

Gabrielle Saunders Ph.D.

**National Center for
Rehabilitative Auditory
Research,
Portland OR**



Clinical applications of the Performance Perceptual Test (PPT)

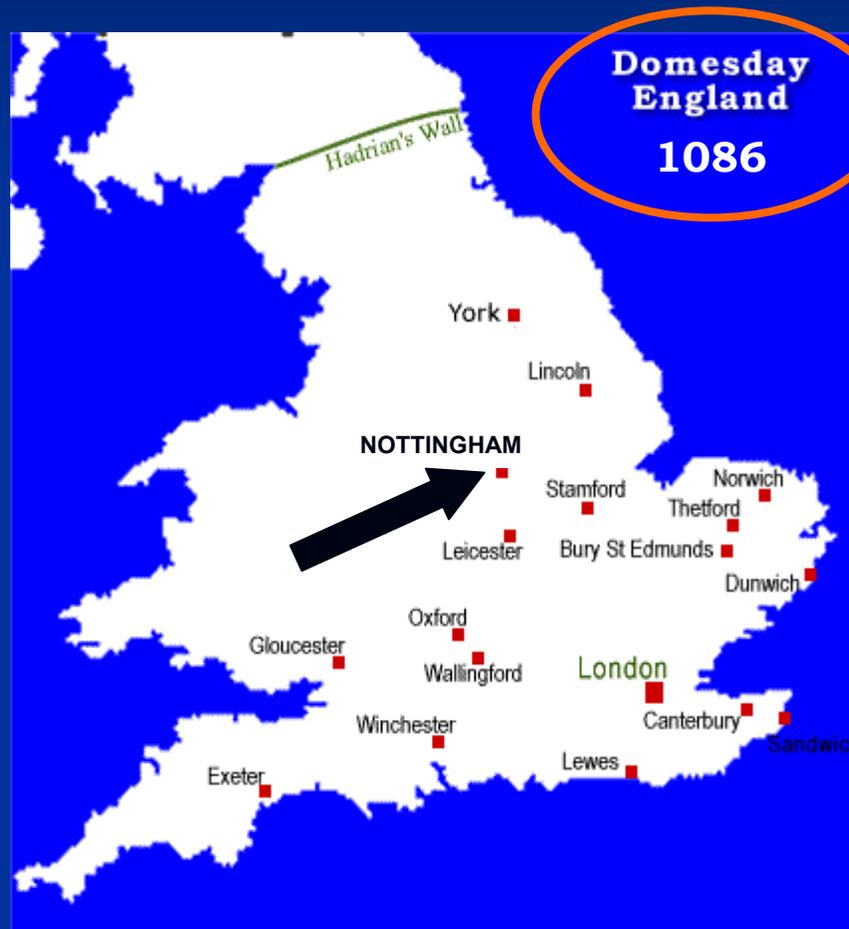
*In case you are wondering
who is at the other end of
the microphone.....*



Content of today's presentation

- Why was the Performance Perceptual Test (PPT) developed?
- What is the PPT?
- What can the PPT tell us?
- PPT as a counseling tool
- Case studies and a little data

Why was the Performance-Perceptual Test (PPT) developed?



Ph.D. thesis:

**People who complain of hearing difficulties,
yet have clinically normal hearing. Named it
Obscure Auditory Dysfunction (OAD)**

***'this is a psychological problem, they think
they can't hear but really they can'***



I wanted an 'objective' way to compare someone's measured ability to understand speech with their perceived ability to understand speech



...and so came the Performance-Perceptual Test, PPT

What is the Performance-Perceptual Test (PPT)?

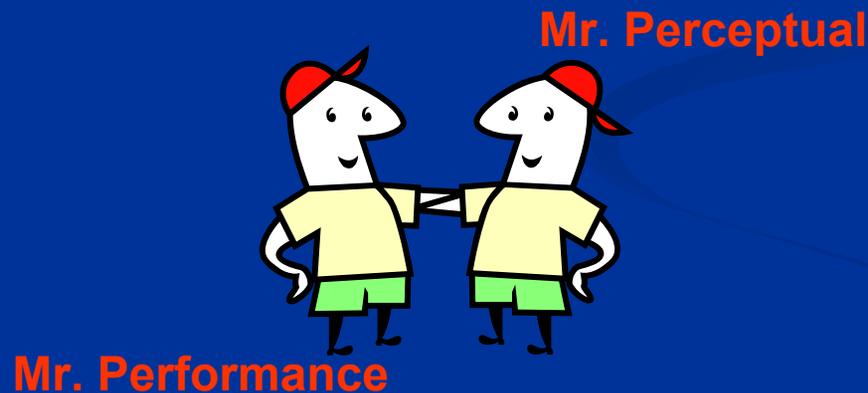
Test that measures two types of speech reception threshold for sentences in noise:

Performance SRTN = Actual ability to understand speech in noise (HINT)

Perceptual SRTN = Perceived ability to understand speech in noise

USING THE SAME TEST MATERIALS AND PROCEDURES

so results from the two are directly comparable



How do we do this?

