



The effect of aging on benefit from basic and premium hearing aid technology

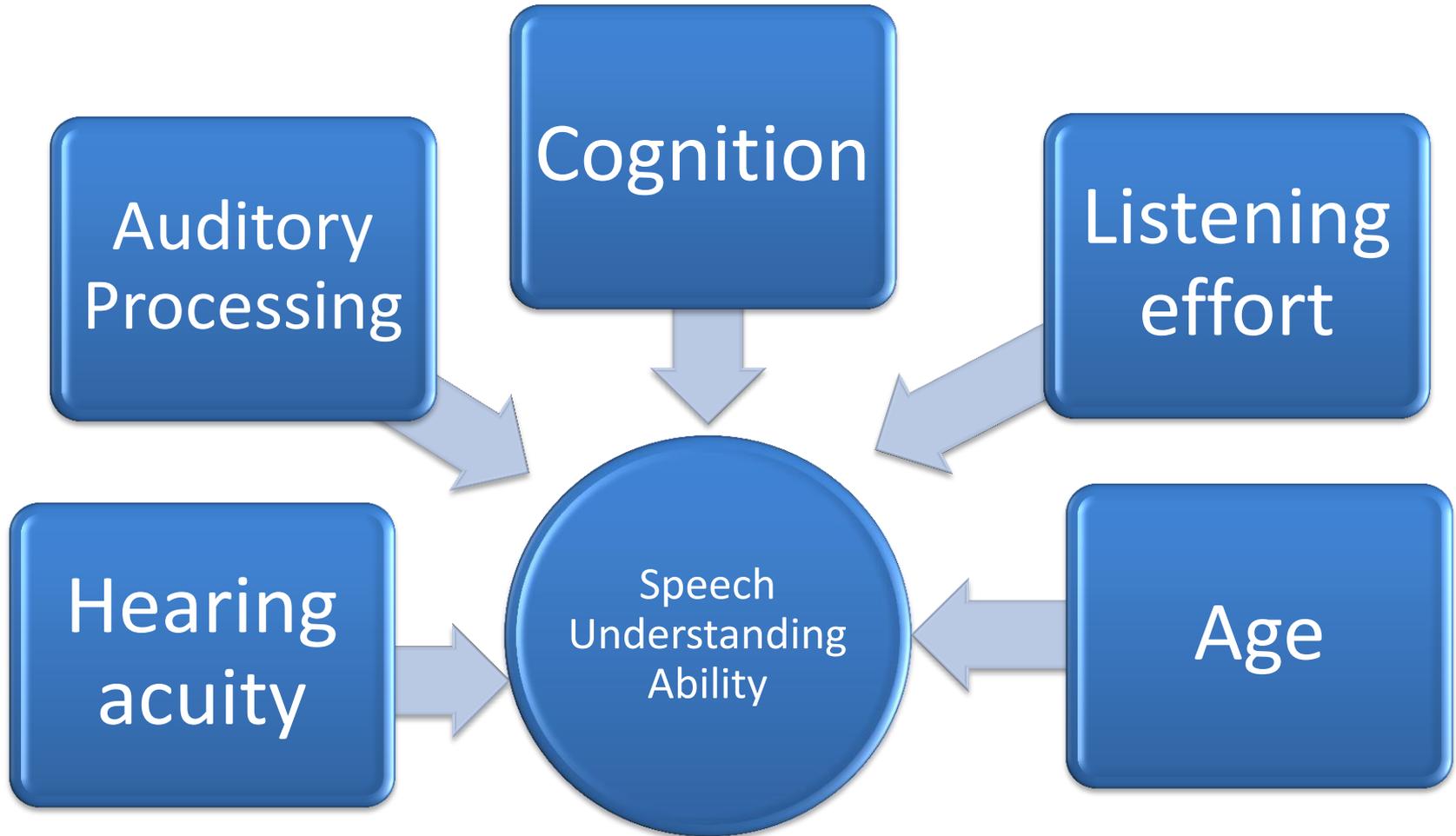
Jani Johnson, Jingjing Xu, Robyn Cox

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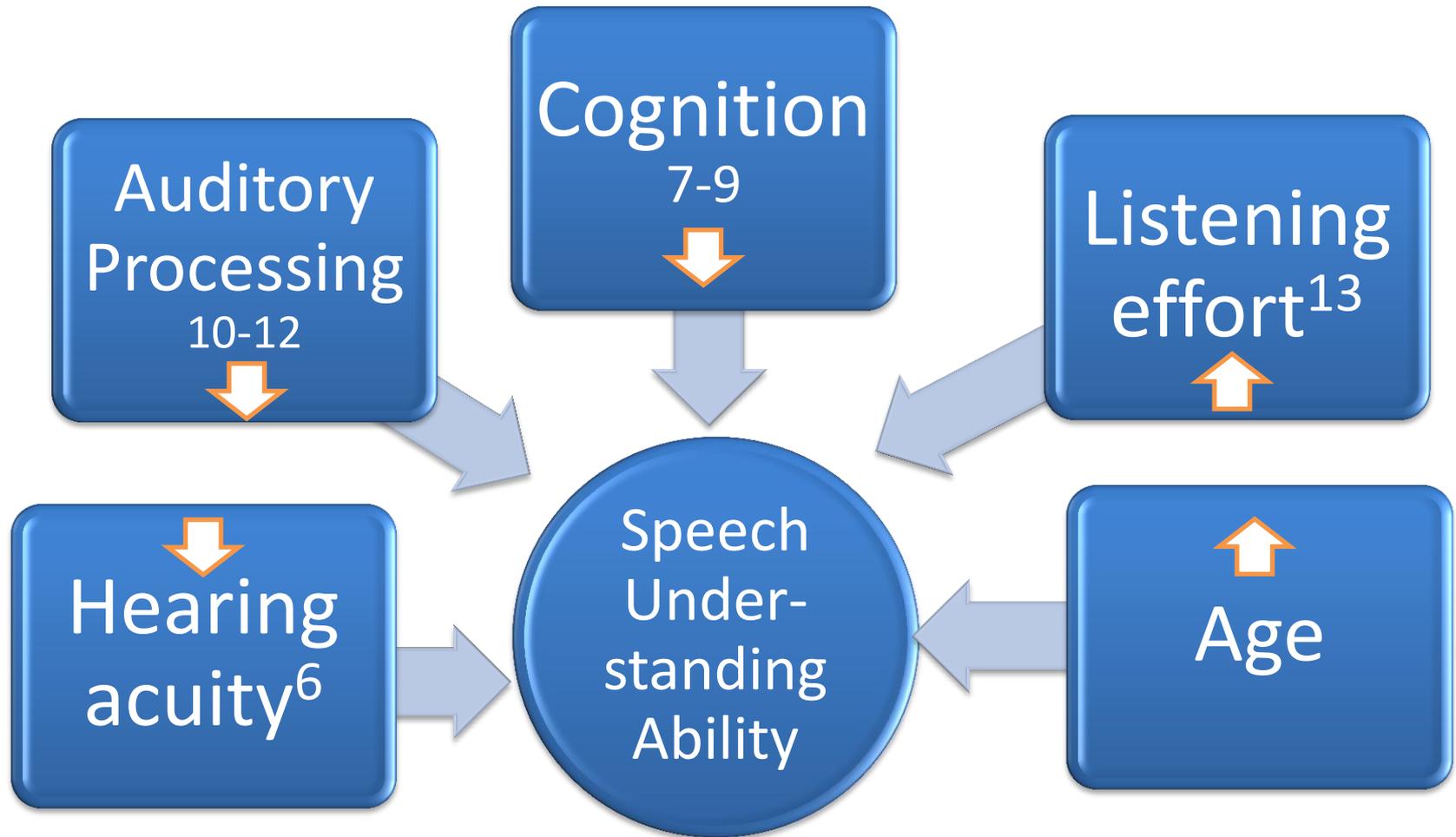
A little review...

- Age-related hearing loss
 - is common
 - ~25-45% of adults in their 60s^{1,2}
 - typically manifests as a high-Hz SNHL^{3,4}
 - worsens with age
 - Prevalence can more than double with each subsequent decade,² and severity accelerates for older ages³
 - often is associated with difficulty understanding speech in background noise. e.g., 5-7

Speech understanding in noise is impacted by...



Older adults' speech understanding problems in noise are a result of...

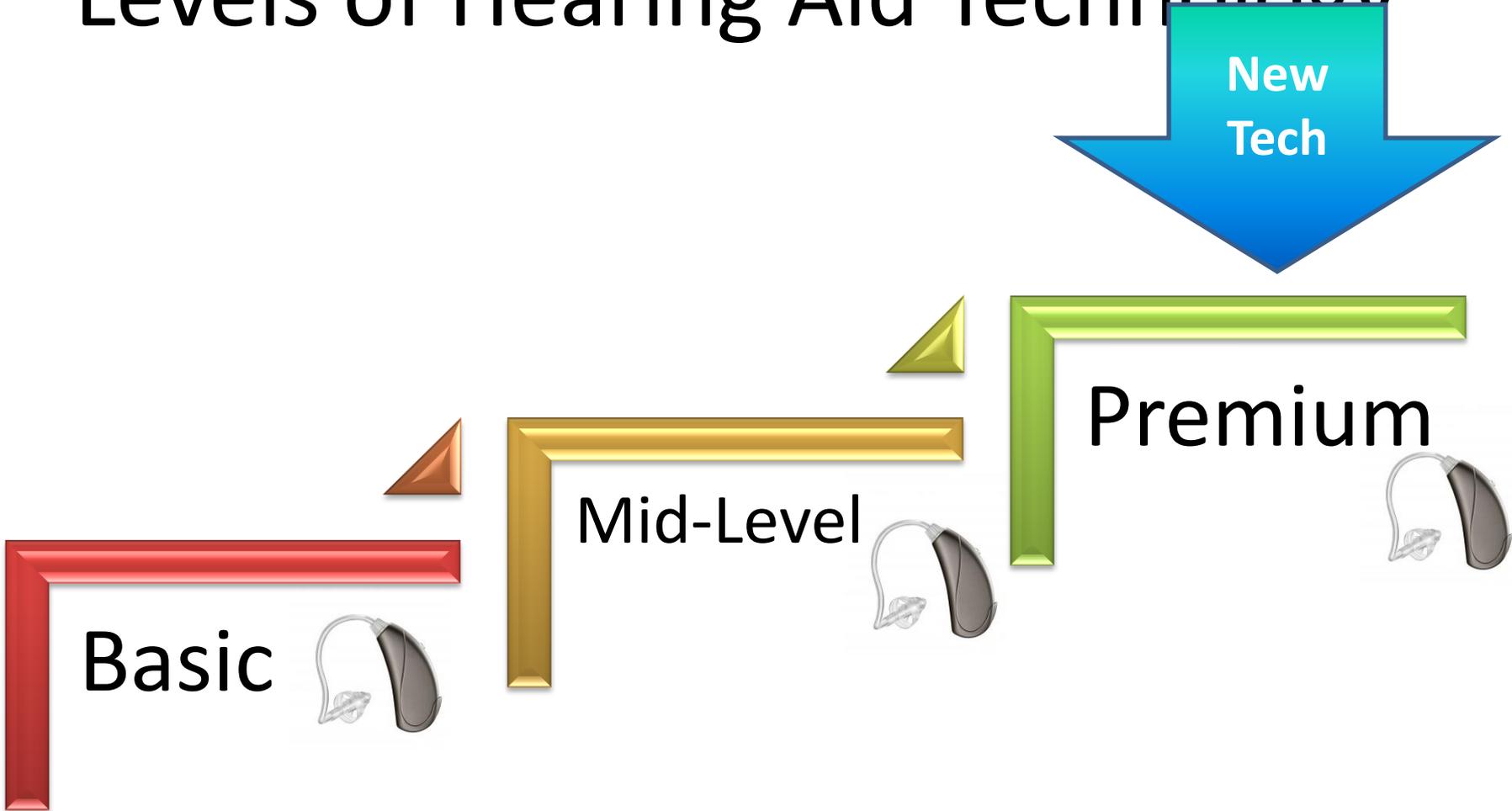


Amplification to the rescue!

- The primary intervention for age-related hearing loss is amplification with hearing aids.
 - Intended to improve audibility
 - Ease listening effort
 - Improve speech understanding in noise
 - Improve overall quality of life



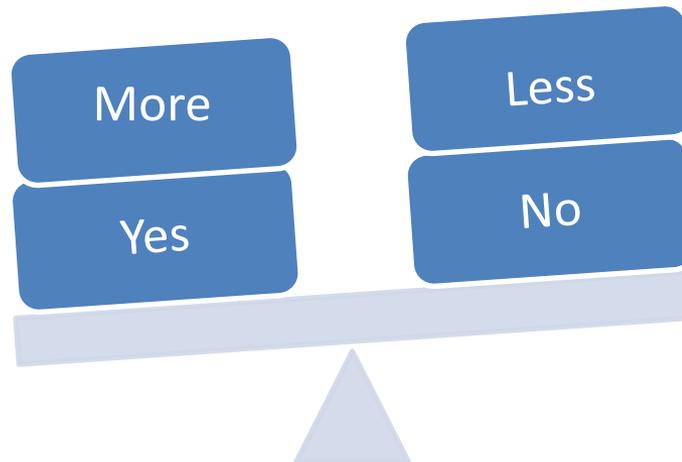
Levels of Hearing Aid Technology



Several features that target speech understanding and listening effort differ for premium and basic hearing aids

Premium

Basic



Are premium features beneficial for older patients?

- Some premium features might be more beneficial for persons with more active lifestyles and higher cognitive function¹⁴
- Older adults have been demonstrated to have less demanding lifestyles¹⁵ and poorer cog function¹⁶⁻¹⁸.
- Further, some HA features process the signal in a manner that results in signal distortions. Older adults are especially susceptible to negative effects of these distortions¹⁹

Premium features come with premium price tags



- Older adults are at risk for reduced SES.²⁰

Cost/Benefit for older adults

- These data might suggest a recommendation in favor of choosing basic-level processing for older adults and premium-level processing for younger adults

The problem:

- Independent research has not demonstrated that use of premium-level technology results in better everyday speech understanding or listening effort outcomes than use of basic-level technology.
- Further, it is not clear how aging impacts benefit from different levels of hearing aid technology.

Purposes

- 1st – To explore the relationship between aging and working memory/auditory lifestyle for a sample of older adults with hearing impairment.
- 2nd - To compare speech understanding and listening effort outcomes for participants in their 60s and participants in their 70s using exemplars of basic and premium hearing aid technology from two major hearing aid manufacturers.

Purposes

- 1st – To explore the relationship between aging and working memory/auditory lifestyle for a sample of older adults with hearing impairment.

Research Questions: Part 1

- For a sample of 30 adults ages 60-81 with mild to moderate age-related hearing loss:
 1. Does cognition decline with age?
 2. Does the auditory environment...
 - a. become quieter for older participants?
 - b. become less diverse for older participants?
 3. Are older participants less active?
 4. Do older participants have a reduced social network?

Participants

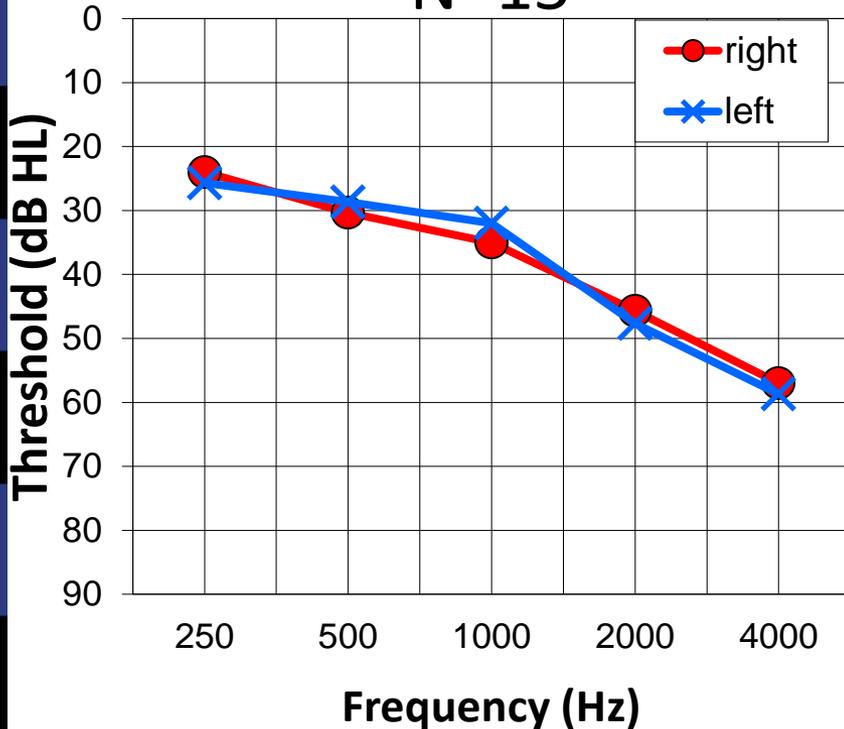
- Recruited from a database of willing participants and through word of mouth
- 30 of 45 participants' completed data are presented here
- Two equal groups (N=15) matched for hearing abilities

Participants

| | Younger | Older |
|-----------|----------------------------|--------------|
| Age | 61-69 (X=65) | 71-81 (X=74) |
| Female | 7 | 5 |
| Race | Cauc = 13; Afr Amer = 2 | Cauc = 15 |
| Owns a HA | 6 | 4 |
| Employed | 13 | 7 |

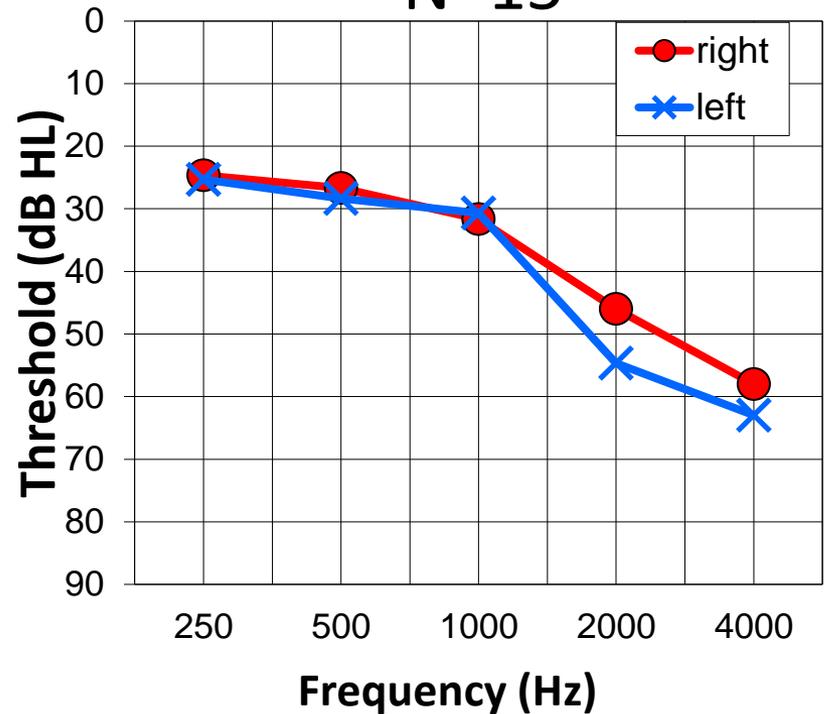
Younger v Older Audiograms

Younger
N=15



| | | |
|------------|------|----------|
| PTA (4 Hz) | SRT | Word Rec |
| R=42 | R=37 | R = 83% |
| L=42 | L=36 | L = 85% |

Older
N=15



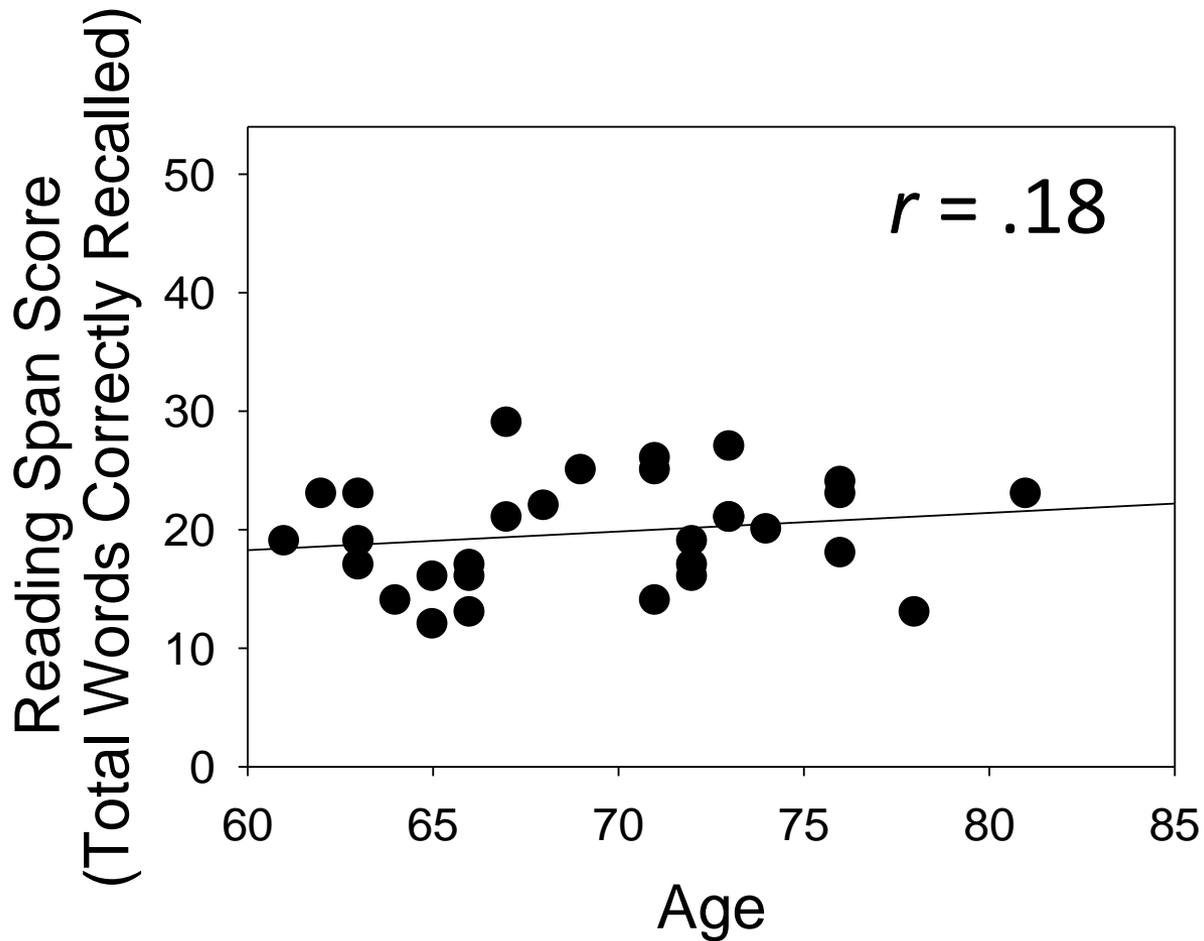
| | | |
|------------|------|----------|
| PTA (4 Hz) | SRT | Word Rec |
| R=41 | R=36 | R = 87% |
| L=44 | L=35 | L = 81% |

Question 1 : Does cognition decline with age?

