.61, p=0.978)	-0.28 (0.66, p=0.668)
TV Radio	3.33 (2.18, p=0.132)	-1.54 (1.98, p=0.435)	0.70 (1.52, p=0.644)	-1.01 (0.77, p=0.191)	0.04 (0.32, p=0.902)	0.04 (0.21, p=0.851)	-0.32 (0.20, p=0.115)	0.10 (0.45, p=0.833)
Phone Interlocutor	7.09 (2.86, p=0.016)	6.21 (3.82, p=0.105)	2.95 (1.78, p=0.098)	0.92 (1.15, p=0.427)	0.22 (0.77, p=0.776)	-0.15 (0.52, p=0.776)	-0.14 (0.45, p=0.751)	0.00 (1.21, p=0.999)

Table 47: Regression Results - Male Slight

Variable	18-29	30 - 39	40 - 49	50 - 59	60 - 69	70 - 79	80 - 89
SNR	-0.50 (0.21, p=0.017)	-0.10 (0.23, p=0.674)	0.45 (0.19, p=0.022)	0.05 (0.11, p=0.670)	0.09 (0.07, p=0.228)	0.10 (0.11, p=0.375)	0.33 (0.26, p=0.224)
SRT	0.25 (0.07, p=0.000)	0.14 (0.05, p=0.005)	0.16 (0.05, p=0.001)	0.16 (0.04, p=0.000)	0.10 (0.02, p=0.000)	0.02 (0.03, p=0.613)	-0.20 (0.09, p=0.032)
Church Meeting	3.70 (1.60, p=0.022)	1.15 (1.53, p=0.456)	1.69 (1.60, p=0.293)	-0.08 (1.03, p=0.941)	1.99 (0.71, p=0.005)	-0.25 (0.94, p=0.792)	3.38 (3.21, p=0.306)
Conversation 1-2	2.50 (1.63, p=0.129)	0.64 (1.28, p=0.620)	-0.65 (1.53, p=0.674)	-0.00 (0.89, p=0.997)	0.53 (0.51, p=0.299)	1.03 (0.60, p=0.087)	NA
Embarrassed	2.60 (1.31, p=0.050)	2.74 (1.57, p=0.083)	0.60 (1.26, p=0.633)	0.74 (0.95, p=0.432)	1.01 (0.63, p=0.108)	1.43 (1.01, p=0.157)	0.42 (1.75, p=0.812)
Group Noise	2.23 (1.20, p=0.066)	3.17 (1.28, p=0.015)	1.05 (0.92, p=0.254)	0.28 (0.64, p=0.662)	0.77 (0.36, p=0.032)	-0.06 (0.52, p=0.902)	3.88 (1.57, p=0.023)
Group Silence	4.79 (1.25, p=0.000)	2.76 (2.07, p=0.185)	-0.65 (1.78, p=0.717)	-0.54 (1.63, p=0.742)	-0.25 (0.78, p=0.753)	-0.98 (1.05, p=0.352)	2.89 (2.09, p=0.183)
Social Contact	0.48 (1.23, p=0.694)	2.42 (1.29, p=0.065)	-1.82 (2.06, p=0.376)	NA	-7.20 (2.22, p=0.001)	NA	7.88 (3.57, p=0.040)
TV Radio	-8.57 (3.29, p=0.010)	6.93 (4.33, p=0.112)	0.10 (2.04, p=0.960)	2.26 (1.64, p=0.169)	0.42 (0.56, p=0.445)	1.07 (0.76, p=0.160)	3.60 (1.32, p=0.013)
Phone Interlocutor	NA	NA	6.01 (4.46, p=0.180)	1.16 (1.93, p=0.550)	2.82 (1.82, p=0.122)	0.18 (1.85, p=0.923)	NA