Performance

Subjects repeat back HINT sentences presented in noise

Noise level is fixed

Speech level is altered depending upon response:

Made quieter when sentence is repeated correctly (S/N more adverse)

Made louder when repeated wrongly (S/N less adverse)

Perceptual

Subjects say whether they can understand sentences presented in noise

Noise level is fixed

Speech level is altered depending upon response:

Made quieter when subjects say they can understand the sentence (S/N more adverse)

Made louder when subjects say they cannot understand the sentence (S/N less adverse)

The difference between these is a direct measure of the degree to which subjects (in)correctly assess their ability to hear:

= Performance Perceptual Discrepancy (PPDIS)

e.g.

$$\begin{array}{ccccc} \mathbf{6\ dB\ S/N} & & \mathbf{minus} & & \mathbf{6\ dB\ S/N} & & \mathbf{= 0\ dB} \\ \text{Performance SRTN} & & & & \text{Perceptual SRTN} & & \text{PPDIS} \end{array}$$

→ Subject accurately estimates hearing ability

Positive PPDIS

$$\begin{array}{rclcl} \mathbf{6 \text{ dB S/N}} & \text{minus} & \mathbf{1 \text{ dB S/N}} & = & \mathbf{+5 \text{ dB}} \\ \text{Performance SRTN} & & \text{Perceptual SRTN} & & \text{PPDIS} \end{array}$$

→ Subject overestimates hearing ability

Negative PPDIS

$$\begin{array}{rclcl} \mathbf{6 \text{ dB S/N}} & \text{minus} & \mathbf{11 \text{ dB S/N}} & = & \mathbf{-5 \text{ dB}} \\ \text{Performance SRTN} & & \text{Perceptual SRTN} & & \text{PPDIS} \end{array}$$

→ Subject underestimates hearing ability



This can go negative

What can the PPT tell us?

2 useful variables:

Performance SRTN

Measured ability to understand sentences in noise

Compare unaided and aided performance i.e.
benefit

Track performance over time

PPDIS

Accuracy of perception

Tool for discussion/counseling

PPDIS is especially useful when there are discrepancies between patient reports and measured scores

because it helps reconcile questionnaire responses and performance scores as follows.....

Patient denies
problems although they
have poor measured
hearing

Overestimator?

Patient reports more
handicap than would be
expected from their
PTA/speech scores

Underestimator?



Patient says
hearing aids aren't
helping but we
measure
substantial benefit

Underestimator?

**Theory is all well and good but is
there evidence the test is any
good?**



What kind of evidence?

Same scores if retested

Reliable

It measures what you think it does

Valid

Clinically meaningful

Clinically useful

Does it tell us something new and useful?

Can we interpret scores?

Reliability

Test-retest reliability:

Performance SRTN range: $r = 0.924$ to 0.988

Perceptual SRTN range: $r = 0.934$ to 0.989

PPDIS range: $r = 0.810$ to 0.880

Reliability of 0.9 means only 10% of any change is due to 'other' factors

✓ **Reliable**

Valid

Clinically meaningful

Clinically useful

DO TEST SCORES RELATE TO EXTERNAL FACTORS AS EXPECTED?

Performance SRTN

Independent of:

Age (when HL is accounted for)

Gender

Self-report (when HL is accounted for)

Related to:

Hearing level (PTA)

Aiding

aided score
better than
unaided score

Better hearing
= better score

PPDIS

Independent of:

Age

Gender

Hearing level (PTA)

Aiding

Underestimator
= more reported
difficulties

Related to:

Self-reported difficulties

Hearing aid satisfaction

Underestimator
= less satisfied

✓ **Reliable**

✓ **Valid**

Clinically meaningful

Clinically useful

Clinically meaningful

Can we interpret the test scores?

Performance SRTN: Normative data available from the HINT manual

Provides values for 5th, 25th, 50th, 75th and 95th percentiles performance for young normal hearing individuals

PPDIS: Normative data have been published

Provides values for categorizing patients into underestimators, overestimators and those who accurately assess their hearing

- ✓ **Reliable**
- ✓ **Valid**
- ✓ **Clinically meaningful**
- Clinically useful**

Clinically useful: Do the scores tell us something new and can we do anything with that information?

Clinically useful

Helps us understand OAD where other tests had not
38% of people with OAD underestimated their hearing ability

Helps explain reported disability and handicap

Performance SRTN explains between 10 & 20% of variance
PPDIS explains between 10 and 18% of variance

Helps explain hearing aid satisfaction

Performance SRTN explains about 10% of variance
PPDIS explains between 10 and 20% of variance

Reports from OADs who received PPT-based counseling:

73% found advice appropriate

89% found visit worthwhile

**Benefited from individual attention and concern,
acknowledgement of their problems**

**Gained confidence, positive acceptance due to
better understanding**

Current work using the PPT as a counseling tool....



PPT as a counseling tool

Use Performance SRTN to

- (a) Educational tool for explaining hearing ability relative to norms
- (b) Tool for showing hearing aid benefit

Use PPDIS to

- (a) Tool for presenting discrepancy data
- (b) Tool to encourage underestimators
- (c) Tool to show deniers they have a hearing loss

Development of Counseling Content

Satisfied patients:

- ✓ provided with facts and given time to talk
- ✓ adhere to treatment plans better
- ✓ better overall health-related outcomes than dissatisfied patients

Patient's perceptions about their illness are more predictive of physical dysfunction, reported pain and depression than are demographic and disease status variables.