- Reading span test ²¹
 - A commonly used measure of working memory
 - Predictive of speech perception abilities

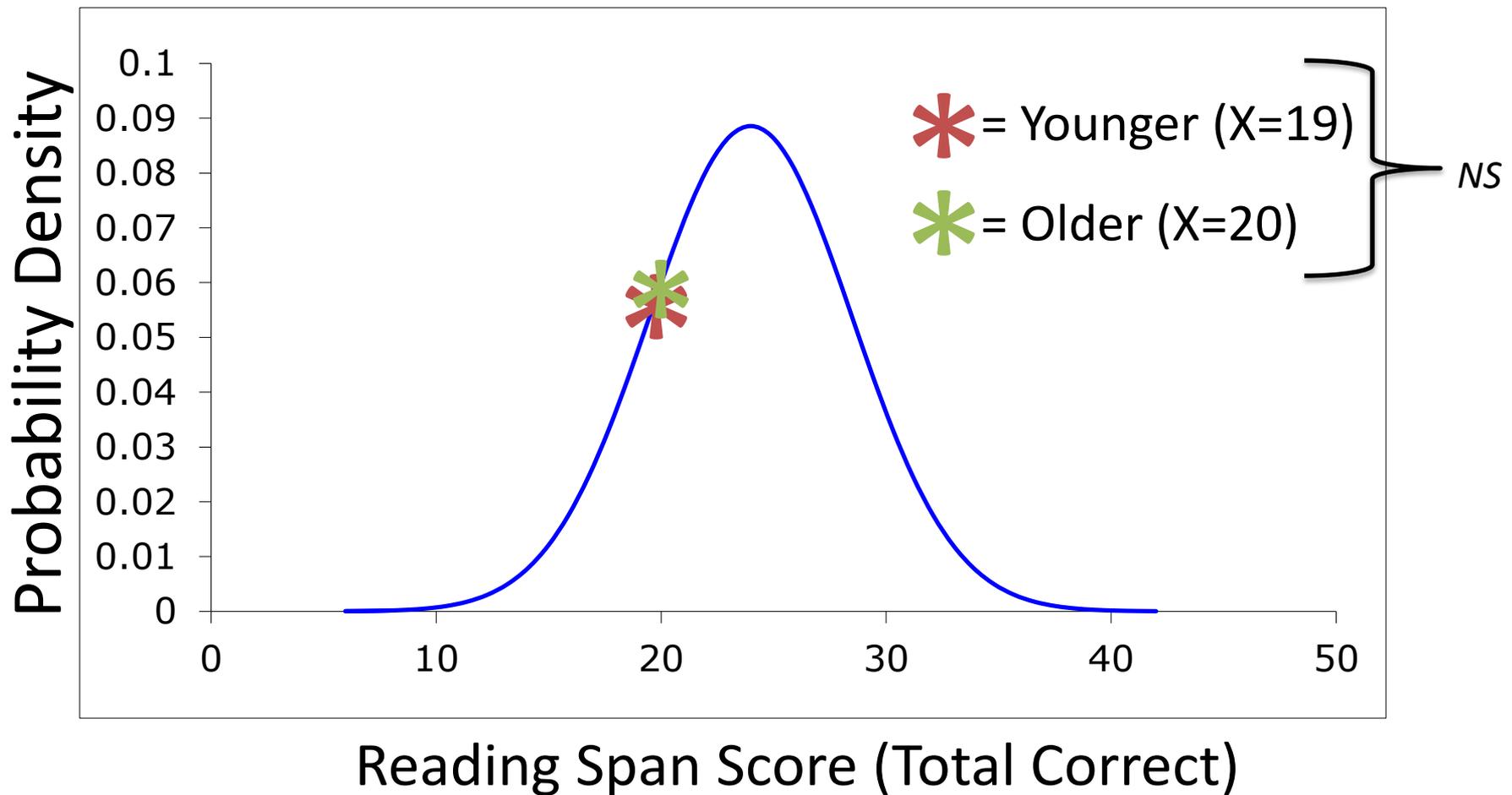
THE FISH

Did cognition decline with age?



Cognition compared to young norms?

- Normative SPAN data (young, normal hearing)²²



Did cognition decline with age?

- For participants ranging in age from 60-81.

NO.

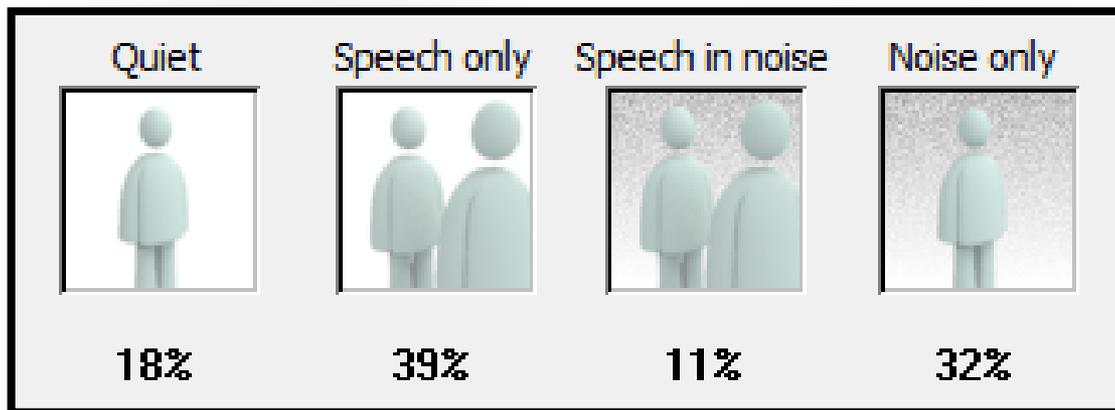
- Compared to young normal hearers.

YES.

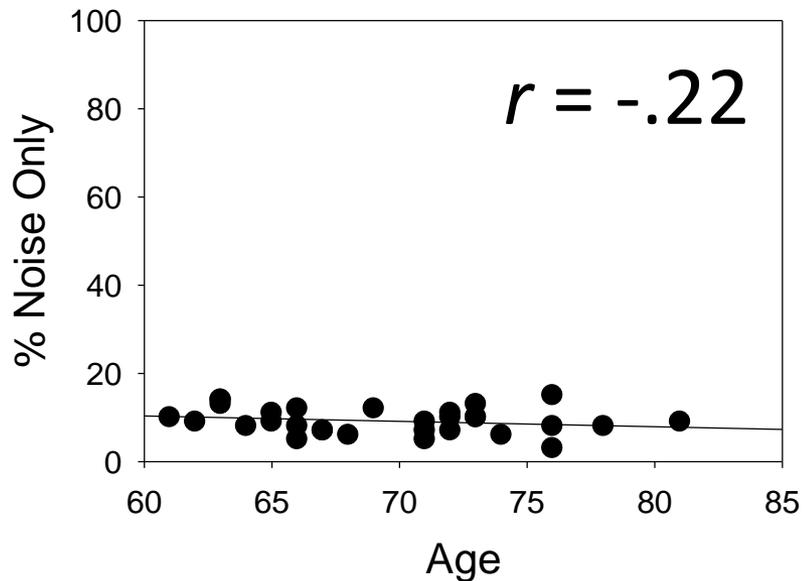
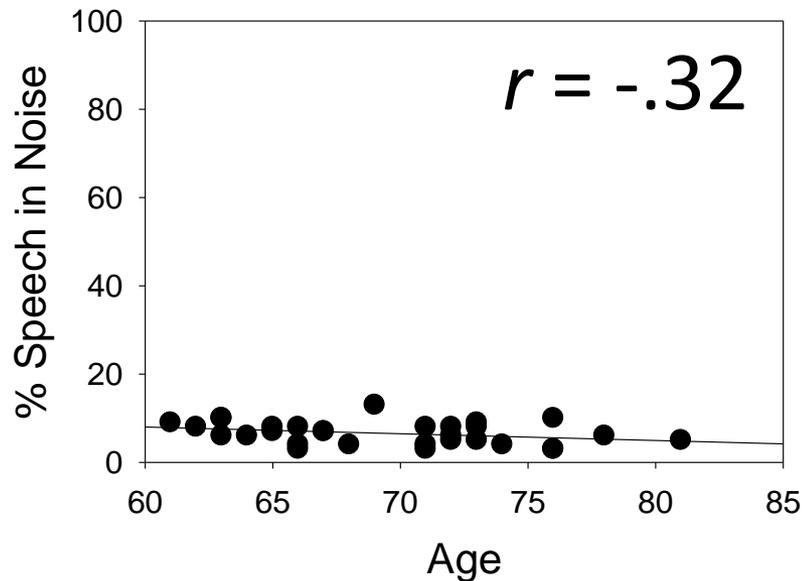
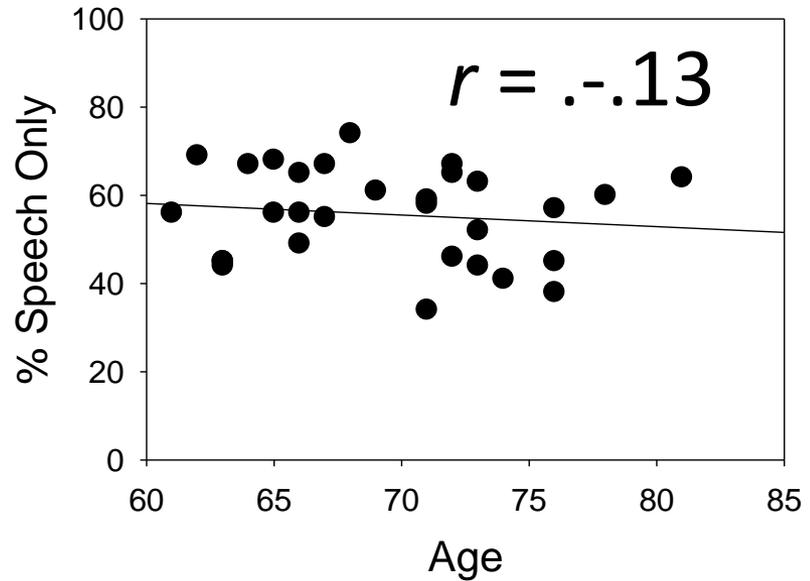
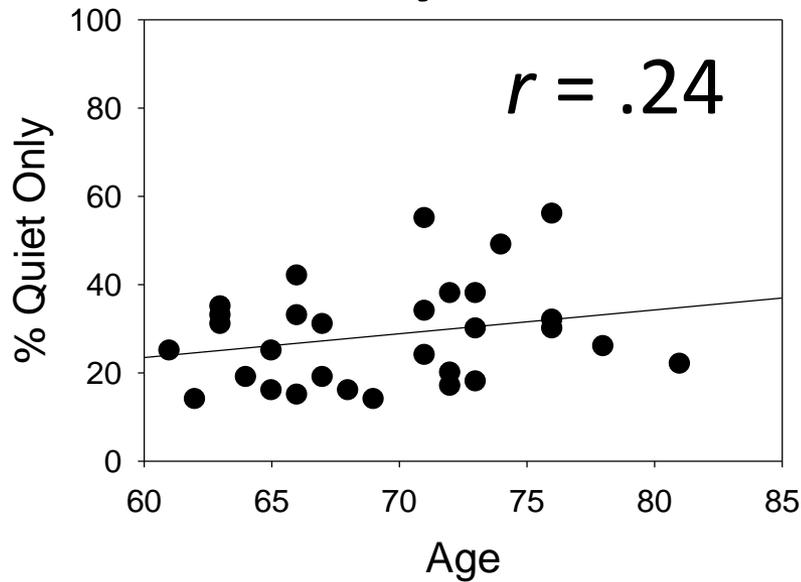
Age and auditory lifestyle

- Objective Measures
 - Sound Activities Meter (SAM)
 - Personal Noise Dosimeter
- Self-report
 - HARL Activities Scale
 - Social Network Index