Table 48: Regression Results - Male Mild

Variable	18-29	30 - 39	40 - 49	50 - 59	60 - 69	70 - 79	80 - 89	90 - 99
SNR	0.14 (0.08, p=0.076)	0.05 (0.10, p=0.638)	0.15 (0.07, p=0.032)	0.06 (0.05, p=0.265)	0.18 (0.03, p=0.000)	0.10 (0.03, p=0.000)	0.02 (0.04, p=0.594)	-0.14 (0.14, p=0.310)
SRT	0.31 (0.03, p=0.000)	0.20 (0.03, p=0.000)	0.18 (0.02, p=0.000)	0.18 (0.02, p=0.000)	0.15 (0.01, p=0.000)	0.16 (0.01, p=0.000)	0.14 (0.02, p=0.000)	0.11 (0.05, p=0.028)
Church Meeting	-0.45 (0.66, p=0.501)	-0.30 (0.82, p=0.711)	0.69 (0.62, p=0.273)	0.04 (0.41, p=0.932)	0.65 (0.36, p=0.069)	0.83 (0.36, p=0.022)	0.19 (0.77, p=0.805)	-4.68 (1.26, p=0.000)
Conversation 1-2	1.35 (0.69, p=0.053)	-0.37 (0.75, p=0.623)	-0.20 (0.56, p=0.723)	0.91 (0.37, p=0.015)	0.57 (0.22, p=0.010)	0.60 (0.20, p=0.002)	0.29 (0.36, p=0.422)	-1.01 (1.20, p=0.406)
Embarrassed	-0.00 (0.69, p=0.996)	-0.01 (0.72, p=0.989)	0.20 (0.54, p=0.714)	-0.09 (0.42, p=0.828)	0.08 (0.26, p=0.759)	0.60 (0.27, p=0.026)	0.32 (0.50, p=0.514)	-1.23 (1.18, p=0.301)
Group Noise	-1.82 (0.64, p=0.005)	0.68 (0.68, p=0.316)	-0.26 (0.51, p=0.604)	-0.09 (0.32, p=0.770)	0.17 (0.19, p=0.363)	0.38 (0.18, p=0.035)	-0.07 (0.33, p=0.825)	0.38 (1.21, p=0.757)
Group Silence	0.12 (0.70, p=0.867)	-0.80 (0.84, p=0.343)	0.51 (0.62, p=0.409)	0.72 (0.51, p=0.157)	0.71 (0.34, p=0.038)	0.80 (0.30, p=0.009)	0.33 (0.55, p=0.552)	2.80 (2.15, p=0.198)
Social Contact	0.35 (0.72, p=0.629)	-0.32 (0.85, p=0.705)	0.73 (0.77, p=0.343)	1.27 (1.64, p=0.438)	1.57 (0.85, p=0.064)	0.60 (0.85, p=0.475)	-0.58 (1.56, p=0.708)	0.40 (1.46, p=0.785)
TV Radio	1.93 (1.76, p=0.275)	1.02 (1.54, p=0.509)	-0.58 (1.02, p=0.571)	0.47 (0.50, p=0.343)	0.10 (0.25, p=0.685)	0.76 (0.21, p=0.000)	0.17 (0.37, p=0.652)	-1.78 (1.63, p=0.278)
Phone Interlocutor	NA	-0.02 (2.41, p=0.993)	-0.88 (1.97, p=0.654)	-0.41 (1.02, p=0.690)	0.27 (0.94, p=0.774)	-0.35 (1.06, p=0.741)	-0.04 (1.07, p=0.971)	1.80 (2.85, p=0.531)

Table 49: Regression Results - Male Moderate

Variable	18-29	30 - 39	40 - 49	50 - 59	60 - 69	70 - 79	80 - 89	90 - 99
SNR	0.45 (0.10, p=0.000)	0.32 (0.10, p=0.001)	0.14 (0.08, p=0.078)	0.27 (0.04, p=0.000)	0.16 (0.03, p=0.000)	0.18 (0.02, p=0.000)	0.11 (0.02, p=0.000)	0.14 (0.04, p=0.001)
SRT	0.05 (0.03, p=0.097)	0.21 (0.04, p=0.000)	0.20 (0.03, p=0.000)	0.11 (0.01, p=0.000)	0.13 (0.01, p=0.000)	0.14 (0.01, p=0.000)	0.14 (0.01, p=0.000)	0.16 (0.02, p=0.000)
Church Meeting	2.41 (0.79, p=0.002)	-1.05 (0.80, p=0.188)	-0.42 (0.73, p=0.567)	0.68 (0.46, p=0.138)	0.05 (0.38, p=0.896)	0.20 (0.32, p=0.521)	-0.77 (0.51, p=0.128)	0.17 (1.10, p=0.880)
Conversation 1-2	1.04 (0.84, p=0.215)	0.37 (0.81, p=0.646)	-0.89 (0.70, p=0.209)	0.66 (0.41, p=0.113)	0.41 (0.23, p=0.067)	0.33 (0.17, p=0.059)	-0.08 (0.23, p=0.733)	0.23 (0.48, p=0.631)
Embarrassed	1.47 (0.81, p=0.070)	0.26 (0.87, p=0.768)	-1.11 (0.76, p=0.145)	0.73 (0.48, p=0.135)	0.56 (0.29, p=0.053)	0.37 (0.22, p=0.097)	-0.08 (0.31, p=0.783)	0.57 (0.54, p=0.294)
Group Noise	2.72 (0.71, p=0.000)	-1.31 (0.73, p=0.072)	-1.54 (0.67, p=0.022)	0.24 (0.36, p=0.505)	0.13 (0.22, p=0.565)	0.16 (0.17, p=0.361)	-0.02 (0.24, p=0.927)	0.76 (0.51, p=0.139)
Group Silence	1.55 (0.80, p=0.054)	-0.70 (0.82, p=0.392)	-0.58 (0.94, p=0.537)	0.37 (0.51, p=0.471)	0.45 (0.35, p=0.200)	0.42 (0.27, p=0.114)	0.48 (0.35, p=0.173)	0.30 (0.57, p=0.594)
Social Contact	0.60 (0.82, p=0.467)	0.32 (0.82, p=0.698)	-1.95 (0.92, p=0.035)	0.97 (1.43, p=0.500)	1.30 (0.89, p=0.143)	0.41 (0.55, p=0.456)	-0.60 (0.81, p=0.458)	0.17 (0.61, p=0.778)
TV Radio	3.15 (2.81, p=0.263)	-0.72 (1.28, p=0.575)	-3.72 (1.25, p=0.003)	-0.08 (0.58, p=0.888)	0.30 (0.27, p=0.261)	0.06 (0.21, p=0.781)	-0.40 (0.26, p=0.131)	0.52 (0.68, p=0.441)
Phone Interlocutor	3.78 (3.91, p=0.334)	-0.47 (1.82, p=0.794)	5.29 (3.70, p=0.154)	-0.73 (1.54, p=0.635)	0.85 (0.87, p=0.324)	0.76 (0.73, p=0.299)	-0.27 (0.72, p=0.707)	0.59 (2.19, p=0.786)

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