PPT-Based Counseling

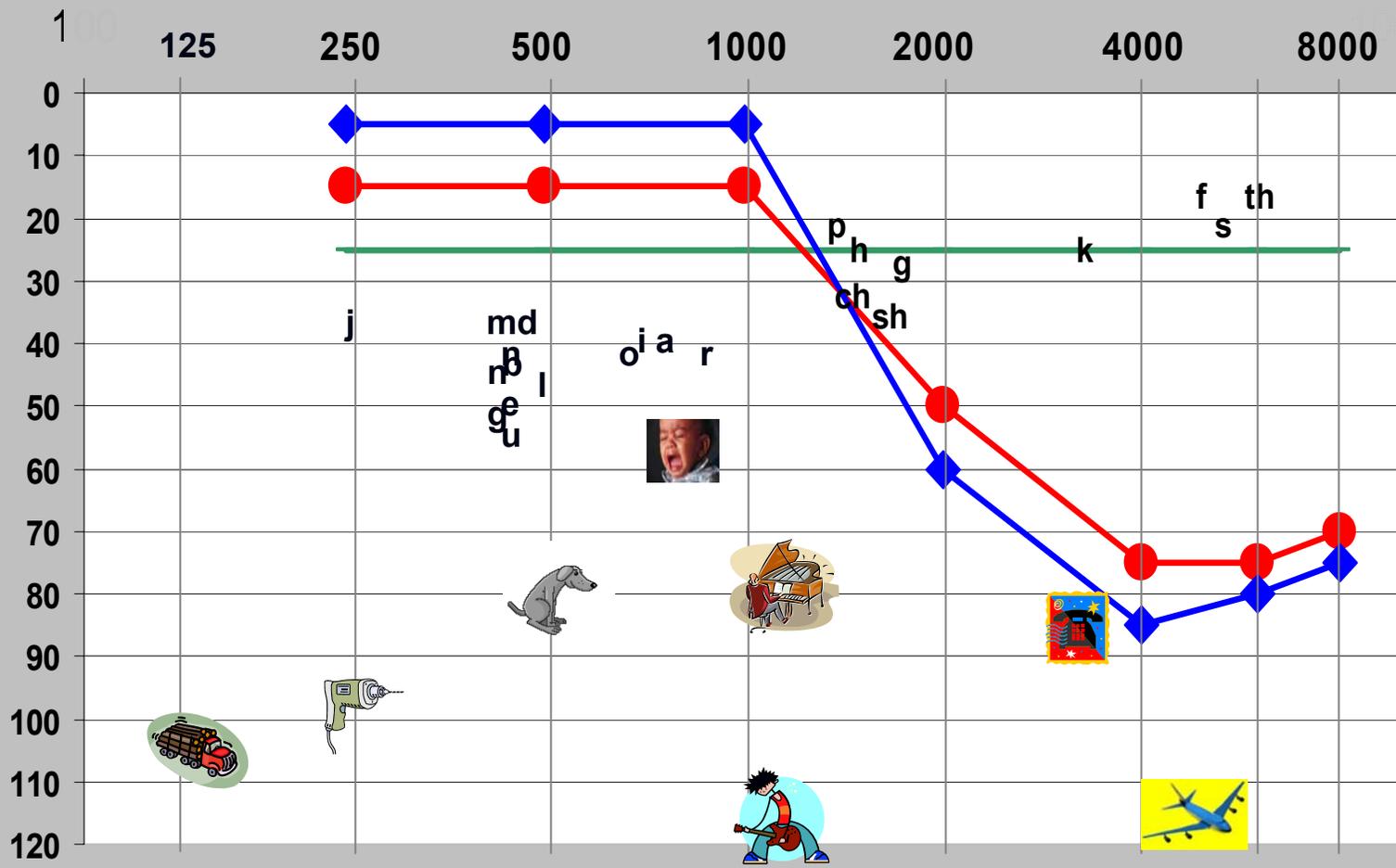
- Provision of information
- Suggested Explanations
- Subject Exposition
- Discussion
- Suggested Solutions