Sound Activity Meter



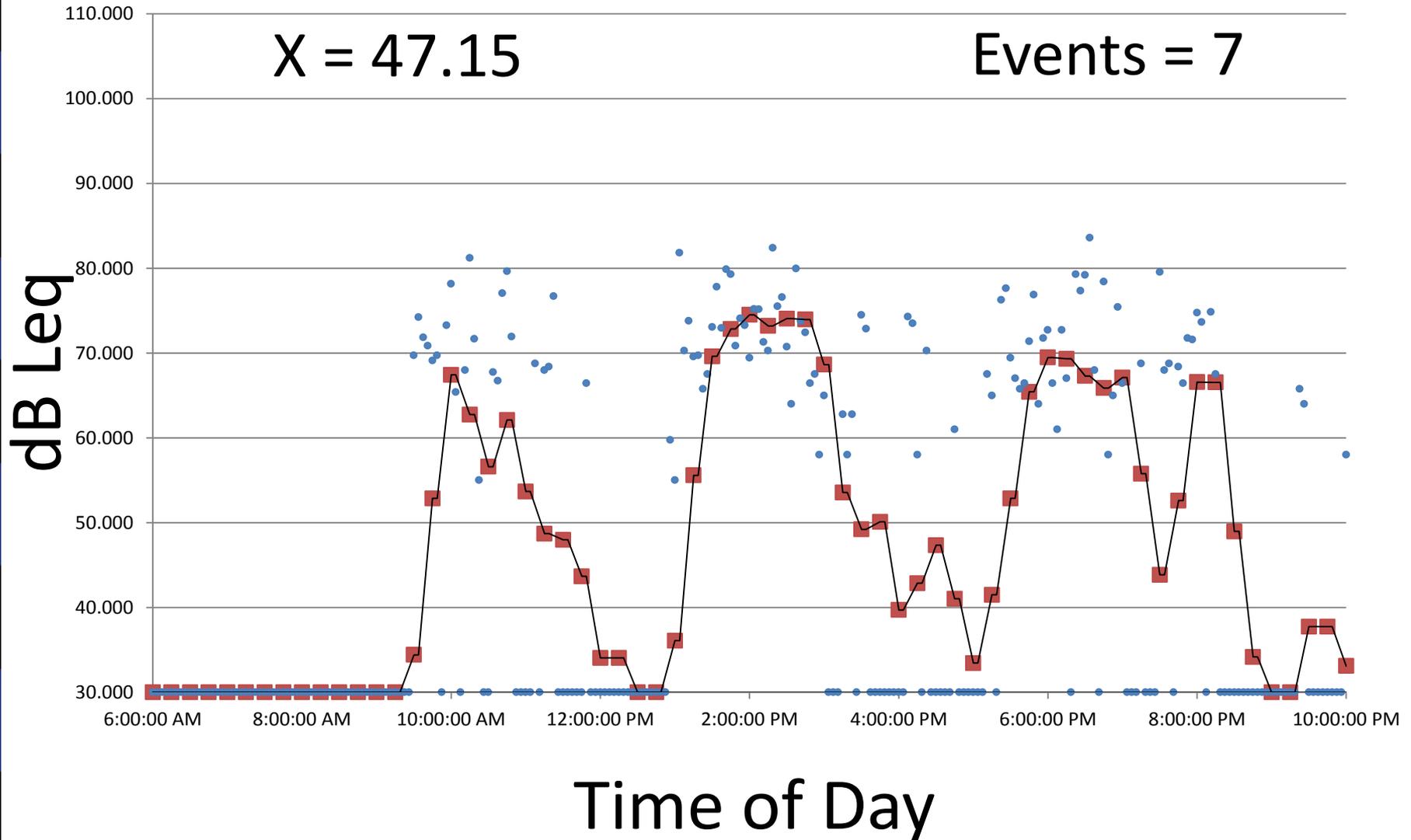
Auditory Environment: Sound Types



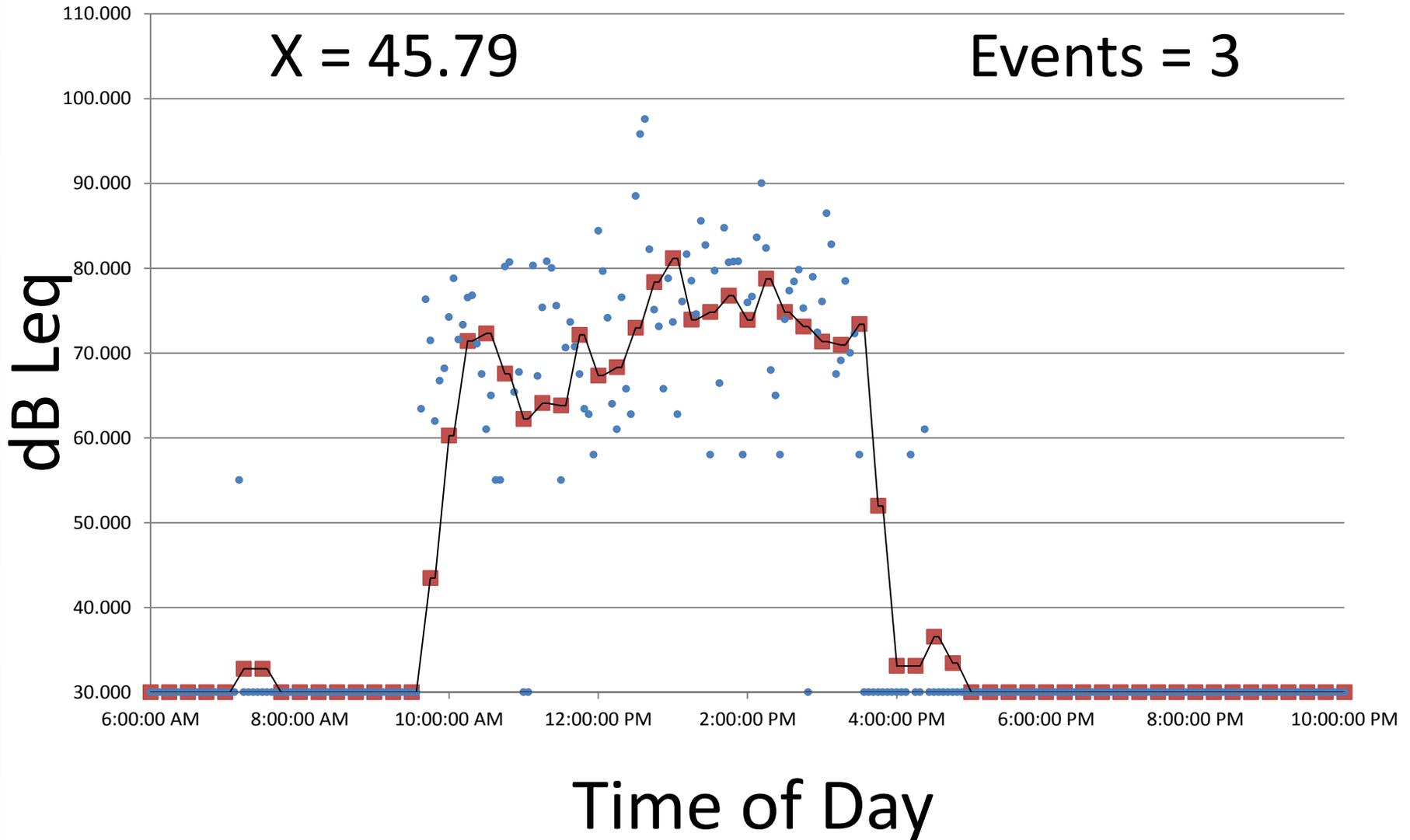
Personal Noise Dosimeter



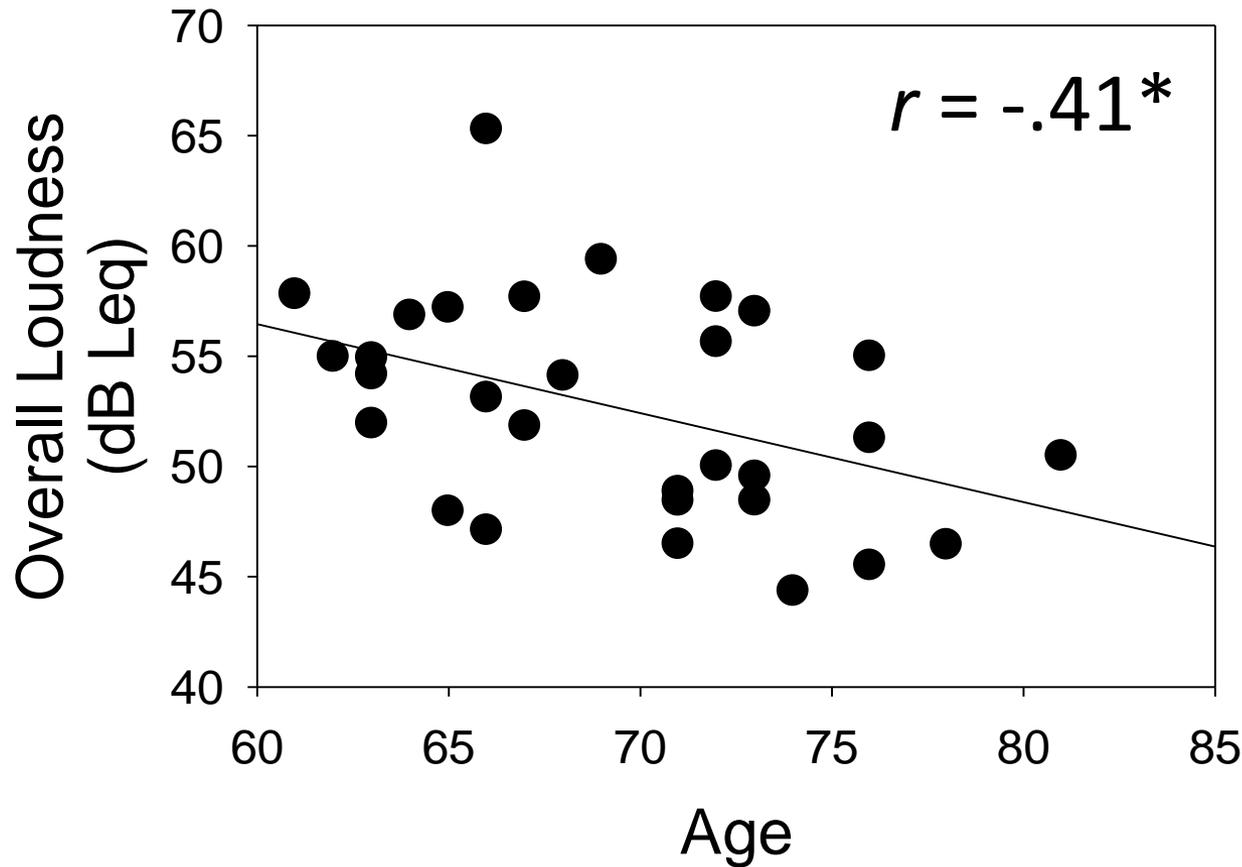
Personal Noise Dosimeter



Personal Noise Dosimeter



Auditory Environment: Loudness



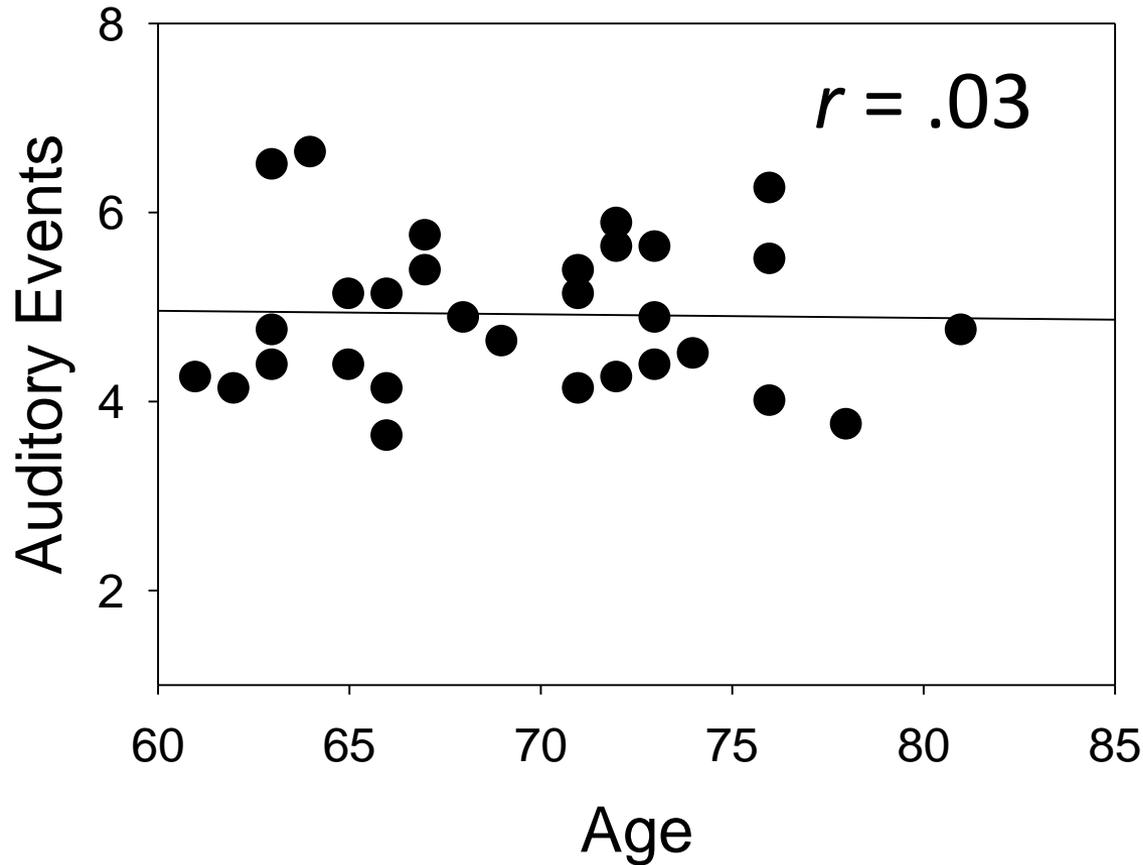
Younger
55 dB Leq

Older
50 dB Leq



$p < .05$

Auditory Environment: Diversity



Younger
4.91

Older
4.93

NS

Did the auditory environment...

- Become quieter for older participants?

YES.

- Become less diverse?

NO.

Question 3: Were the older participants less active?

- HARL Activities Scale
 - Modified from Swedish Welin Activities Scale (WAS)²³
 - A participation measure that assesses the frequency of activities that respondents engage in.

Question 3: Were the older participants less active?

NO.

- Consistent with previous research¹⁵

Question 4: Did older participants have a reduced social network?

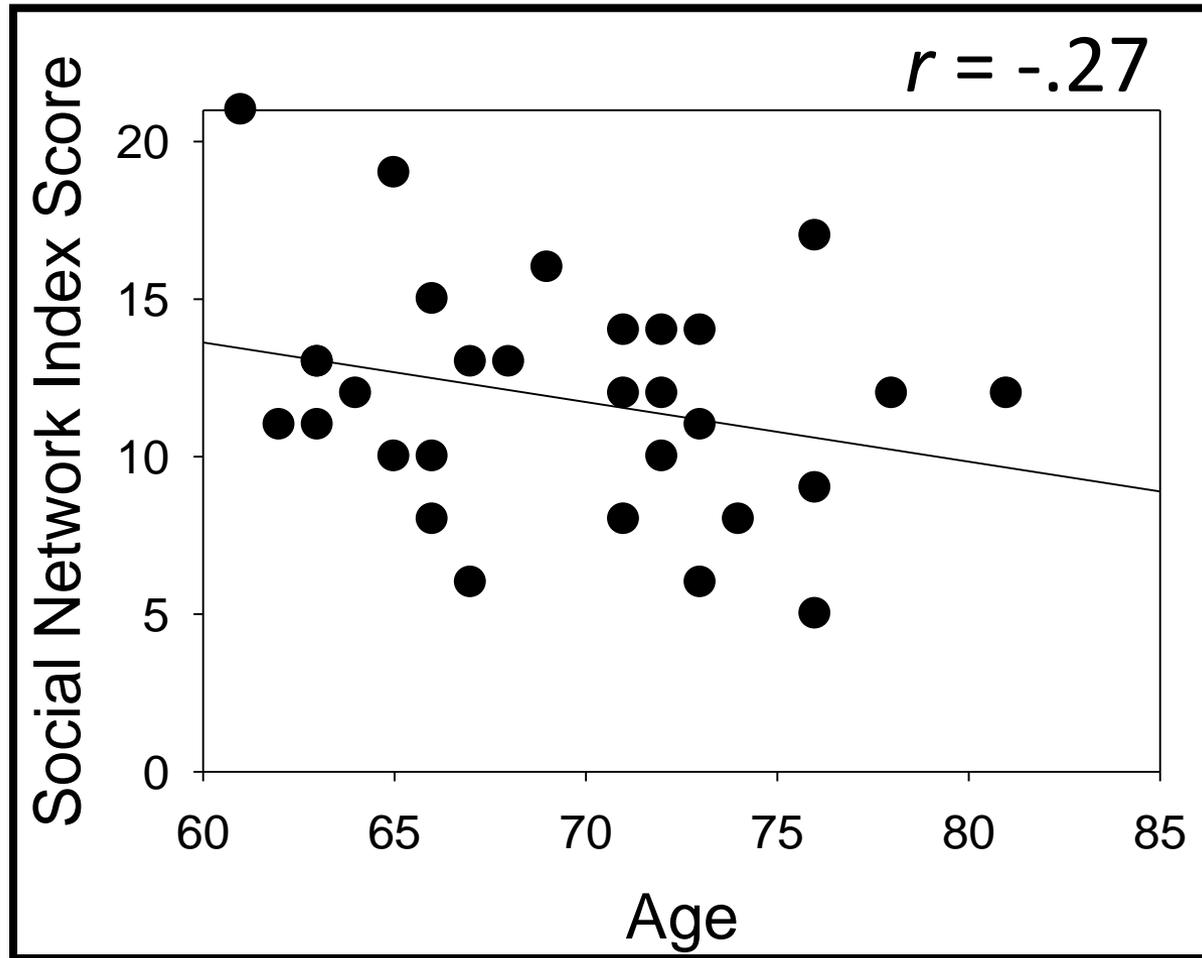
- Social Network Index (SNI)²⁴

Social Network Index (revised)

Instructions: This questionnaire is concerned with how many people you see or talk to on a regular basis including: family, friends, workmates, neighbors, etc. Please read and answer each question carefully. Answer follow-up questions where appropriate.

| | | | | | |
|---|---|--|-----------------------------|------------------------------|--|
| + | 1 | Are you currently living with a spouse or partner? | No <input type="checkbox"/> | Yes <input type="checkbox"/> | |
| | 2 | Do you have children? | No <input type="checkbox"/> | Yes <input type="checkbox"/> | Do you see or talk on the phone to any of your children at least once every 2 weeks? No <input type="checkbox"/> Yes <input type="checkbox"/> |
| | 3 | Are either of your parents are still living? | No <input type="checkbox"/> | Yes <input type="checkbox"/> | Do you see or talk on the phone to either of your parents at least once every 2 weeks? No <input type="checkbox"/> Yes <input type="checkbox"/> |
| | 4 | Are either of your in-laws (or partner's parents) living? | No <input type="checkbox"/> | Yes <input type="checkbox"/> | Do you see or talk on the phone to either of your partner's parents at least once every 2 weeks? No <input type="checkbox"/> Yes <input type="checkbox"/> |
| | 5 | Do you have relatives other than your spouse, parents & children that you feel close to? | No <input type="checkbox"/> | Yes <input type="checkbox"/> | Do you see or talk to on the phone to any of these relatives at least once every 2 weeks? No <input type="checkbox"/> Yes <input type="checkbox"/> |
| | 6 | Do you have close friends who aren't relatives? (People that you feel at ease with, can talk to about private matters, and can call on for help) | No <input type="checkbox"/> | Yes <input type="checkbox"/> | Do you see or talk to any one of these friends at least once every 2 weeks? No <input type="checkbox"/> Yes <input type="checkbox"/> |

Question 4: Did older participants have a reduced social network?



Question 4: Did older participants have a reduced social network?

Yes, but the trend did not reach statistical significance.

- Trend consistent with previous research¹⁵

Big Picture

| | Younger | Older |
|------------------------------|---------------------------------------|----------------|
| Age | 61-69 (X=65) | 71-81 (X=74) |
| Owns a HA | Similar | |
| Employed | 13 | 7 |
| 4Hz PTA (dB HL) | Similar | |
| Working Memory | Similar | |
| Environment: Loudness | Louder | Quieter |
| Environment: Diversity | Similar – Both groups mostly in quiet | |
| Lifestyle: Activities | Similar | |
| Lifestyle: Social Network | Larger | Smaller |

Any differences in hearing aid benefit between the two groups...

- Are likely a result of age-related differences in auditory processing.
- Might be impacted by slight differences in environmental loudness and social network.

Purpose

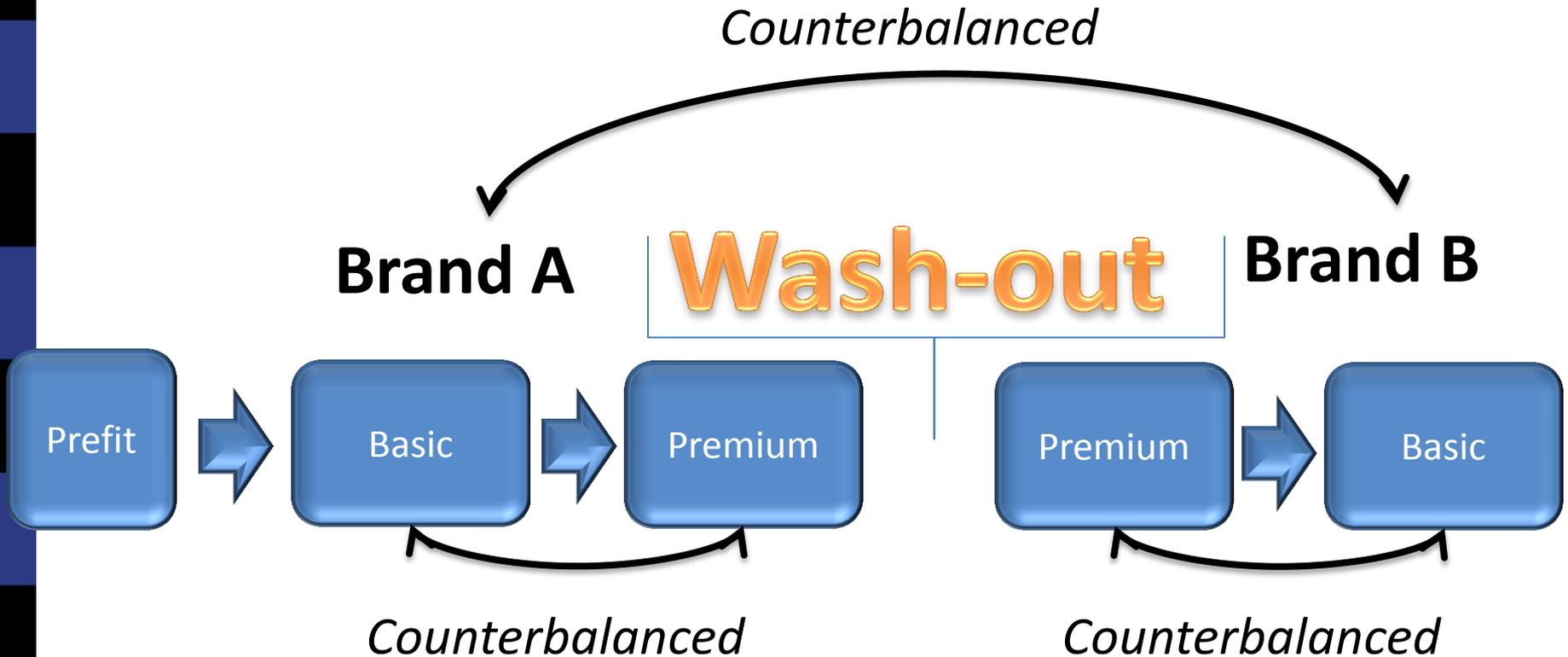
- 2nd - To compare speech understanding and listening effort outcomes for participants in their 60s and participants in their 70s using exemplars of basic and premium hearing aid technology from two major hearing aid manufacturers.

Research Questions

For younger (60s) and older (70s) adults in the laboratory and in daily life, are speech understanding and listening effort:

1. Better with hearing aids compared to without?
2. Better with examples of premium hearing aids compared to basic?

Design (e.g.)



Hearing aid fittings

- Bilateral, with appropriate coupling
- Fitted using best-practice protocols, starting with NAL targets
- Features set to manufacturers' recommendations.
- 3 manually selectable programs:
 - “everyday” - default automatic
 - “look and listen” - fixed front-facing directional
 - “speech finder” - for 360° listening

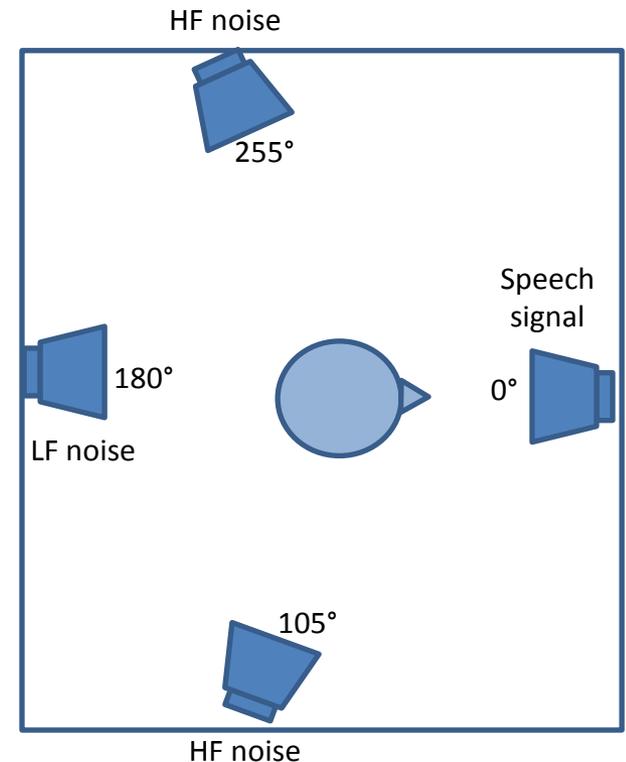
Outcomes

- Assessed prior to the first hearing aid fitting*, and again after a 4 week acclimatization with each pair of hearing aids
 - Self-report measures:
 - Abbreviated Profile of Hearing Aid Benefit (APHAB)²⁵
 - Device-Oriented Subjective Outcome (DOSO) Scale²⁶
 - Speech, Spatial, and Qualities of Hearing Scale (-Benefit) (SSQ & SSQ-B)^{27,28}
 - In the laboratory –
 - American Four Alternative Auditory Feature (AFAAF) test.²⁹
 - Three simulated environments with soft, average, and loud noise.