Takes 10-15 minutes

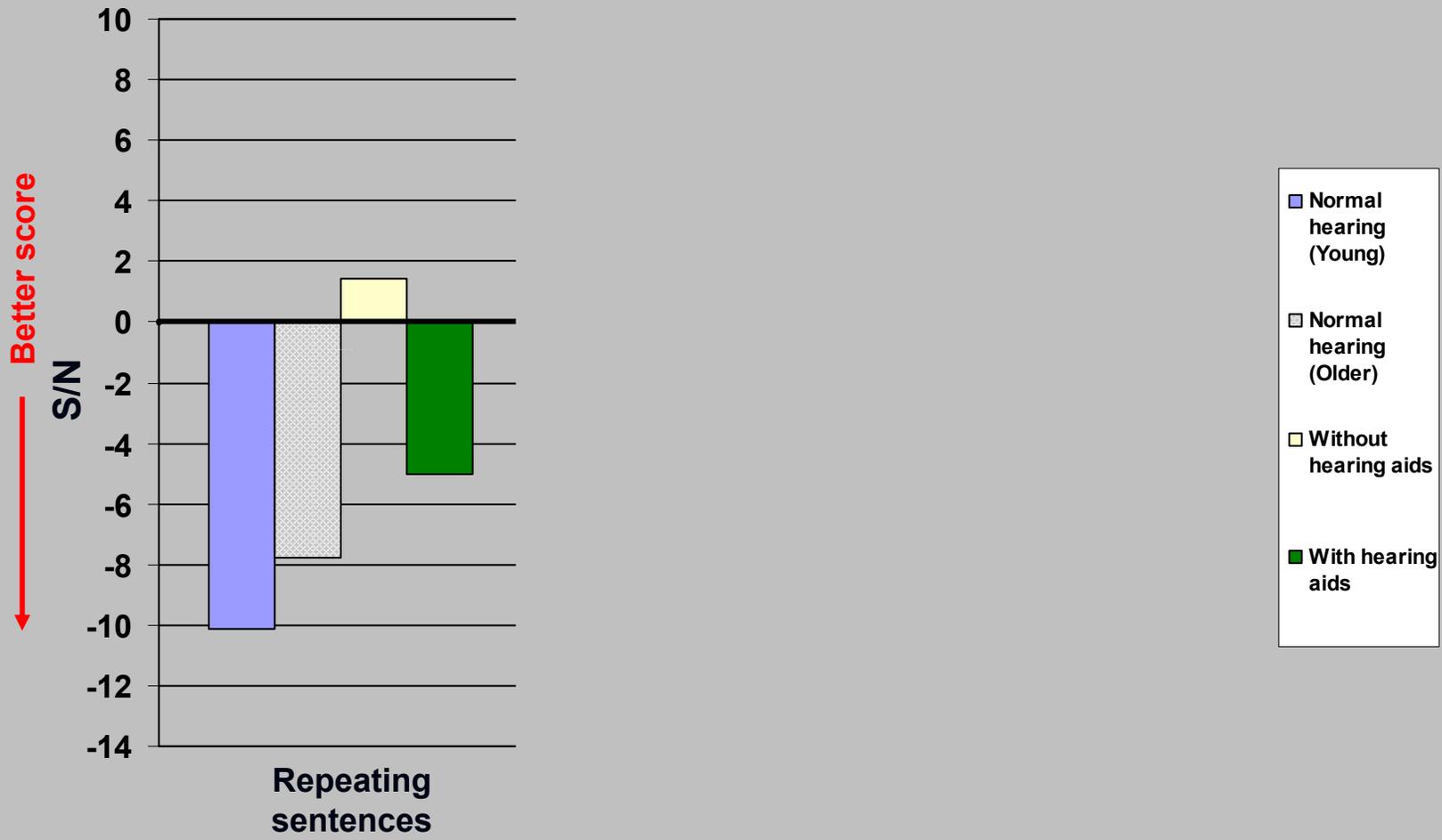
Step-by-step

- **Audiometric evaluation**
- **Run PPT**

- **Underestimation:** Value of ≤ -3
PPDIS $<$ 33rd percentile of normative data
- **Accurate:** Value of > -3 and $< +0.2$
PPDIS between 33rd & 66th percentile of normative data
- **Overestimation:** Value of $\geq +0.2$
PPDIS $>$ 66th percentile of normative data



Testing in Noise



Provision of information

Underestimate (Content A)	Accurate (Content B)	Overestimate (Content C)
This test shows you hear better than you think you do.	You accurately assess your hearing ability.	This test shows you overestimate how well you can hear

Suggested Explanation

Underestimate (Content A)	Accurate (Content B)	Overestimate (Content C)
High expectations, cautious, reluctant to take risks, lack of confidence, not want to fail		Denial to self and others, slow onset of HL, over confident

Subject Exposition

Underestimate (Content A)	Accurate (Content B)	Overestimate (Content C)
Response to above, other explanations?	Response to above, comments?	Response to above, other explanations?

Discussion/Implications

Underestimate (Content A)	Accurate (Content B)	Overestimate (Content C)
Fearful of social interaction, withdrawal, dependency.	Accepting of hearing loss and of the limitations it imposes.	Frustrate others, appear unintelligent or arrogant, misunderstandings or wrong information

Solutions

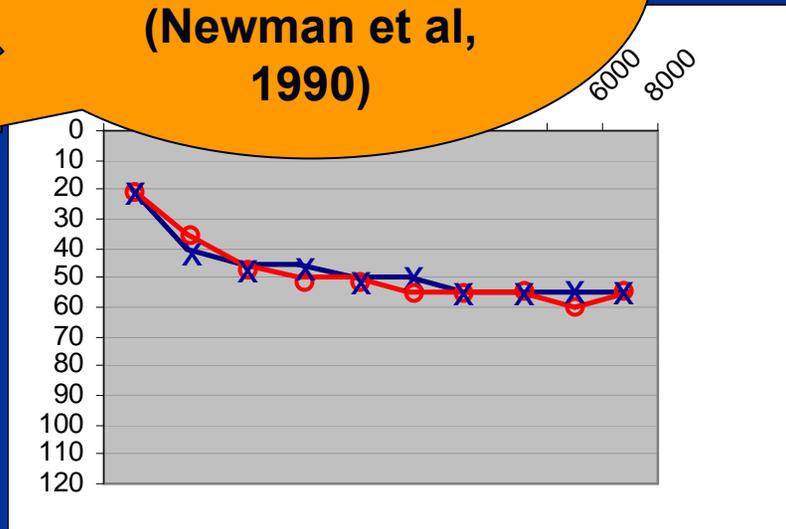
Underestimate (Content A)	Accurate (Content B)	Overestimate (Content C)
<p>Try guessing, take risks assume you heard correctly, rephrase to clarify to boost confidence, communication strategies</p>	<p>NA. Discuss communication strategies</p>	<p>Ask for clarification, admit to difficulties to self, communication strategies</p>

Case studies and examples

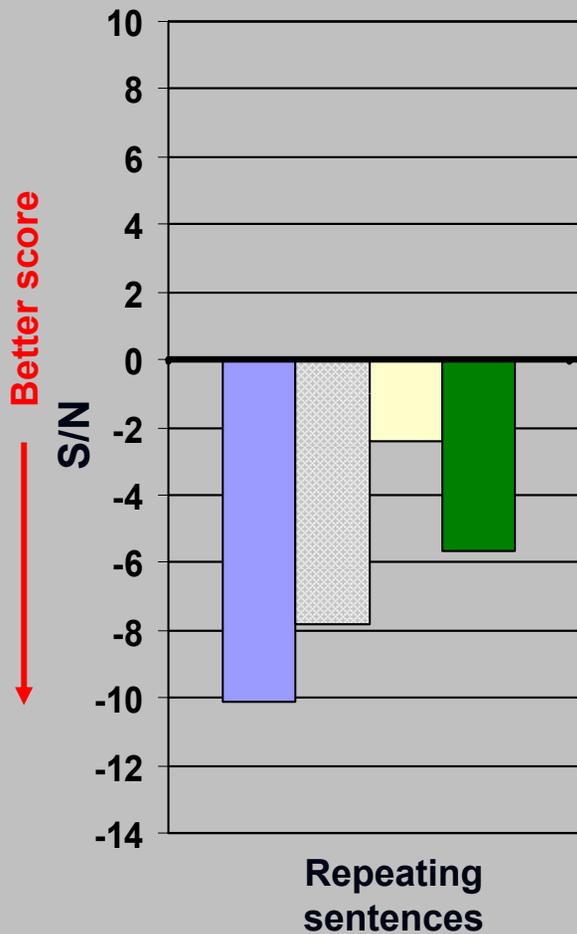
Case study 1. A 61 yr old male (MM)

- HHIA score = 50
- HHIA score is higher than expected based on his PTA
- Wears HAs fulltime (CICs)
- Worn HAs for 8 years
- Unhappy with HA performance in noise

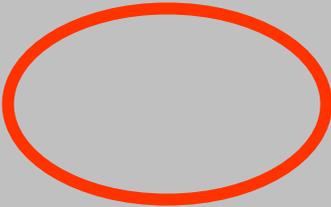
For a PTA of 46,
mean HHIA s = 22.5,
range 14-40
(Newman et al,
1990)



Testing in Noise



Getting almost 4 dB benefit (almost 40%)



- Normal hearing (Young)
- Normal hearing (Older)
- Without hearing aids
- With hearing aids

Action:

- Provided counseling for underestimators
- He returned 8 weeks later for a follow-up visit

Testing in Noise



Case study 1

Patient comments 8 weeks later:

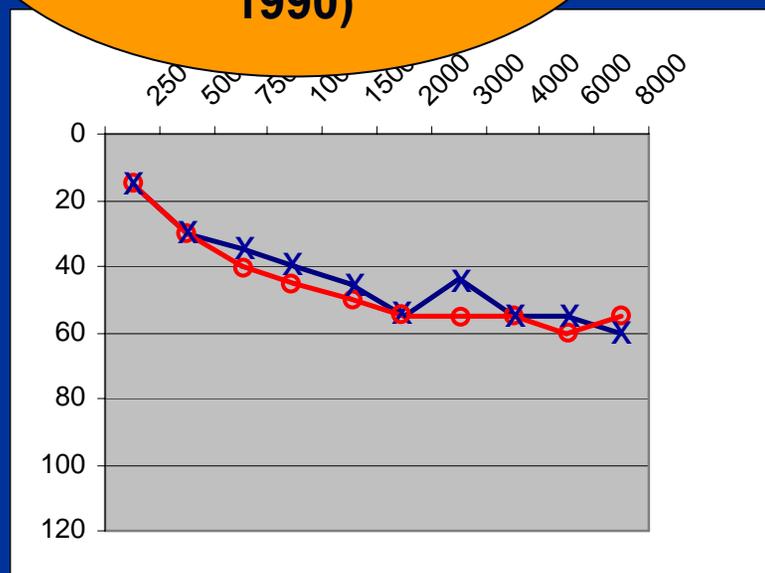
- Felt hearing with HAs had improved a bit
- He was using advice provided
- Found the advice helpful
- He paid more attention to hearing and listening
- Valued HAs more
- Wife was more communicative



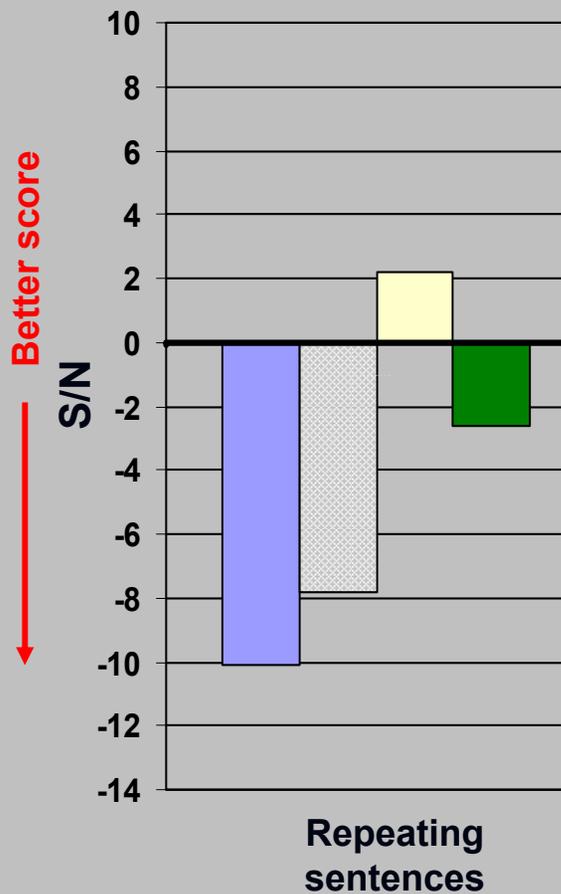
Case study 2. A 58 yr old male (DP)

- HHIA score = 96
- Very high HHIE score for his PTA
- Rates hearing as 30/100 unaided, 60/100 aided
- Noticed HL 20 years ago. Waited 17 yr before getting HAs
- Worn HAs for 10 yrs for 1-4hr/day

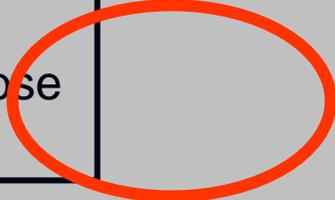
For a PTA of 43,
mean HHIA = 48.5
range 26-74
(Newman et al,
1990)



Testing in Noise



Getting almost >4dB benefit from HAs (> 40%) but still not close to 'normal'