*Responses to DOSO and SSQ-B questionnaires were collected post-hearing aid fitting only

Laboratory Outcome Measure

- AFAAF
 - Example prompt: “*Can you hear OLD clearly?*”
 - Select from: *HOLD, OLD, COLD, GOLD*
- 80 items for each listening environment.
- HA set to default program



Laboratory Outcome Measure

- **Speech Understanding:**
 - Proportion correct scores were converted to rationalized arcsine units (RAUs) for analysis.³⁰
- **Listening Effort**
 - Measured simultaneously with speech understanding. Rated after blocks of 20 words. Ratings were averaged for each environment.

Listening Effort Scale

1. No effort
2. Very little effort
3. Little effort
4. Moderate effort
5. Considerable effort
6. Much effort
7. Extreme effort

RESULTS

Statistical comparisons

- A priori planned contrasts of:
 - Unaided and Aided (Question 1)
 - Basic and Premium (Question 2)
 - Basic and Premium (Brand A)
 - Basic and Premium (Brand B)

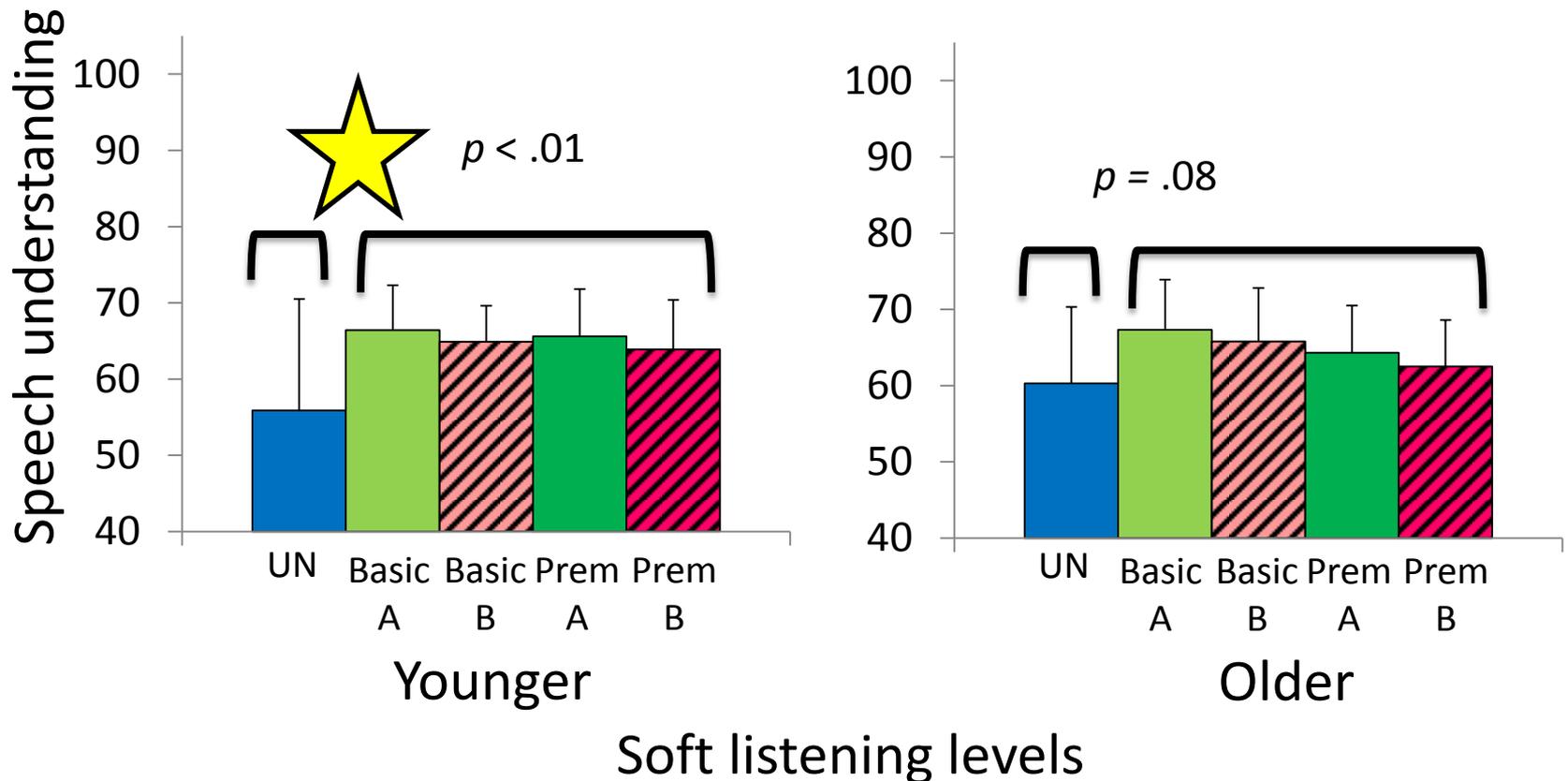
SPEECH UNDERSTANDING

Question 1- Was speech understanding better with hearing aids compared to without?

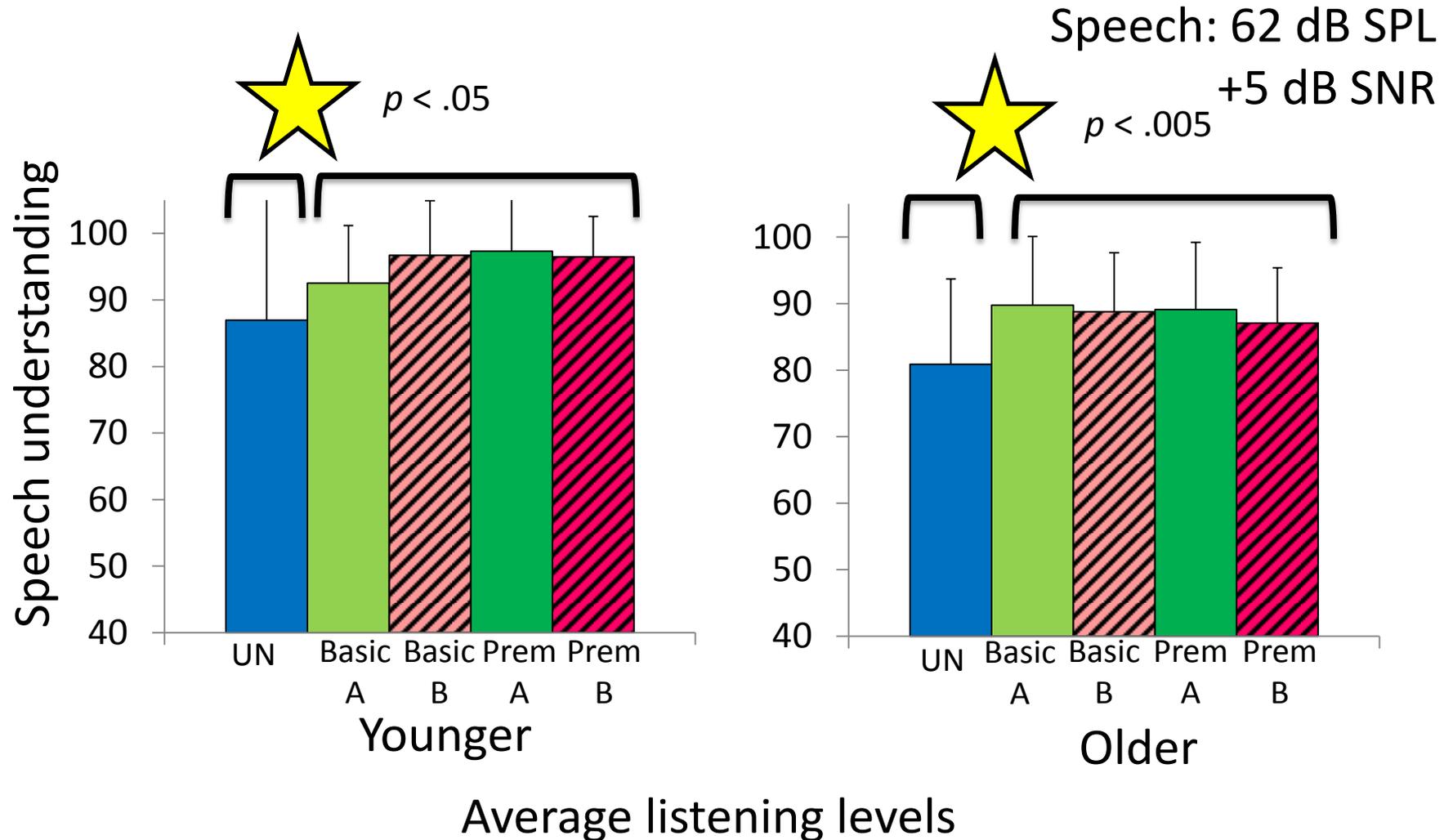
| | Younger | Older |
|--------------------|---------|-------|
| In the laboratory? | | |
| In daily life? | | |

Question 1- Unaided vs Aided

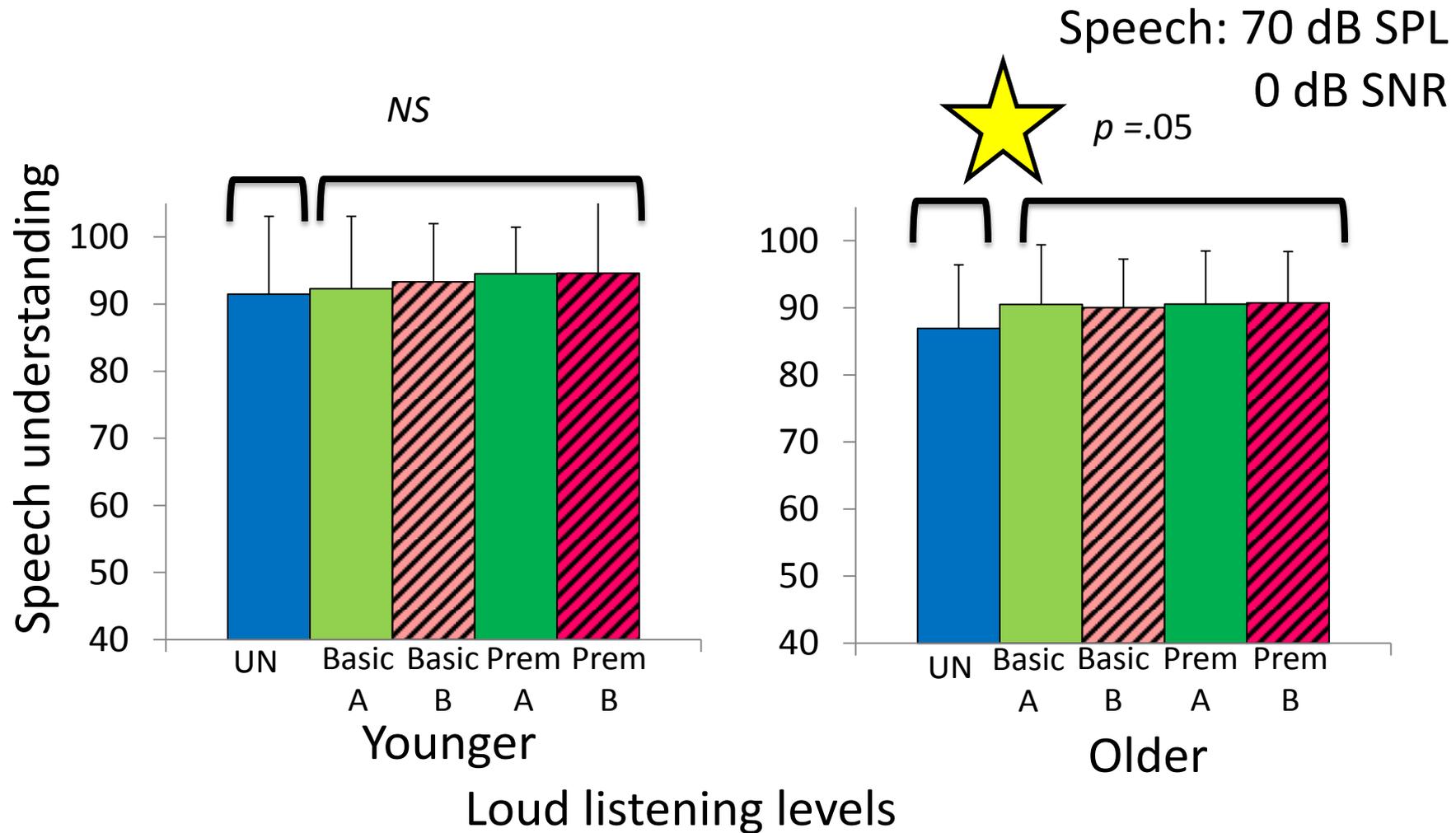
Speech: 55 dB SPL
+10 dB SNR



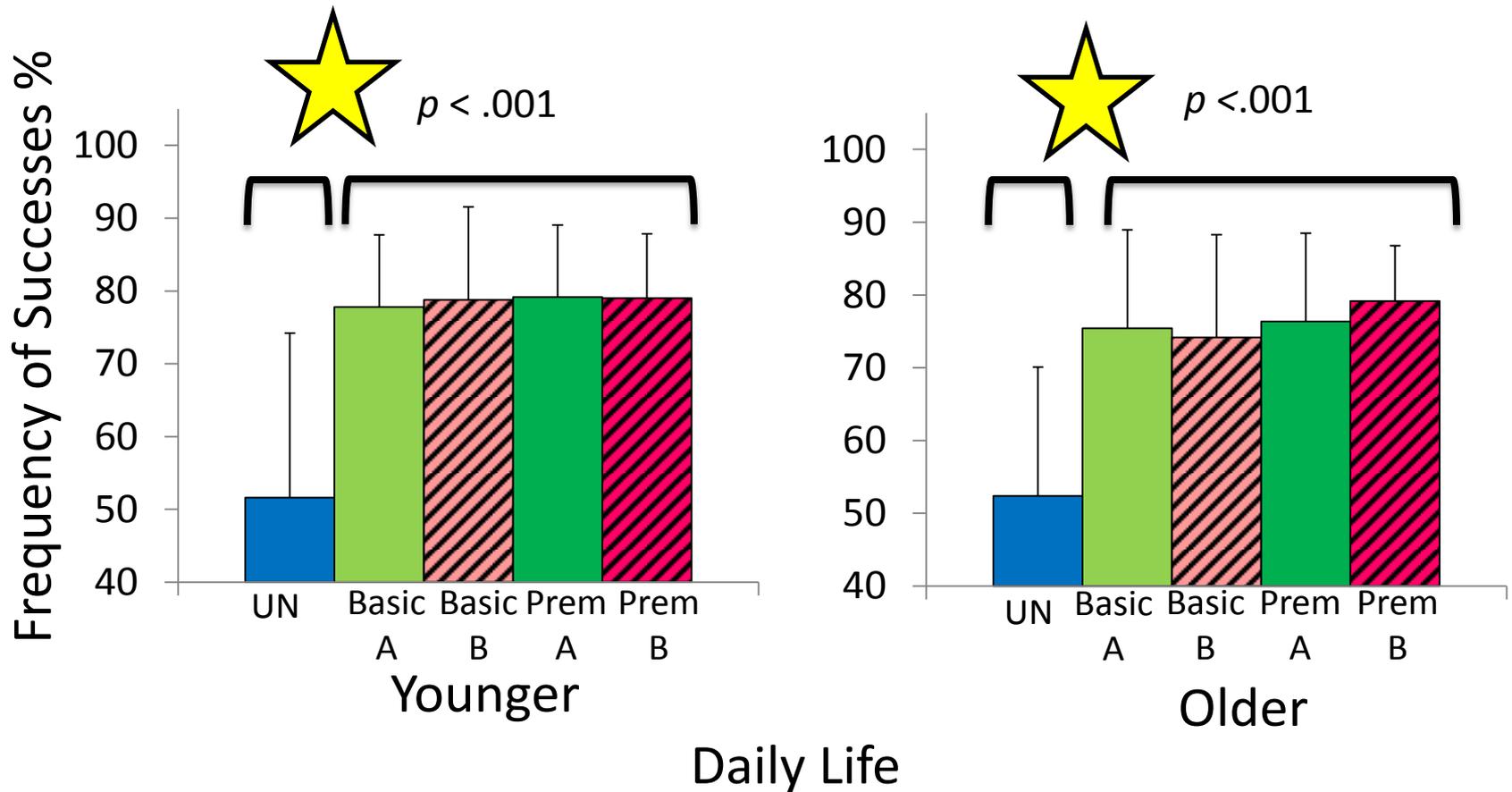
Question 1- Unaided vs Aided



Question 1- Unaided vs Aided



Question 1- Unaided vs Aided



Question 1- Was speech understanding better with hearing aids compared to without?