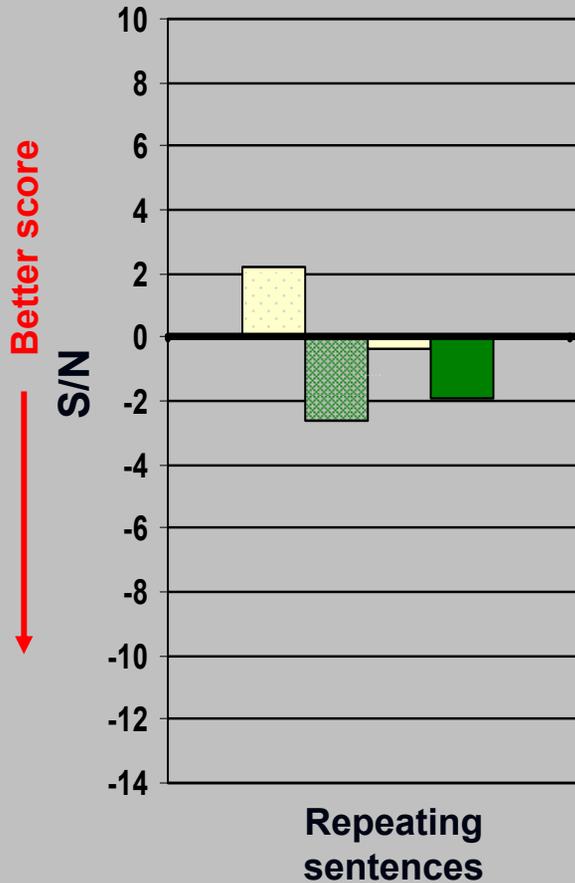


- Normal hearing (Young)
- Normal hearing (Older)
- Without hearing aids
- With hearing aids

Action:

- **Discussed overestimation in relation to unaided hearing**
- **Returned 8 weeks later**

Testing in Noise



Unaided performance changed, aided did not (as expected). *Probably says more about the test than about the patient*

- Visit 1 unaided
- Visit 1 aided
- Visit 2 unaided
- Visit 2 aided

Case study 2



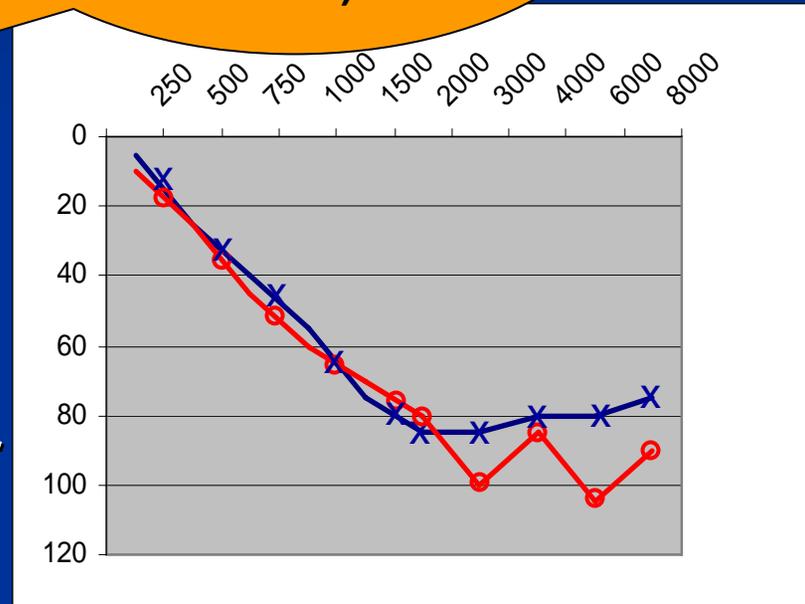
Patient comments 8 weeks later:

- Wearing HAs a lot more
- Helped him explain HL to his family
- Uses communication strategies – especially by making sure he can see person speaking
- Thinks we accurately interpreted the situation
- Knows now what he can and cannot hear
- Slight improvement in HHIE and APHAB scores

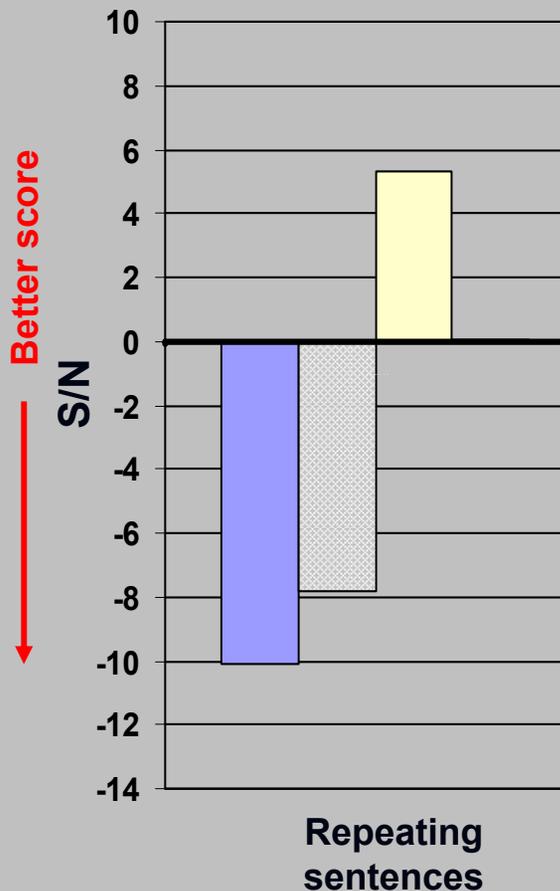
Case study 3. A 62-year-old male (RH)

For a PTA of 55,
mean HHIA = 48.5
range 26-74
(Newman et al,
1990)

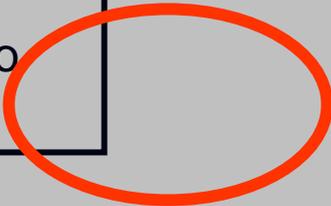
- HHIA score = 50
- PTA = 55 dB HL
- Rates unaided hearing as 72/100, aided as 95/100
- Has had HAs since 1970's but almost never wears them
- Active life style, working in office