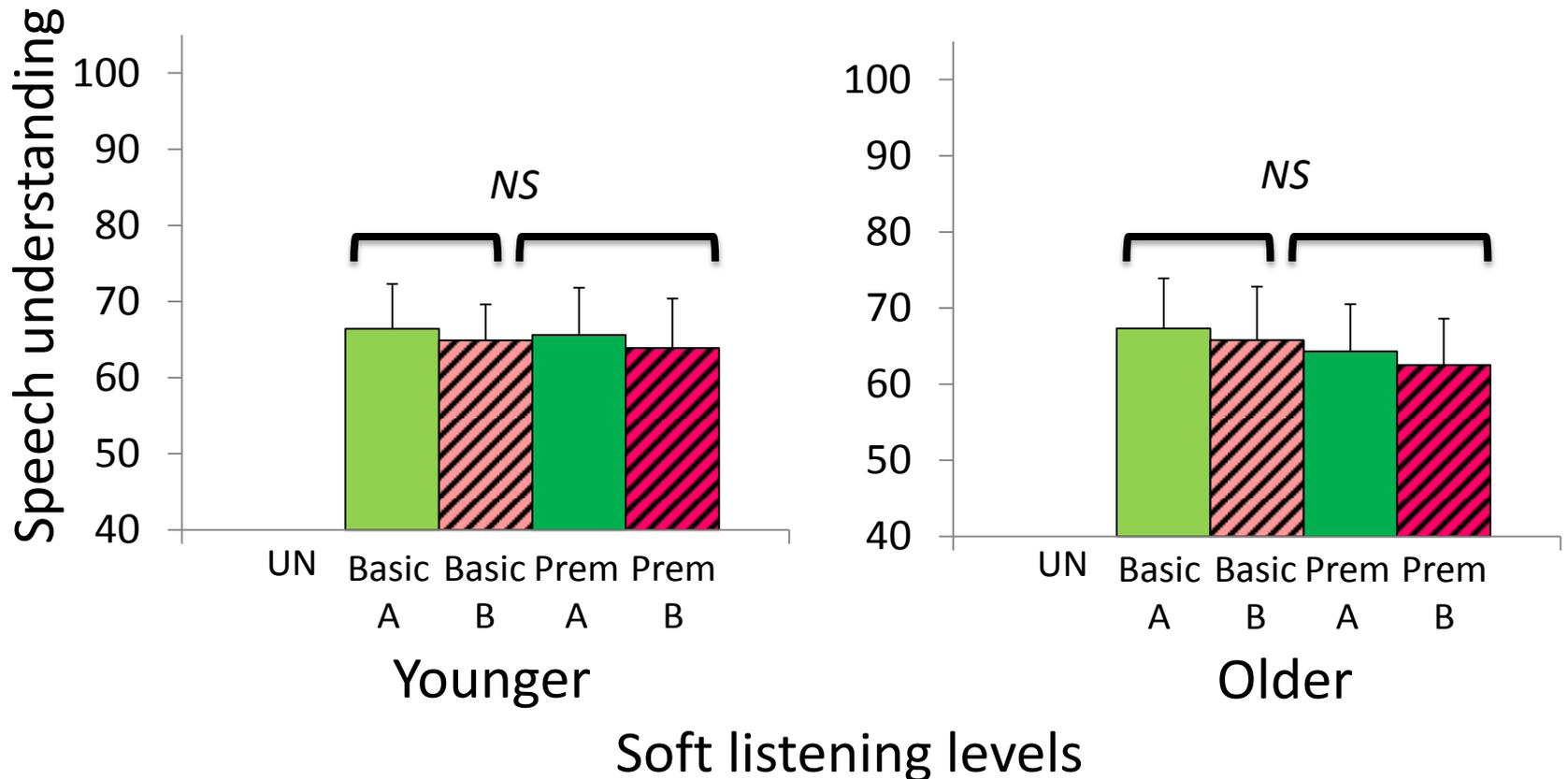
| | Younger | Older |
|--------------------|--|---|
| In the laboratory? | Yes. For soft and average level speech. | Yes. Especially for average and loud speech. |
| In daily life? | Yes. | Yes. |

Question 2- Was speech understanding better with examples of Premium hearing aids compared to Basic hearing aids?

| | Younger | Older |
|--------------------|---------|-------|
| In the laboratory? | | |
| For brand A? | | |
| For brand B? | | |
| In daily life? | | |
| For brand A? | | |
| For brand B? | | |