Testing in Noise

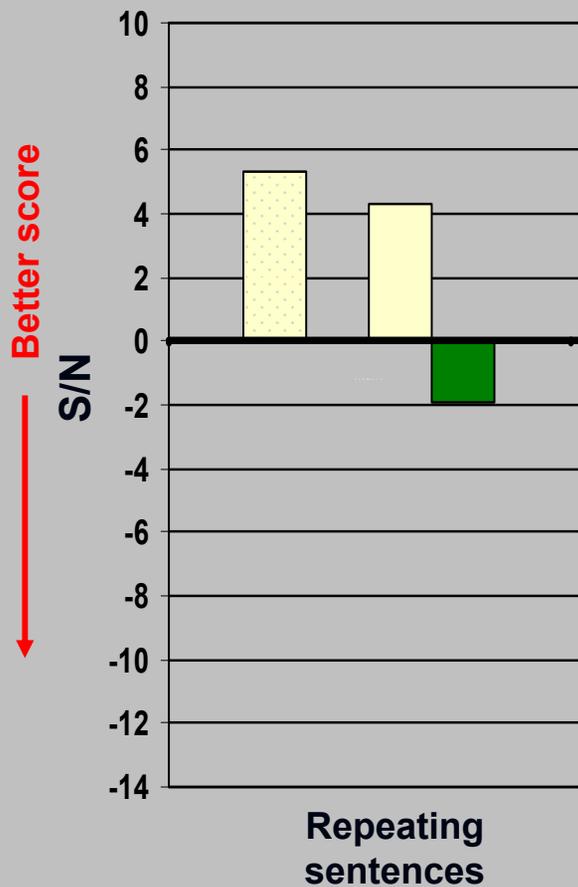


Getting ABOUT 5 dB benefit from HAs BUT still not close to 'normal'

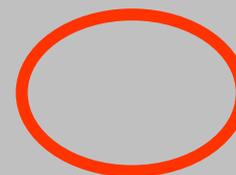


- Normal hearing (Young)
- Normal hearing (Older)
- Without hearing aids
- With hearing aids

Testing in Noise



Small change
in performance
(not expected)



- Visit 1 unaided
- Visit 1 aided
- Visit 2 unaided
- Visit 2 aided

Case study 3



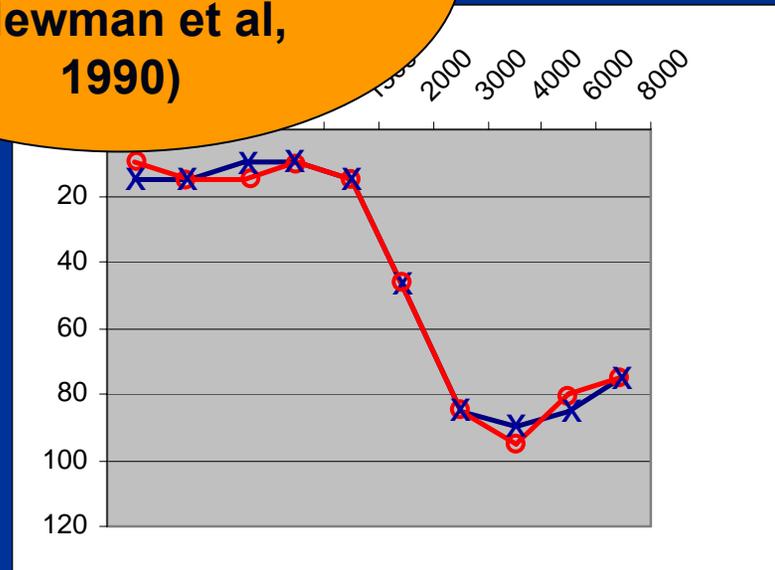
Patient comments 8 weeks later:

- Wearing HAs much more than before
- Is more in control of hearing loss when using HAs
- Feels more positive towards his HAs
- Thinks our interpretation was accurate
- Feels HAs really do have a positive psychosocial impact (competence, adaptability, self-esteem)
- Is doing better communicating with wife and boss
- Appreciated the information and time given to him

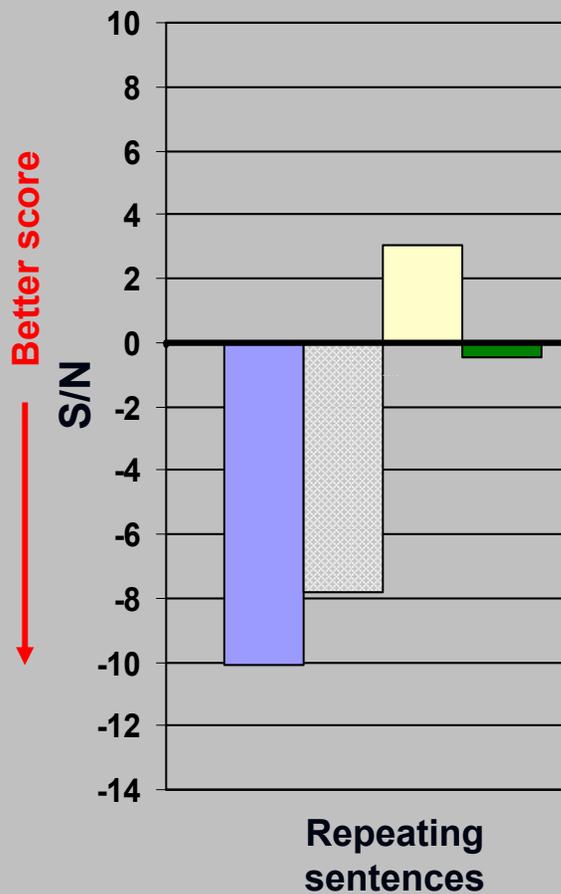
Case study 4: 42 yr old male (JF)

- **HHIE score = 76**
- **Very high HHIA score for PTA**
- **Rates unaided hearing as 40/100**
- **Reports no HA benefit (hard to fit)**
- **Noise exposure at work and in service**
- **Very dissatisfied with HAs (Phonak CICs)**

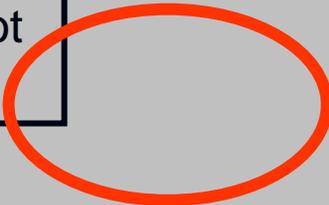
Mean HHIA for PTA
of 25 = 34.2
range 0-84
(Newman et al,
1990)



Testing in Noise

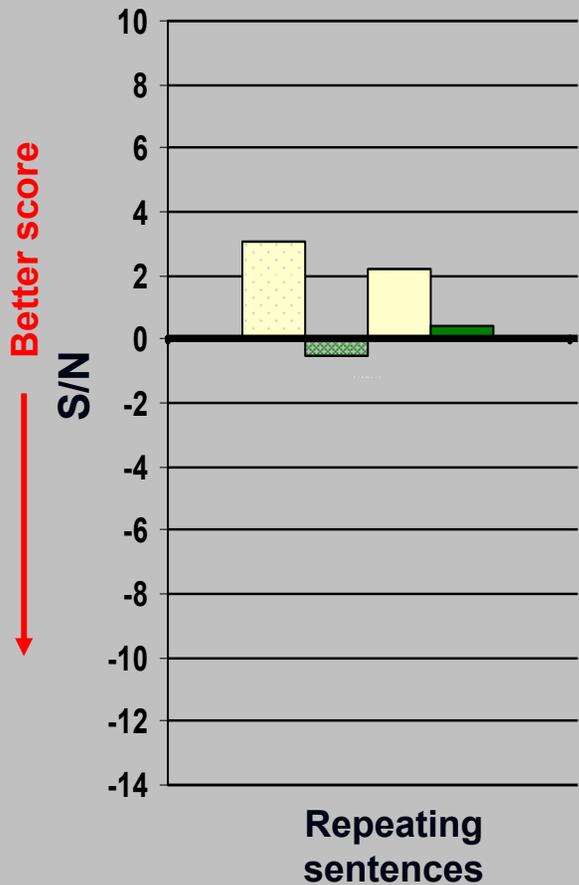


Getting almost 3dB benefit from HAs (almost 30%) but still not close to 'normal'



- Normal hearing (Young)
- Normal hearing (Older)
- Without hearing aids
- With hearing aids

Testing in Noise



No change in performance (as expected)



- Visit 1 unaided
- Visit 1 aided
- Visit 2 unaided
- Visit 2 aided

Patient comments 8 weeks later:

- Wearing HAs same as before
- Doing better communicating with wife
- Makes effort to use communications strategies such as being in same room, looking at person speaking
- Doesn't accept our interpretation



More comments from people who received PPT-based counseling from a research study

2 groups of participants:

Group 1: PPT-based counseling

Group 2: informational counseling only
(audiogram with speech banana, unaided and aided performance SRTN and communication strategies)

2 visits:

Visit 1: baseline testing and counseling

Visit 2 8 weeks later

As a result of being in this study do you feel differently about your hearing?

PPT-Based counseling participants

I realize I 'fake' a lot

Am more willing to rely on HAs

Questionnaires made me think about my hearing

Your positive feedback was helpful

Now I realize I need HAs

I am more willing to try wearing my HAs

I can better explain my difficulties to my family

I am more aware of what I miss

I feel vindicated to know I do have a problem

As a result of being in this study do you feel differently about your hearing?

Informational counseling only

I am more aware of my difficulties

I accept and understand my HL better

I know there is hope

I pay more attention to what is said

I have more confidence now

I ask for help from people

I understand I have a hearing loss and now have lower expectations

Do you feel differently about your hearing aids as a result of being in this study?

PPT-based counseling participants

Before study I thought HAs didn't help, now I know they do

I have more respect for my HAs

I realize they help me a lot

I now realize I'll never hear normally again

I wear them more

I'm pleased to have them now

Intellectually I realize their value

I am more aware of what they do for me

Do you feel differently about your hearing aids as a result of being in this study?

Informational Counseling only

I have an FM system now and so I wear them more

Now I leave them in after work, this helps at home

I feel friendlier towards them

I am more relaxed with them in

I know they help

I am more accepting of the HAs

- ✓ **Reliable**
- ✓ **Valid**
- ✓ **Clinically meaningful**
- ✓ **Clinically useful**

- ✓ Underestimator to accurate
- ✓ Overestimator to accurate

- ✗ Accurate to overestimator
- ✗ Accurate to underestimator

- Overestimator to underestimator
- Accurate to accurate
- Underestimator to overestimator

	PPDIS Desirable change	PPDIS Undesirable Change	PPDIS Neutral/ No Change
PPT-based counseling	10	3	10
Informational counseling	3	2	15

Have you been wearing your hearing aids more since starting this study?

	Yes	Same	Wore fulltime
Group 1	9	3	11
Group 2	11	4	6

Seventy-three percent of patients who didn't already wear their hearing aids all waking hours reported increased use on Visit 2

Take-home messages



- **PPT is quick and efficient (10 minutes)**
- **It provides information additional to that currently measured by audiometric and performance tests**
- **Has applications as a counseling tool**

Applications of the PPT

- ✓ to help 'deniers' (people who overestimate their hearing ability?) become aware of their hearing loss
- ✓ to give individuals that underestimate their hearing ability
- ✓ satisfaction

Spending time explaining test results is helpful

Acknowledgements

These

Thank you all for
listening



Thank you

Keri Bonnell and Marc
Crowell my invaluable
research audiologists