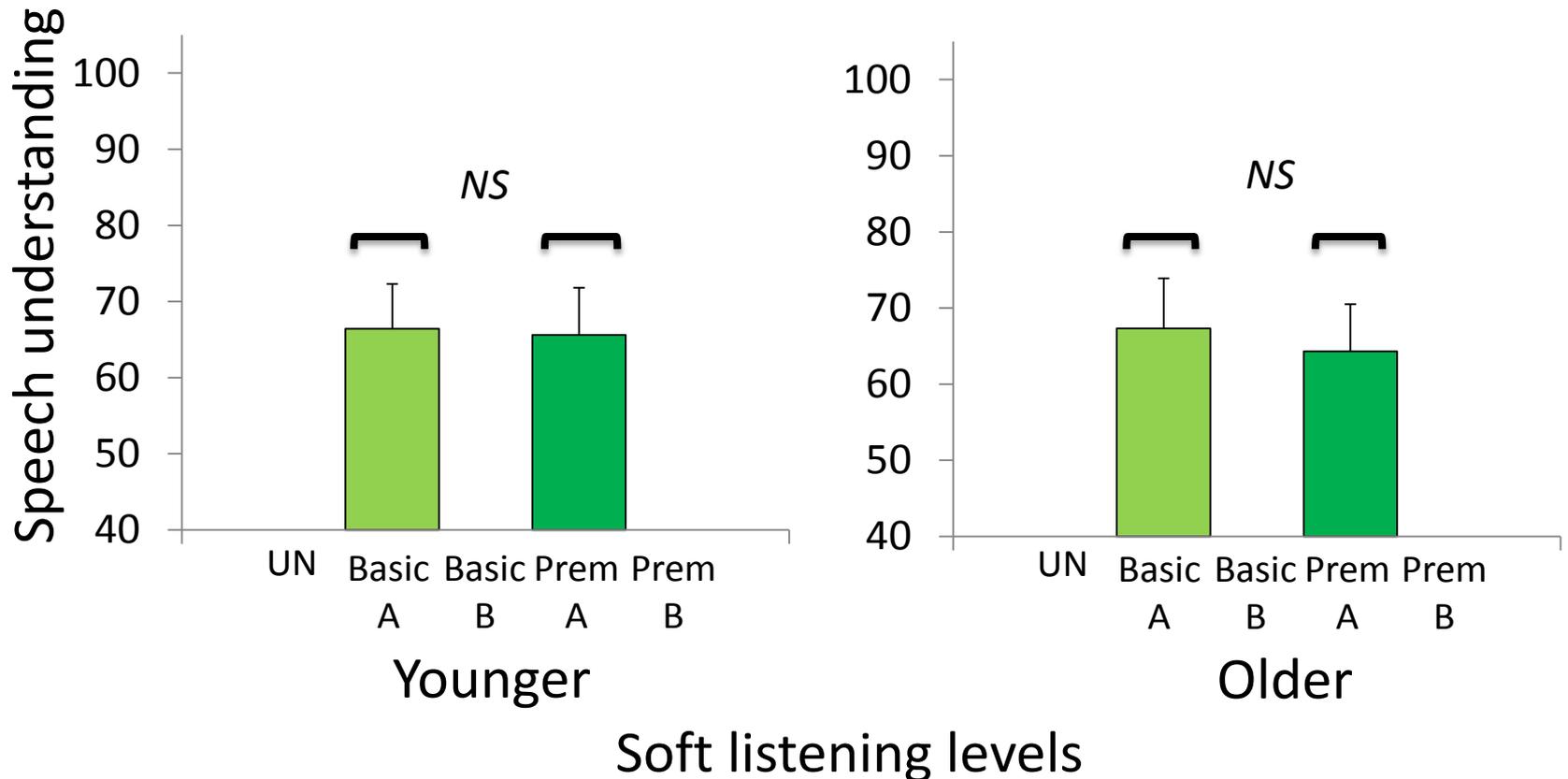
Question 2- Premium v Basic

Speech: 55 dB SPL
+10 dB SNR



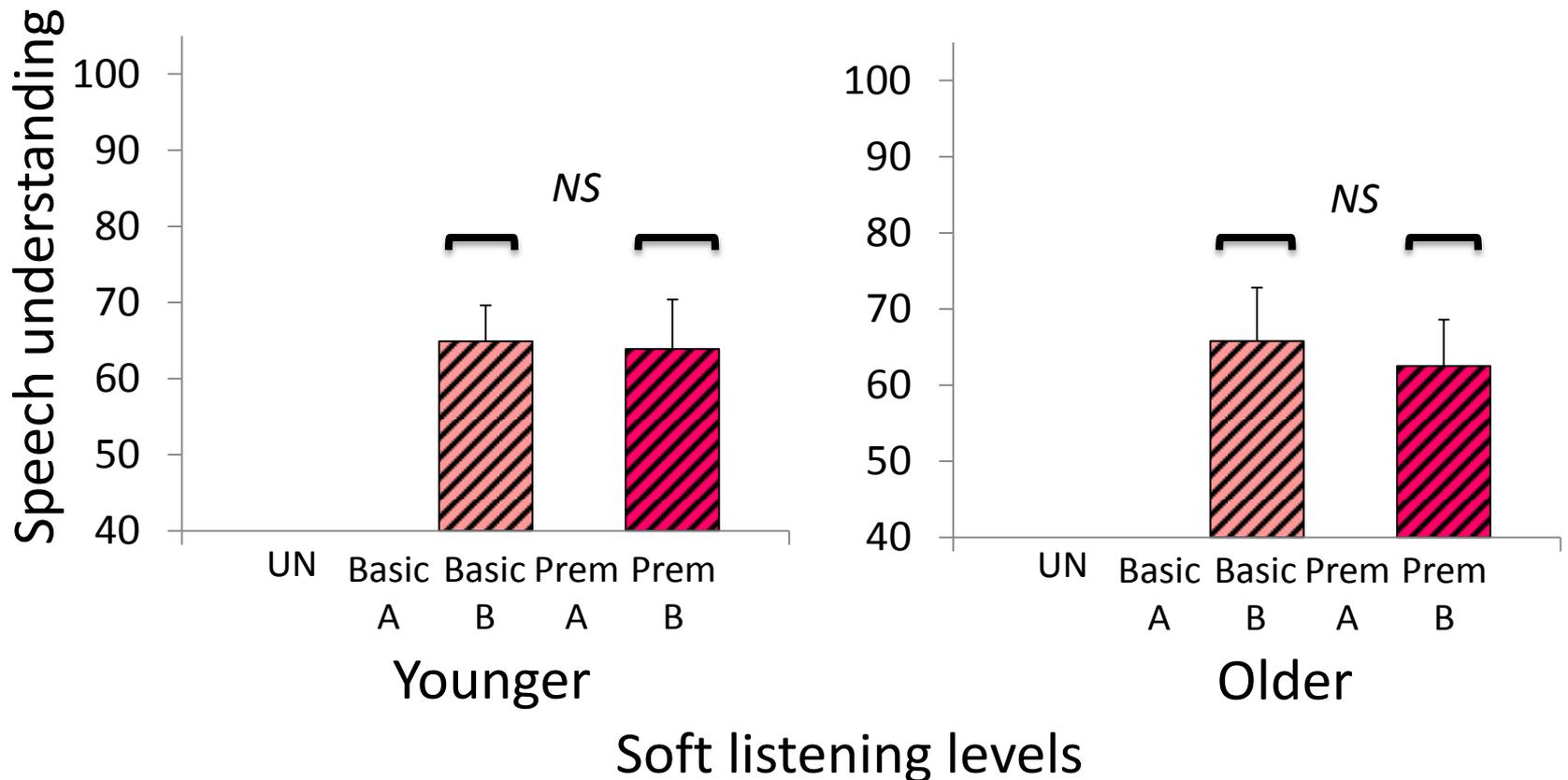
Question 2- Premium v Basic

Speech: 55 dB SPL
+10 dB SNR



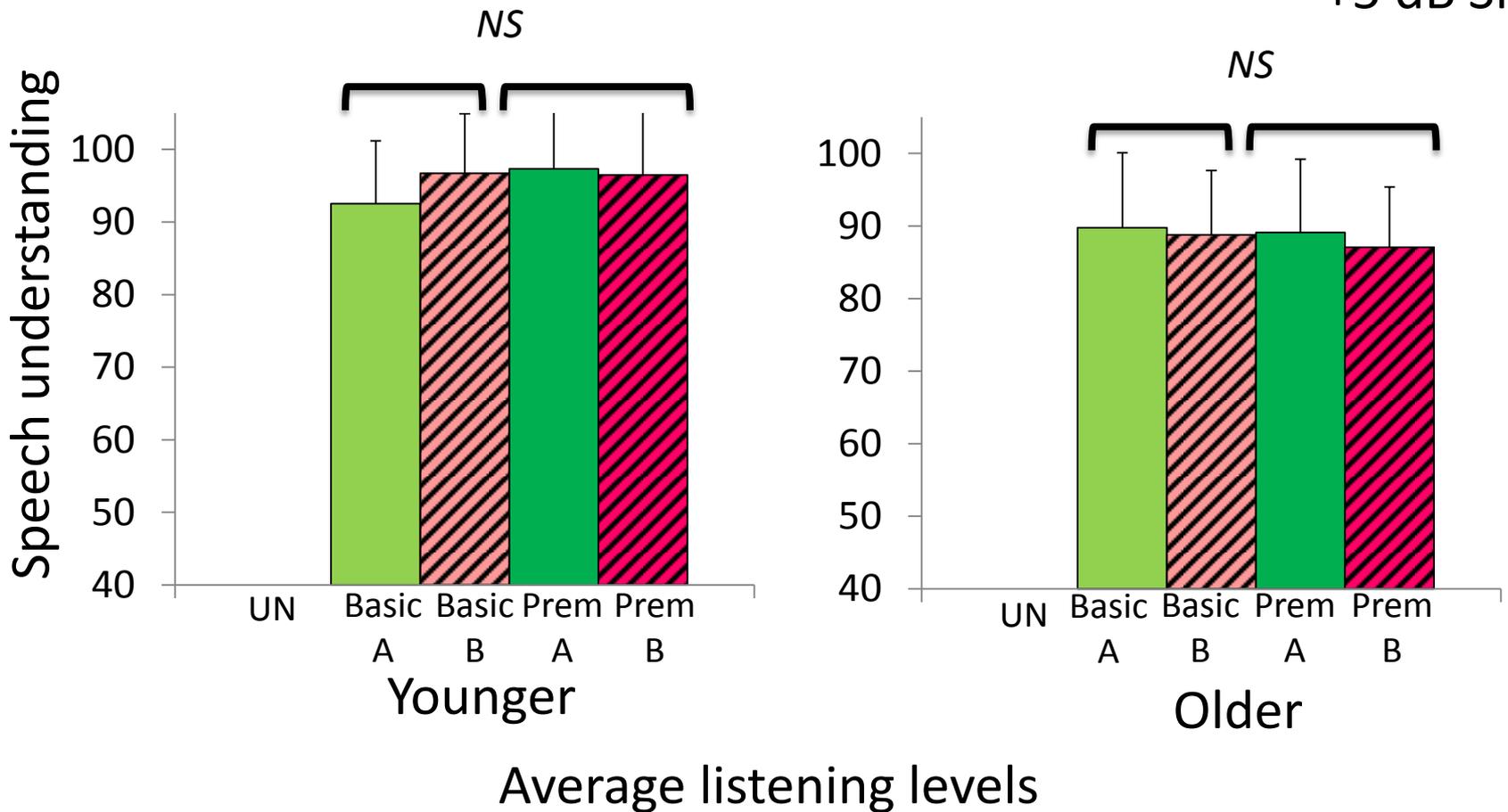
Question 2- Premium v Basic

Speech: 55 dB SPL
+10 dB SNR



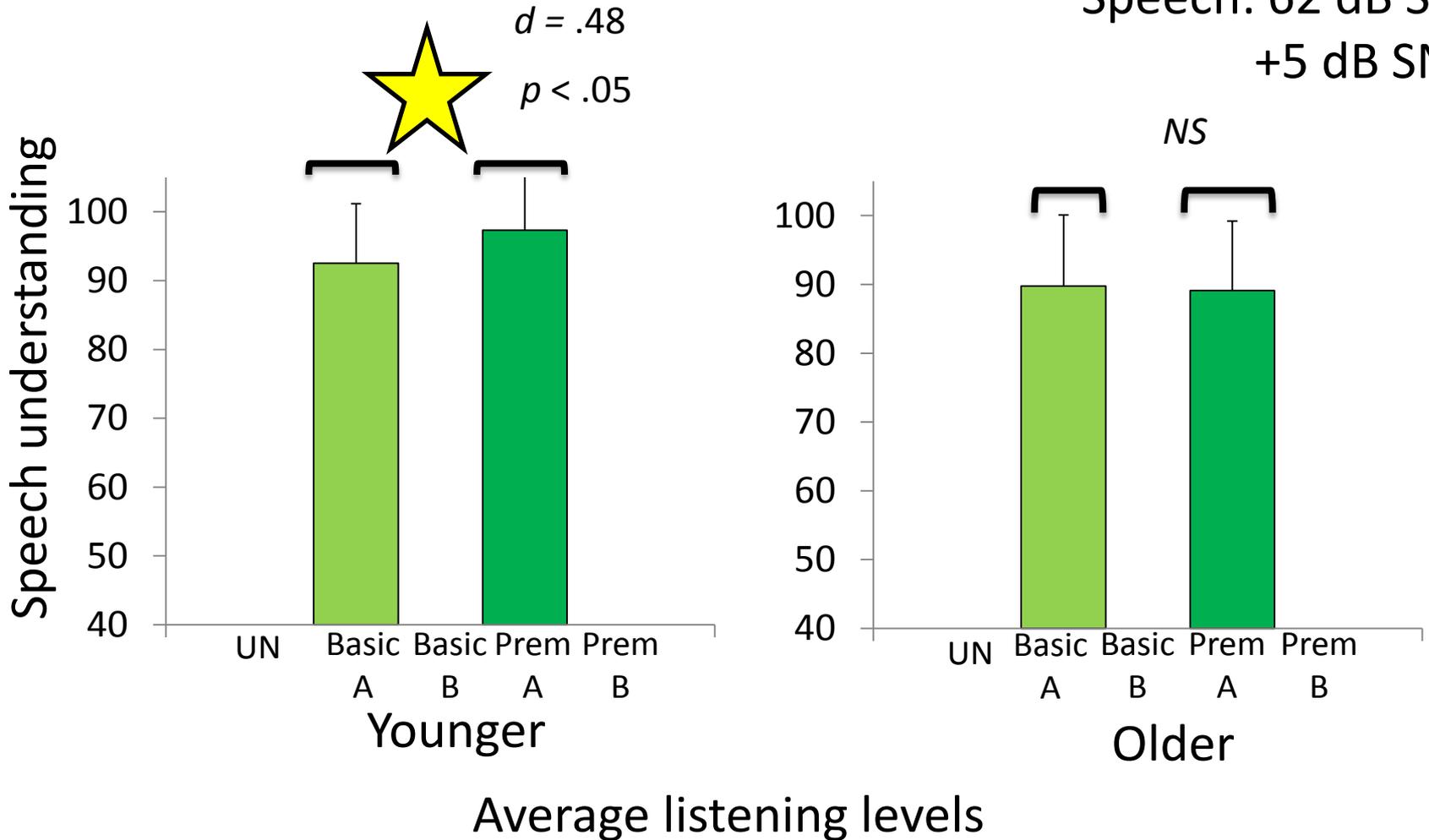
Question 2- Premium v Basic

Speech: 62 dB SPL
+5 dB SNR



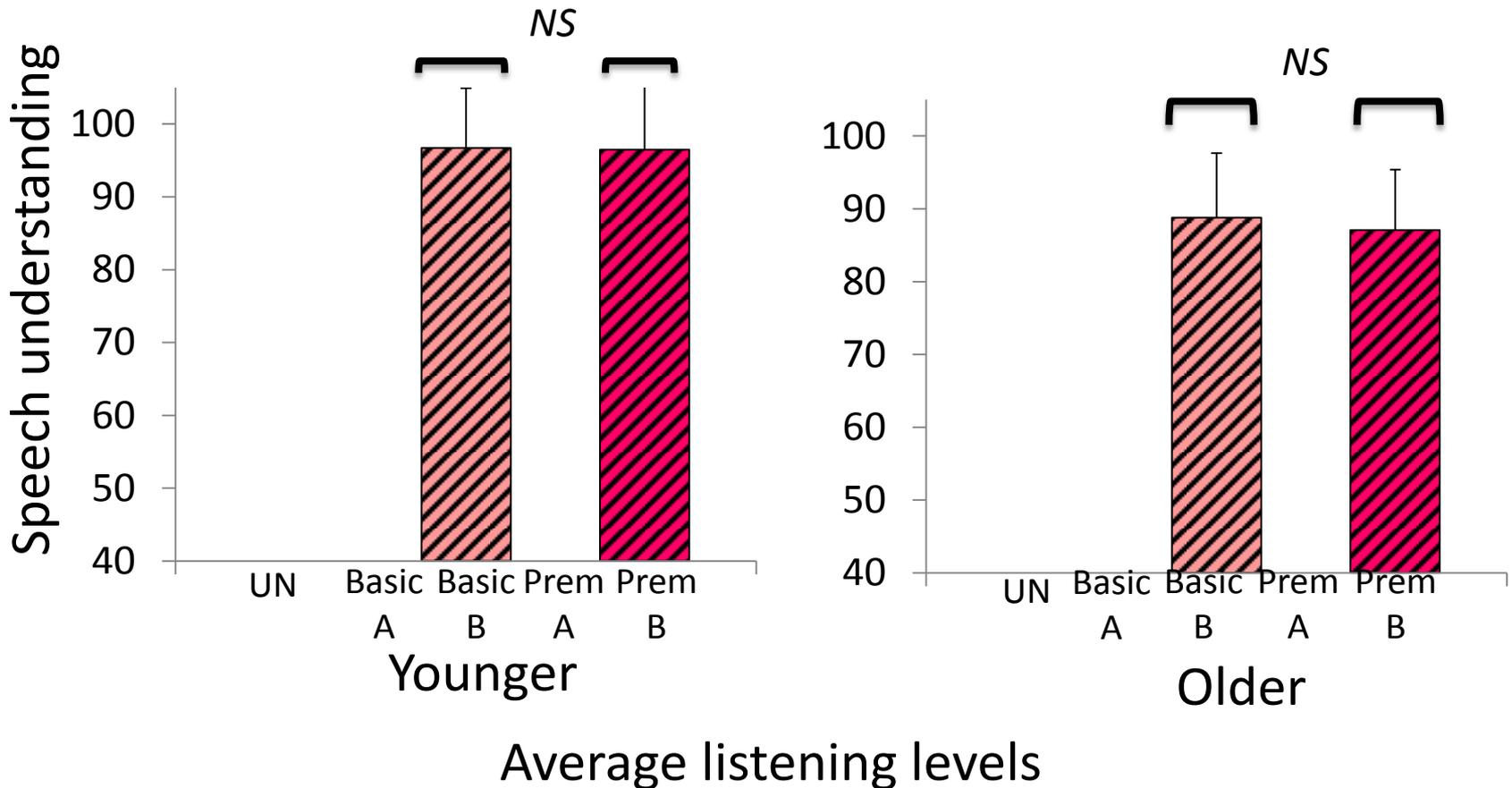
Question 2- Premium v Basic

Speech: 62 dB SPL
+5 dB SNR



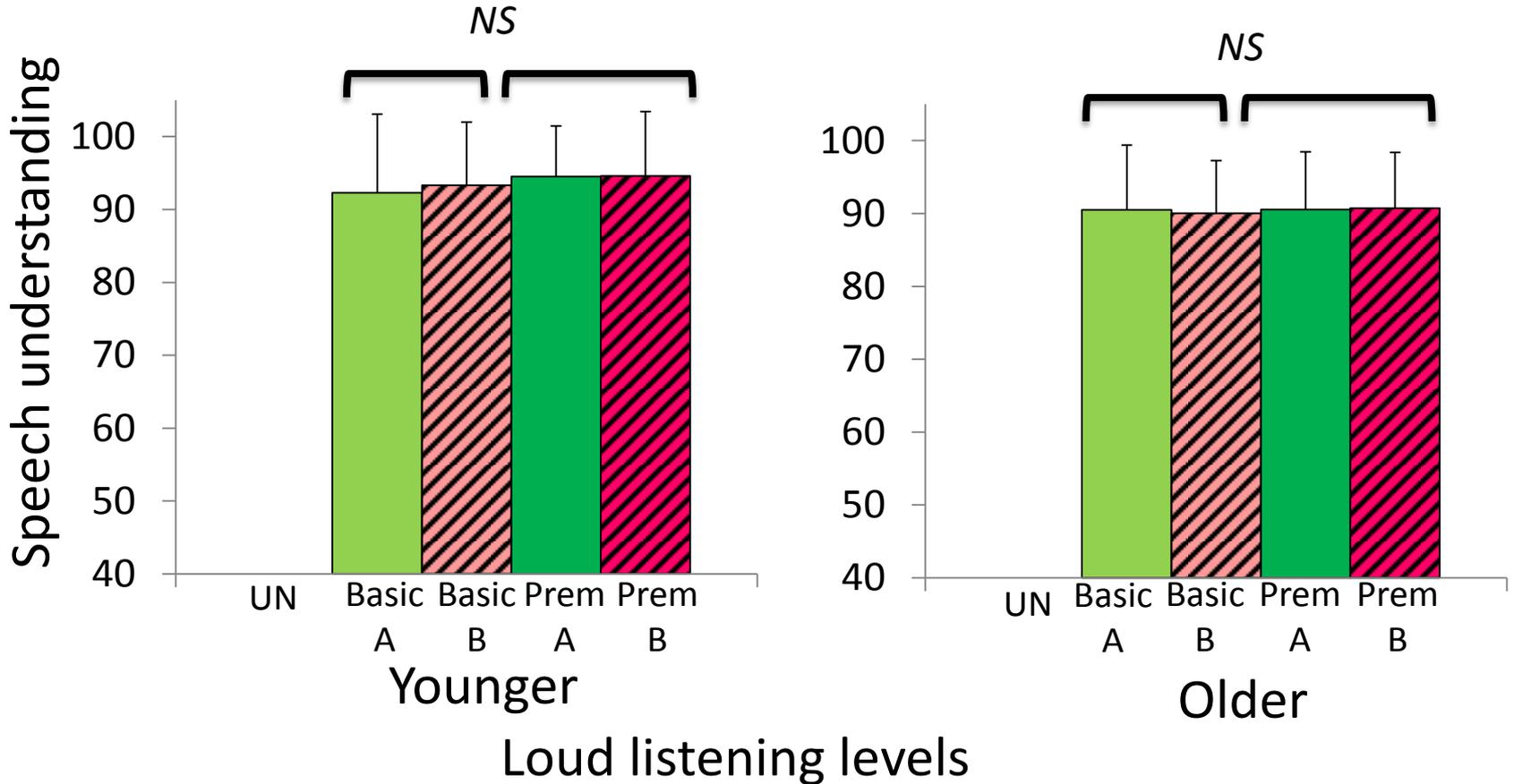
Question 2- Premium v Basic

Speech: 62 dB SPL
+5 dB SNR



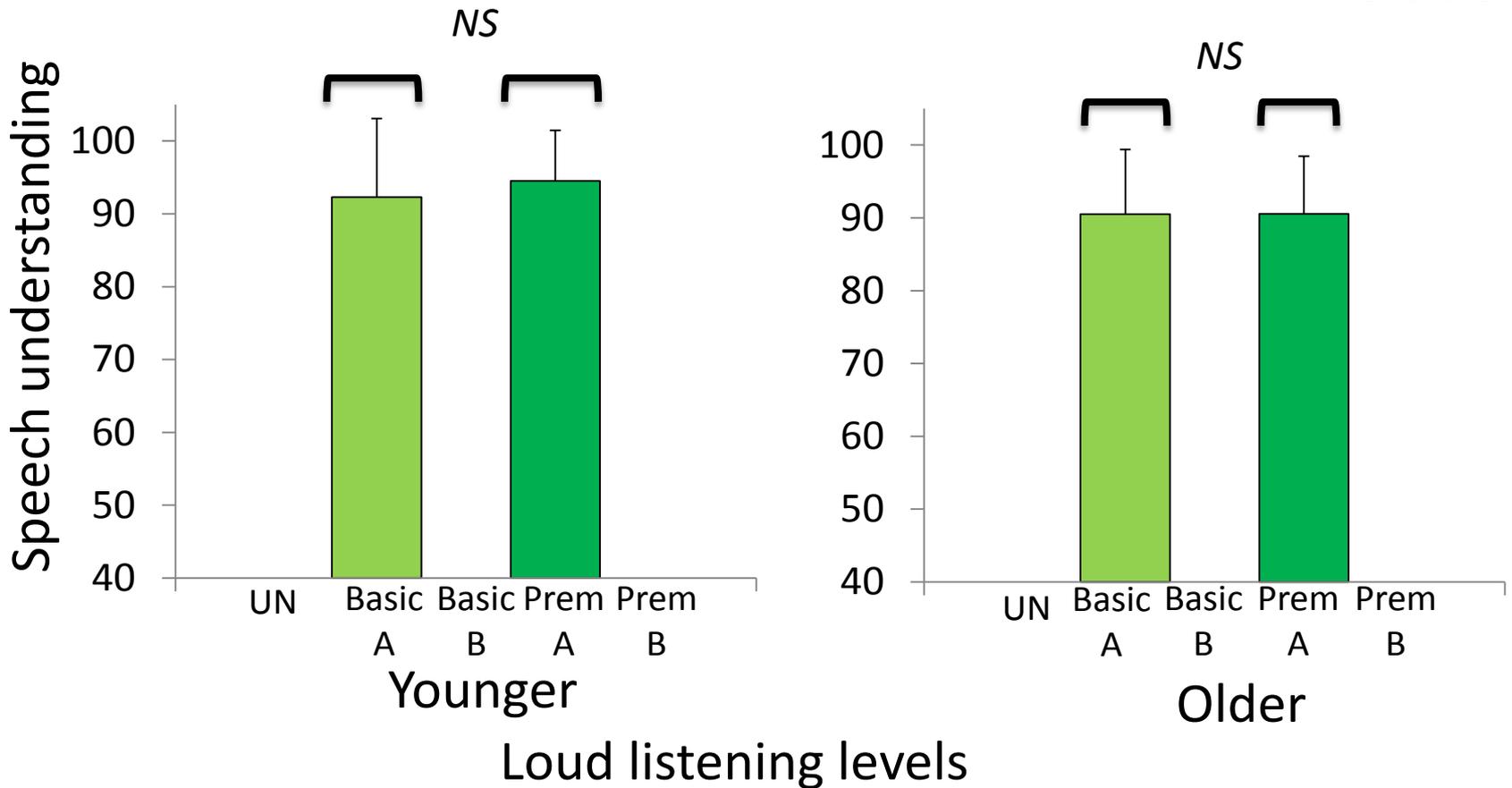
Question 2- Premium v Basic

Speech: 70 dB SPL
0 dB SNR



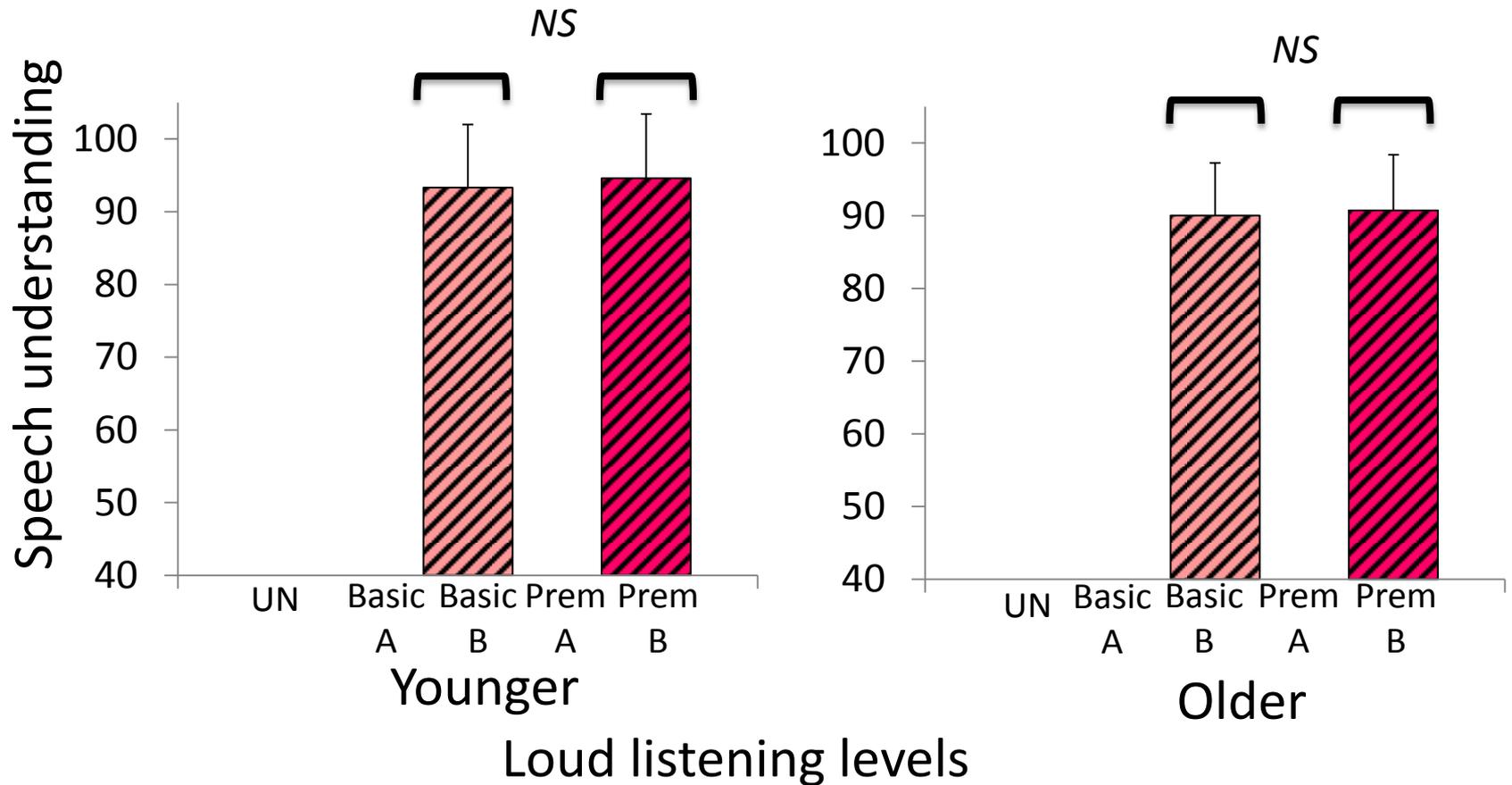
Question 2- Premium v Basic

Speech: 70 dB SPL
0 dB SNR



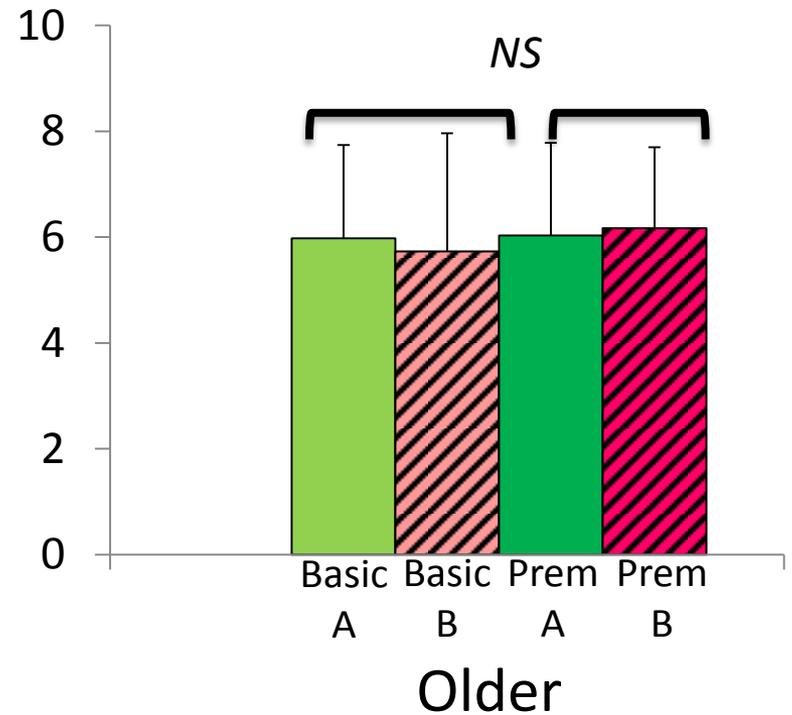
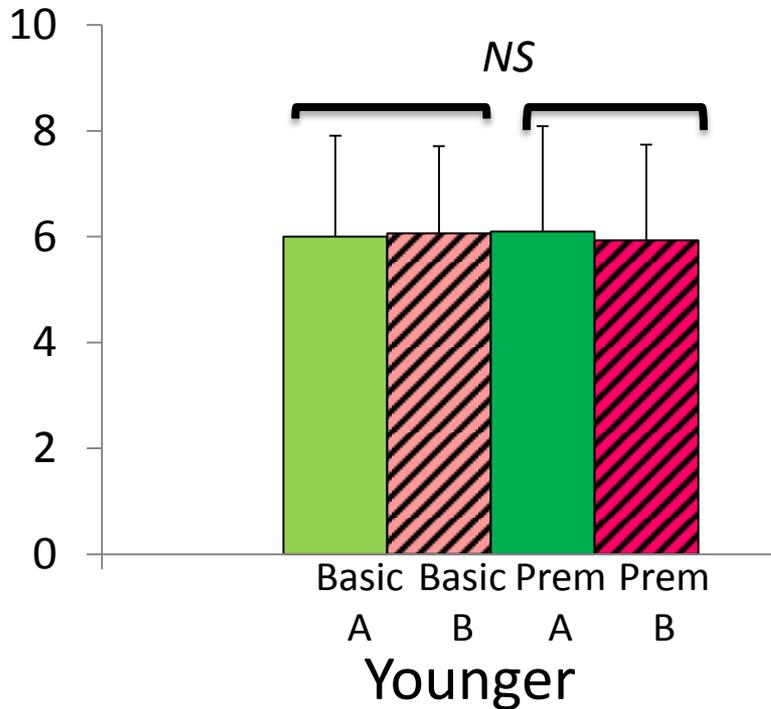
Question 2- Premium v Basic

Speech: 70 dB SPL
0 dB SNR



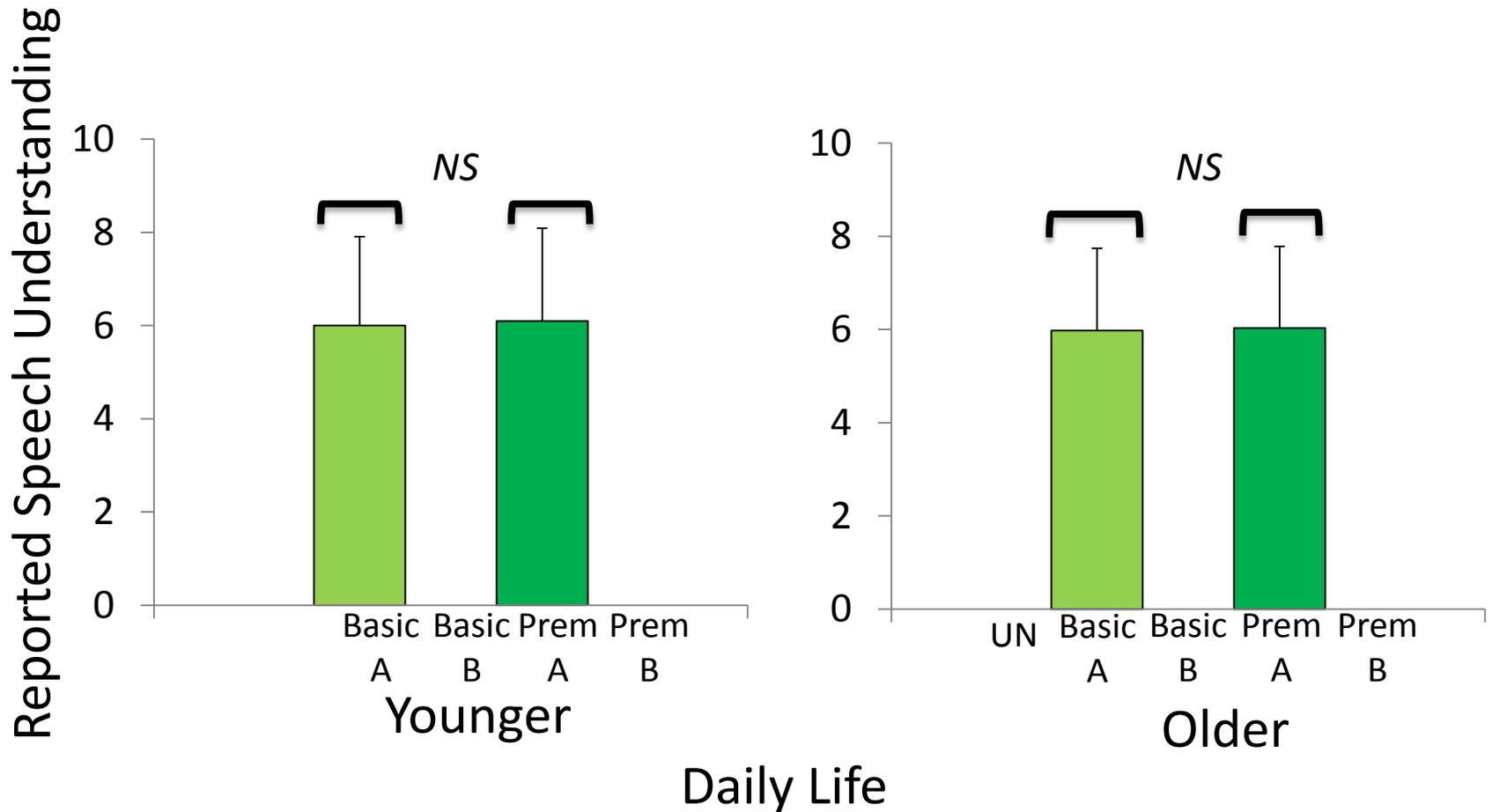
Question 2- Premium v Basic

Reported Speech Understanding

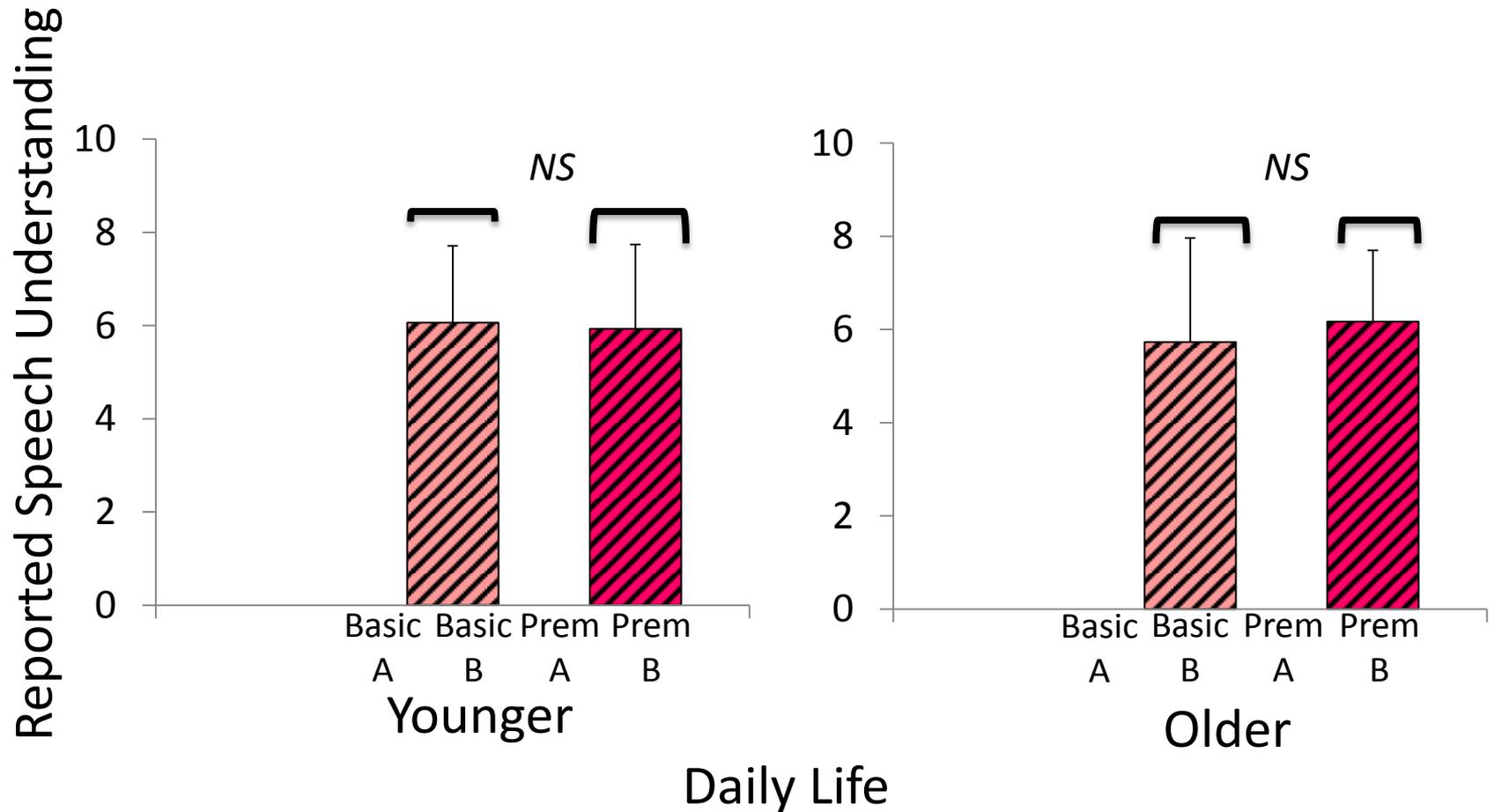


Daily Life

Question 2- Premium v Basic



Question 2- Premium v Basic



Question 2- Was speech understanding better with examples of Premium hearing aids compared to Basic hearing aids?

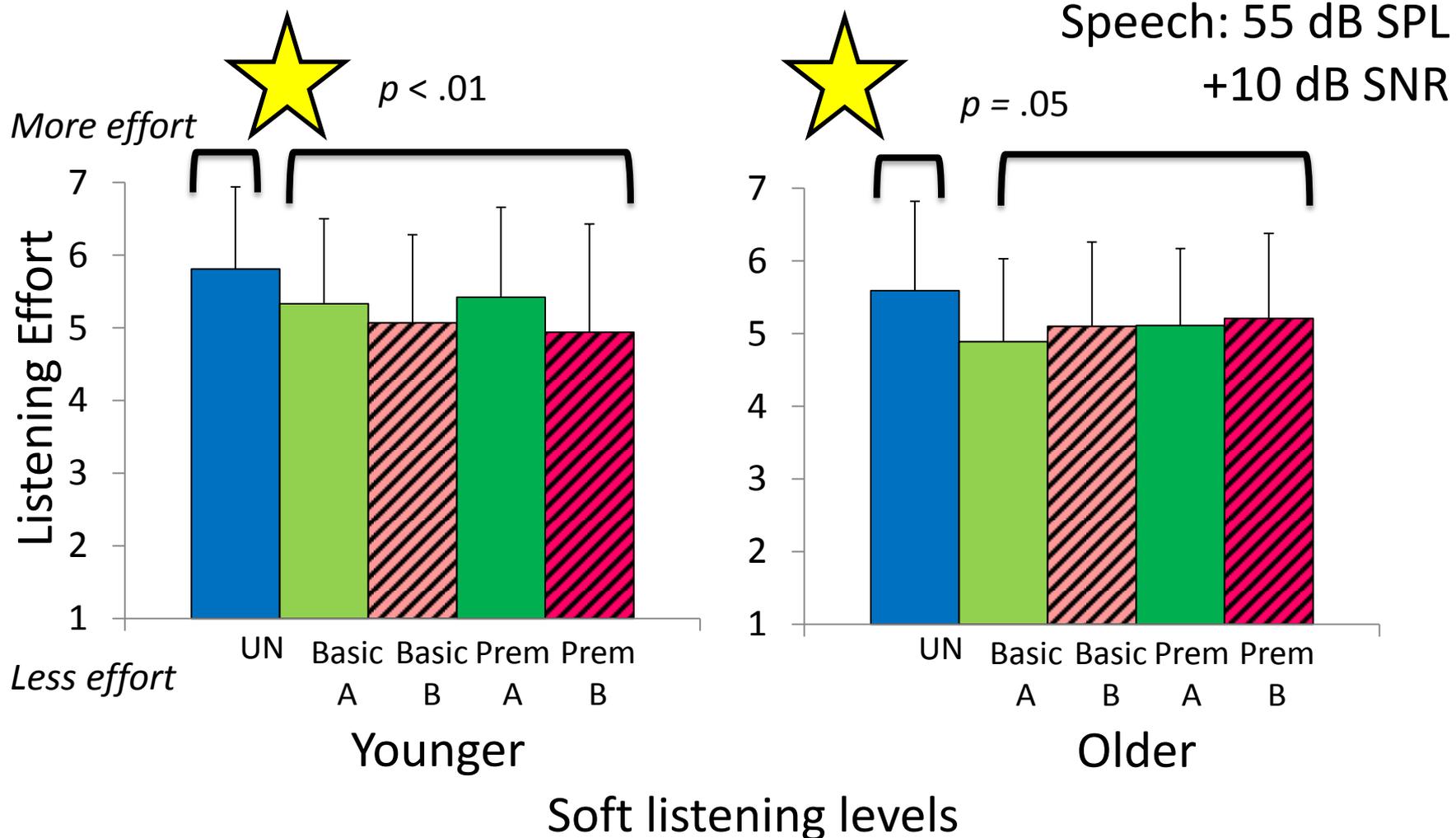
| | Younger | Older |
|--------------------|-----------------------|-------|
| In the laboratory? | No. | No. |
| For brand A? | Yes – average speech. | No. |
| For brand B? | No. | No. |
| In daily life? | No. | No. |
| For brand A? | No. | No. |
| For brand B? | No. | No. |

LISTENING EFFORT

Question 1- Was listening effort (LE) better with hearing aids compared to without?

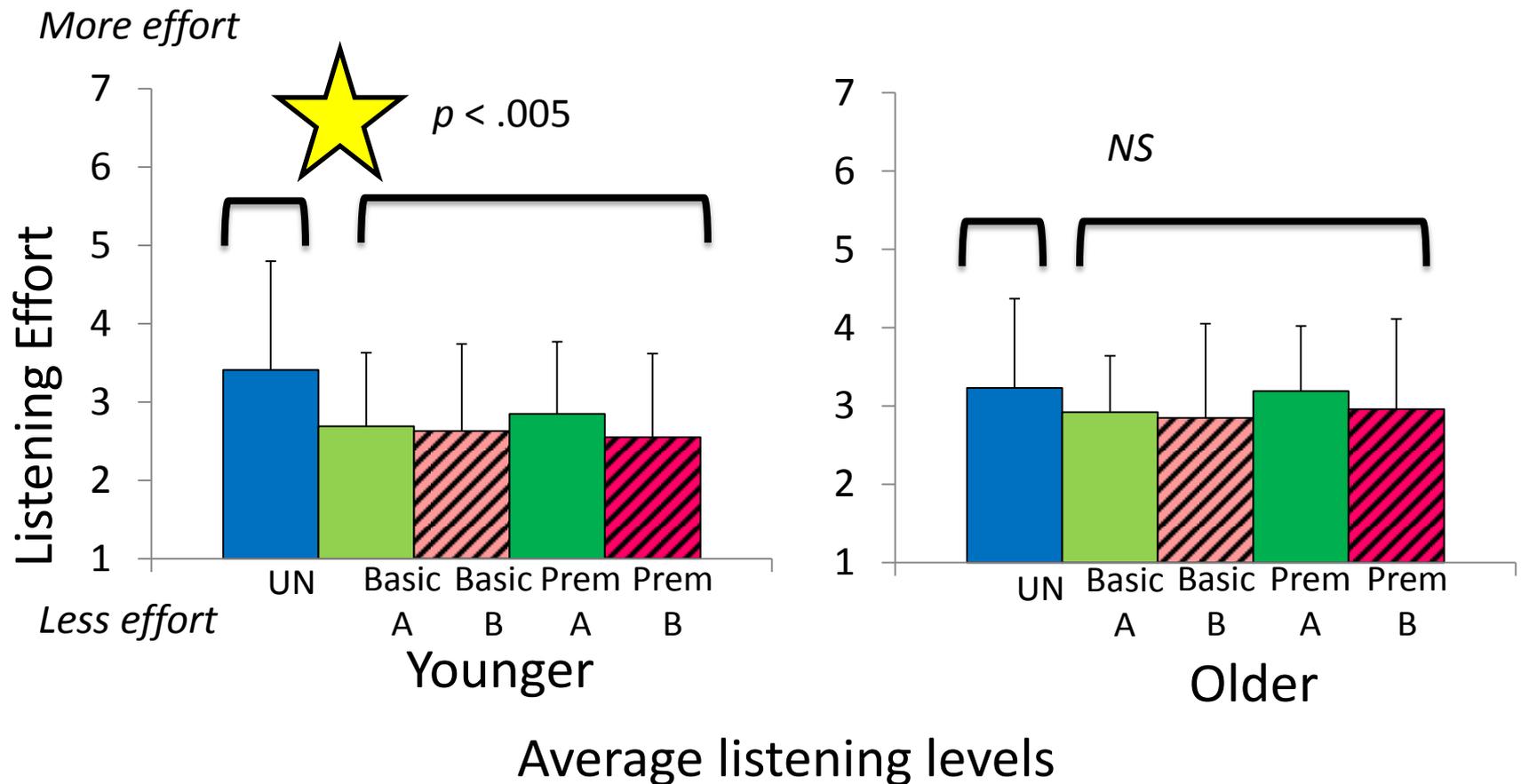
| | Younger | Older |
|--------------------|---------|-------|
| In the laboratory? | | |
| In daily life? | | |

Question 1- Unaided vs Aided LE



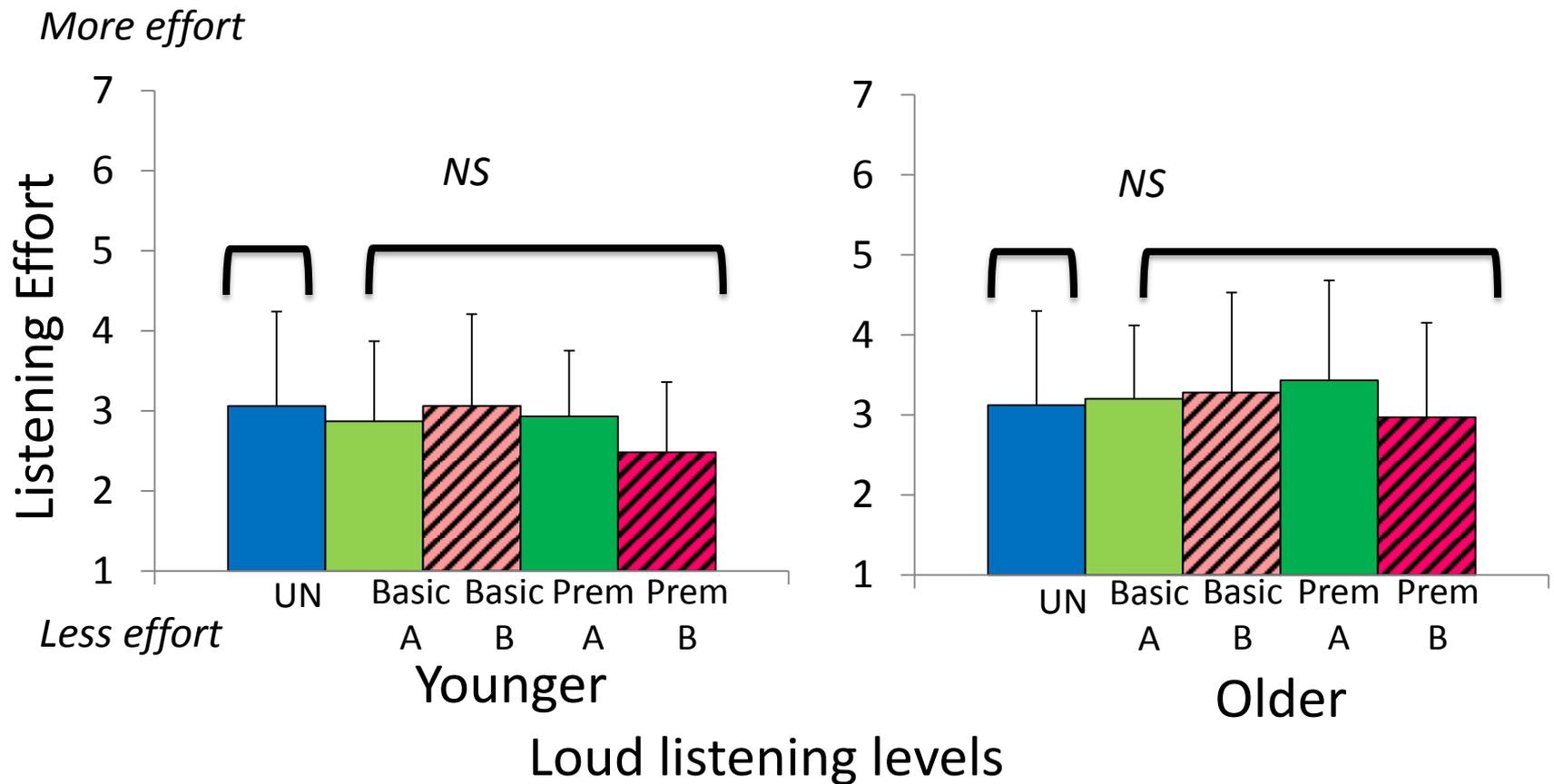
Question 1- Unaided vs Aided LE

Speech: 62 dB SPL
+5 dB SNR

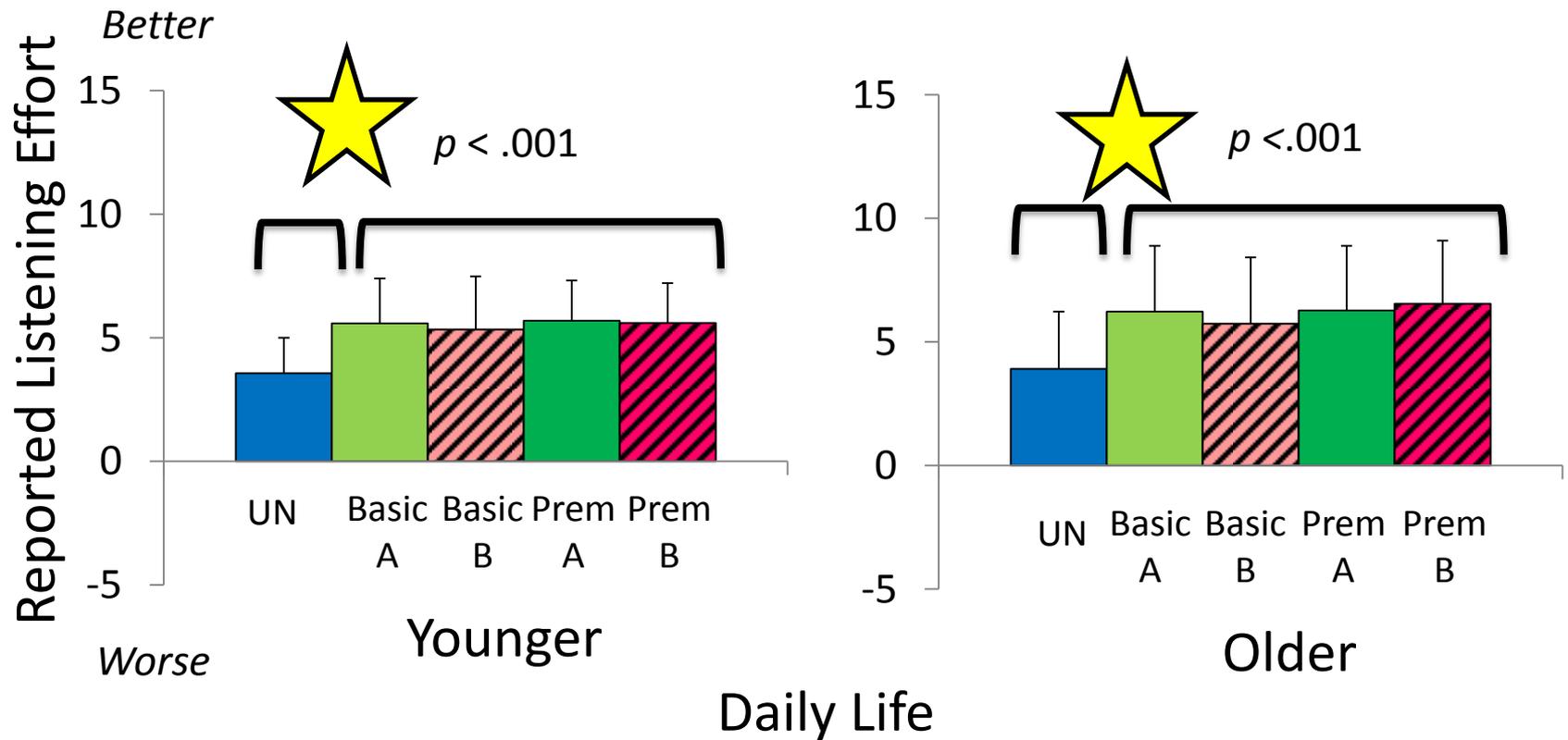


Question 1- Unaided vs Aided LE

Speech: 70 dB SPL
0 dB SNR



Question 1- Unaided vs Aided LE



Question 1- Was listening effort (LE) better with hearing aids compared to without?

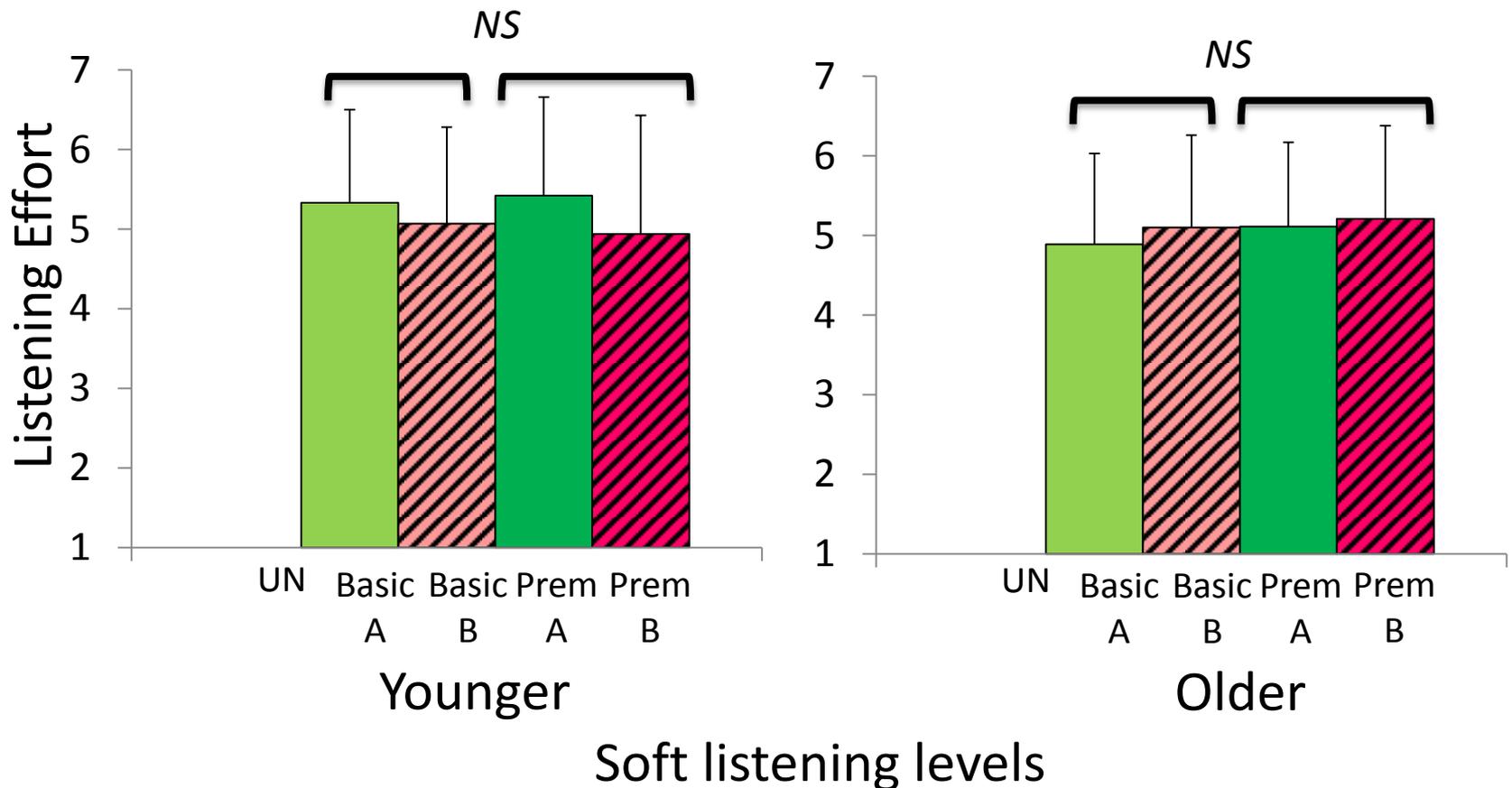
| | Younger | Older |
|--------------------|-------------------------------|------------------------------|
| In the laboratory? | Yes – soft and average levels | Yes – soft level speech only |
| In daily life? | Yes. | Yes. |

Question 2- Was listening effort better with examples of Premium hearing aids compared to Basic hearing aids?

| | Younger | Older |
|--------------------|---------|-------|
| In the laboratory? | | |
| For brand A? | | |
| For brand B? | | |
| In daily life? | | |
| For brand A? | | |
| For brand B? | | |

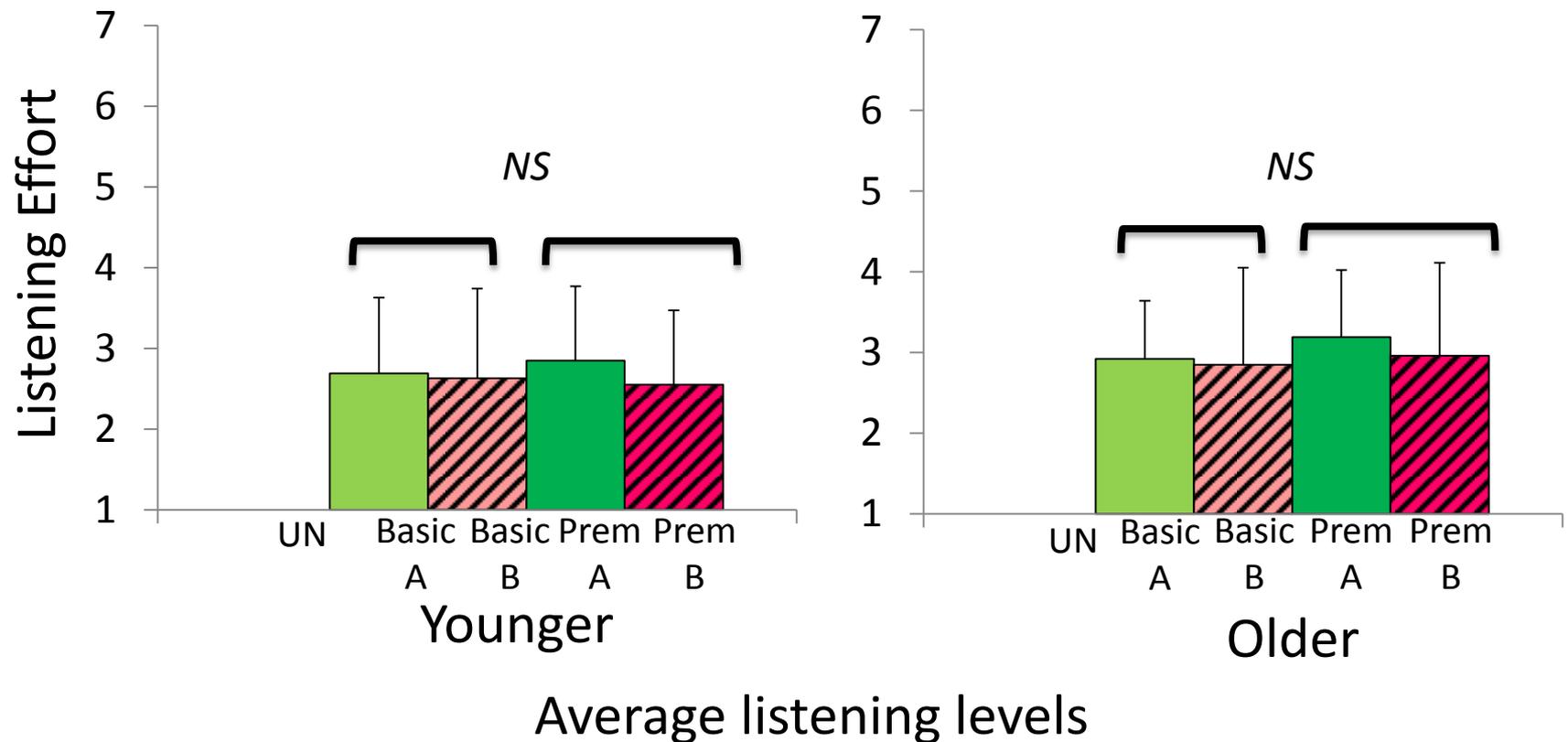
Question 2b- Premium v Basic LE Different between groups?

Speech: 55 dB SPL
+10 dB SNR



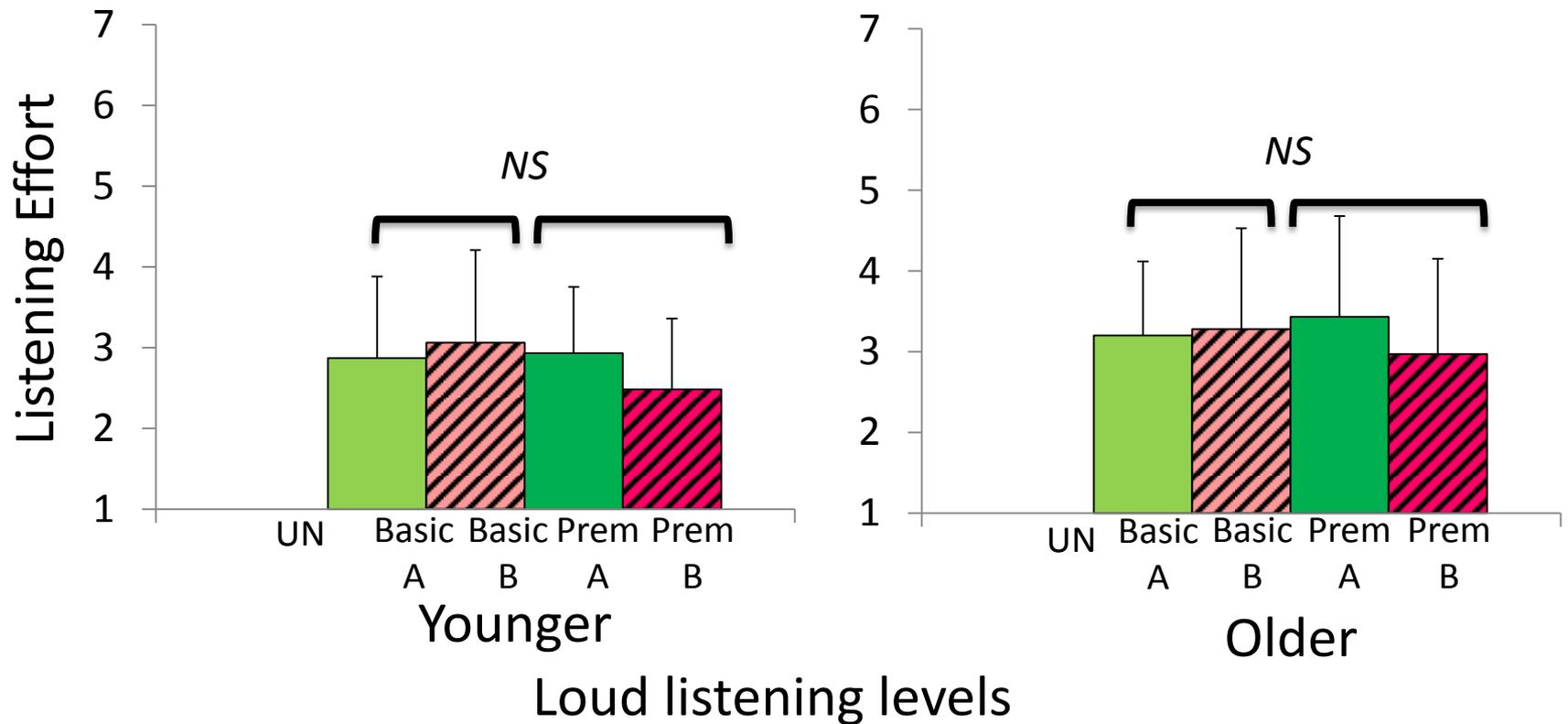
Question 2b- Premium v Basic LE Different between groups?

Speech: 62 dB SPL
+5 dB SNR



Question 2b- Premium v Basic LE Different between groups?

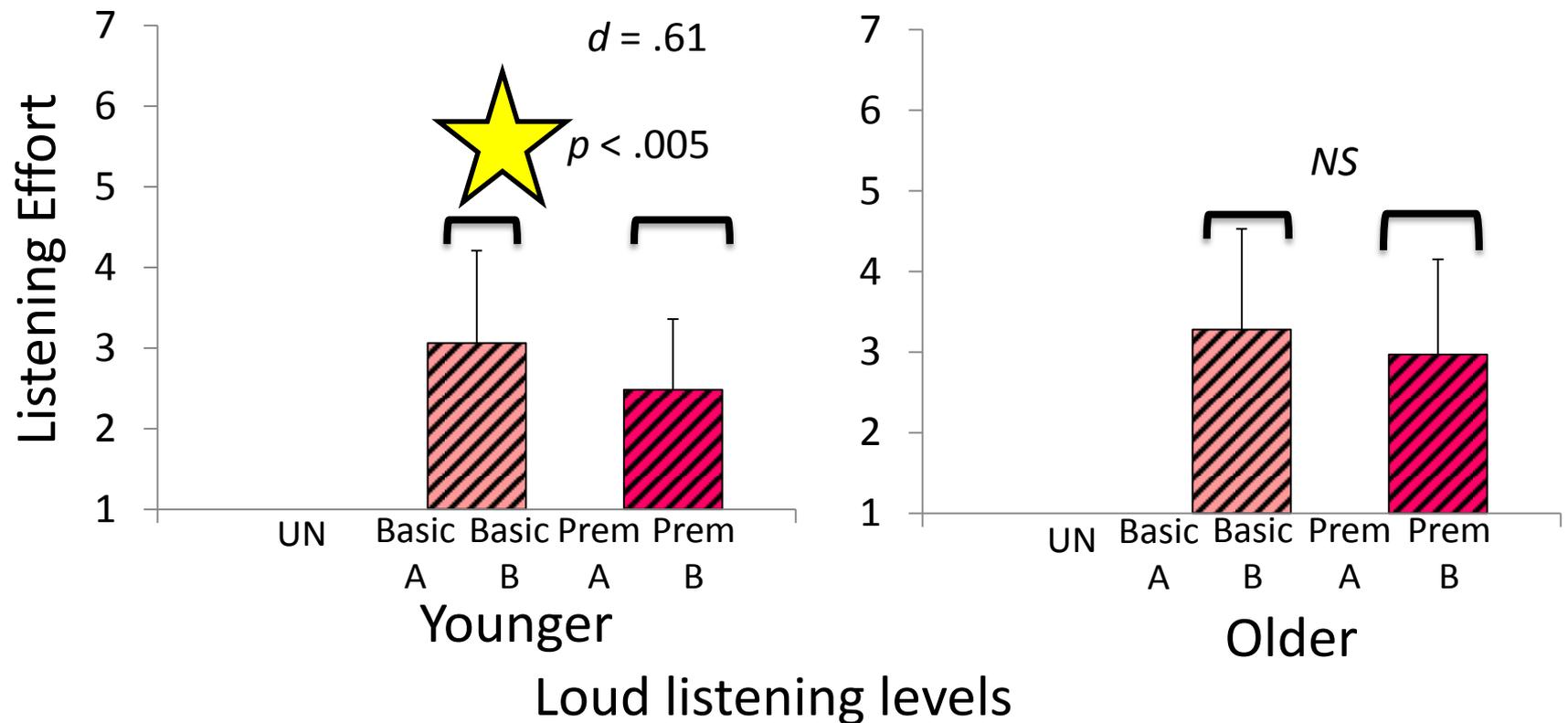
Speech: 70 dB SPL
0 dB SNR



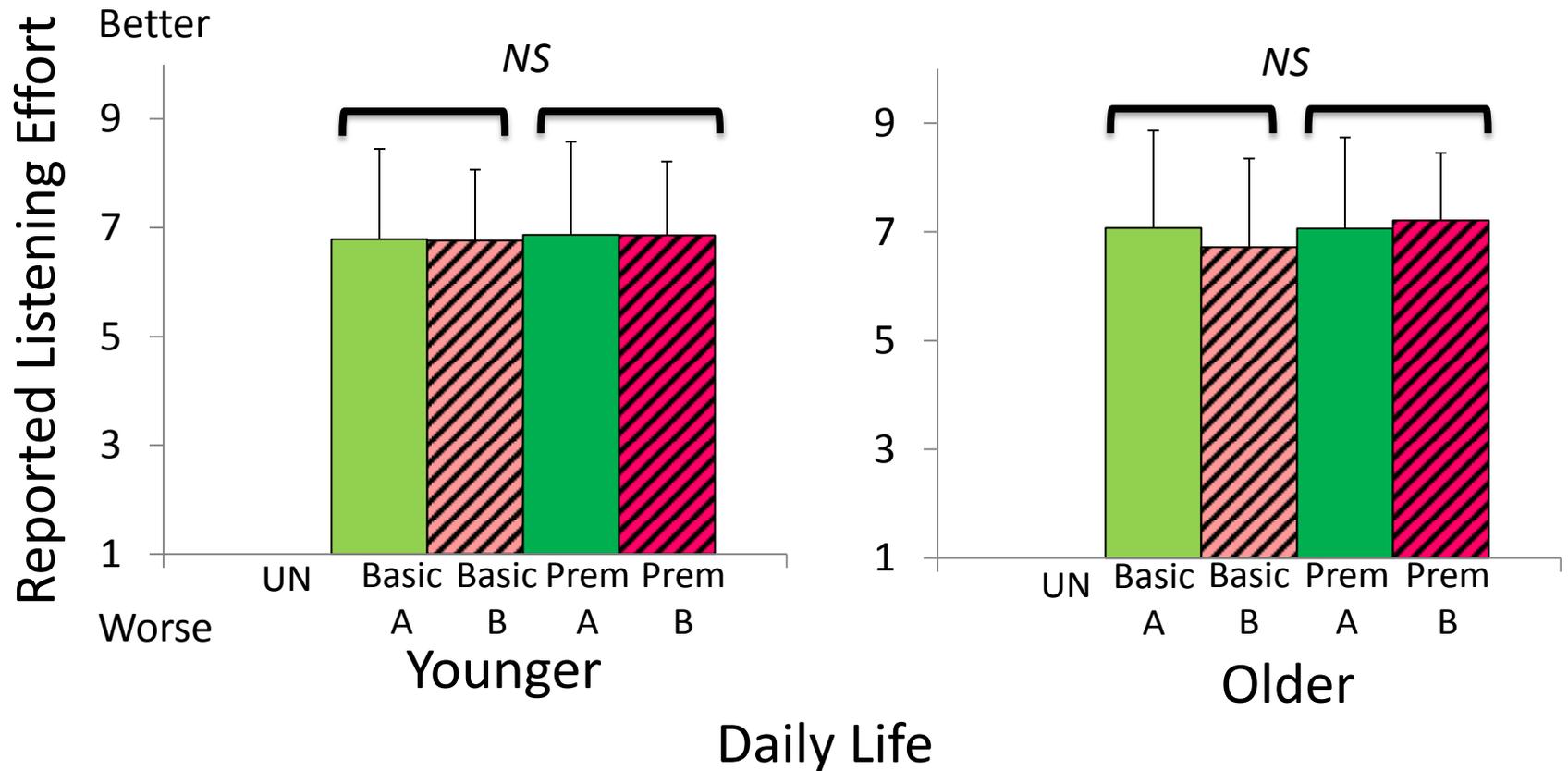
Question 2b- Premium v Basic LE

Different between groups?

Speech: 70 dB SPL
0 dB SNR



Question 2b- Premium v Basic LE Different between groups?



Question 2- Was listening effort better with examples of Premium hearing aids compared to Basic hearing aids?

| | Younger | Older |
|--------------------|--------------------|-------|
| In the laboratory? | No. | No. |
| For brand A? | No. | No. |
| For brand B? | Yes – loud speech. | No. |
| In daily life? | No. | No. |
| For brand A? | No. | No. |
| For brand B? | No. | No. |

Big picture

| Question | Answer |
|---|--|
| Do the HAs improve speech understanding? | Yes. For both groups. Younger more benefit at soft levels. Older more benefit at loud levels. |
| Is listening easier with the HAs? | Yes – especially softer speech levels. |
| Is Prem > Basic for older participants? | No. |
| Is Prem > Basic for younger participants? | Yes for 2 cases: 1 - understanding avg speech with Brand A. 2 – ease of listening to loud speech with Brand B. |

Summary

Using exemplars of basic and premium hearing aid technology from two major hearing aid manufacturers, speech understanding and listening effort in the laboratory and in daily life was:

1. Better with hearing aids compared to without.
2. Not further improved with examples of premium hearing aids compared to basic for the older participants.
3. Further improved with examples of premium hearing aids compared to basic in a few laboratory conditions for the younger participants.

Considerations

- Small sample
 - N=15 per group
- Robustness
 - Numerous comparisons
 - Moderate effect sizes
 - Cost/benefit
- Representation
 - Artificial matching of groups for hearing

Take home message

- In general, this research does not provide scientific evidence in favor of a clinical recommendation for more costly premium-feature hearing aids for younger (60s) or older (70s) adults with age-related mild to moderate hearing loss.
- There might be some indications of age-related differences in benefit from premium and basic-feature hearing aids.
- More research is needed.

Acknowledgement

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References

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