Using Personal Response Systems in the Classroom as a Means to Evaluate the Efficacy of Soundfield Amplification.

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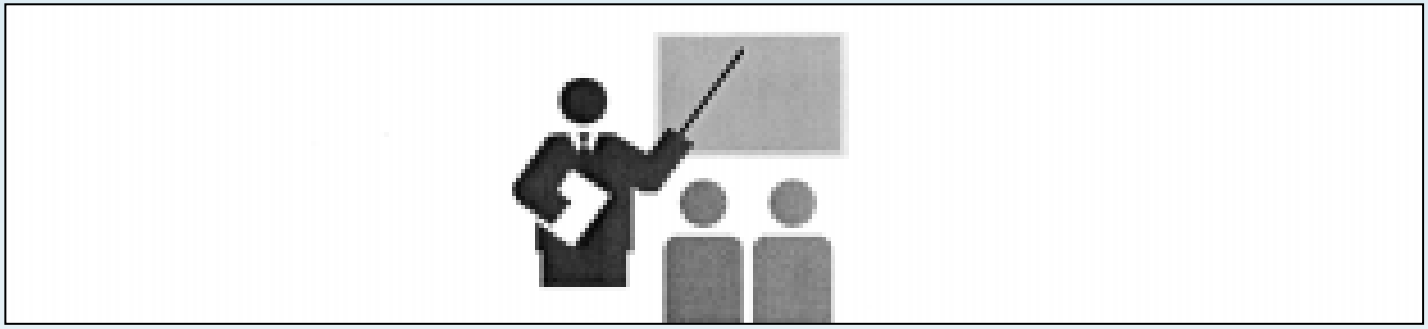
Factors Affecting Classroom Speech Perception



Talkers (Teacher and Other Students)	Communication Channel (Classroom)	Listeners (Students)
•Speech Level •Clarity	•Noise Level •Reverberance •Signal/Noise Ratio	•Age/Development •Hearing Status •English Proficiency •Other Disorders

Nelson, P.B & Soli, S (2000). Acoustical Barriers to Learning: Children at Risk in Every Classroom. Language, Speech, and Hearing Services in Schools 31, 356–361

Input - Poor Acoustics Affect the Teachers' Voice

- Teachers must adjust voices to be audible above background noise when noise > 40dBA
- Vocal adjustments contribute to increased vocal fatigue/strain
- Teacher's voice quality and speech signal are compromised; poorer perception for children
- A disproportionate number of teachers experience voice problems

Communication Channel - Noise

- 28% of schools in the US report that noise is their primary problem
- Noise interferes with speech intelligibility
- One third of the content of lessons can be missed due to poor acoustics
- Typically speech at **65dBA** has vowels at 75-80 dB and consonants at 45-50 dB
  - Could be very difficult for children to detect consonants

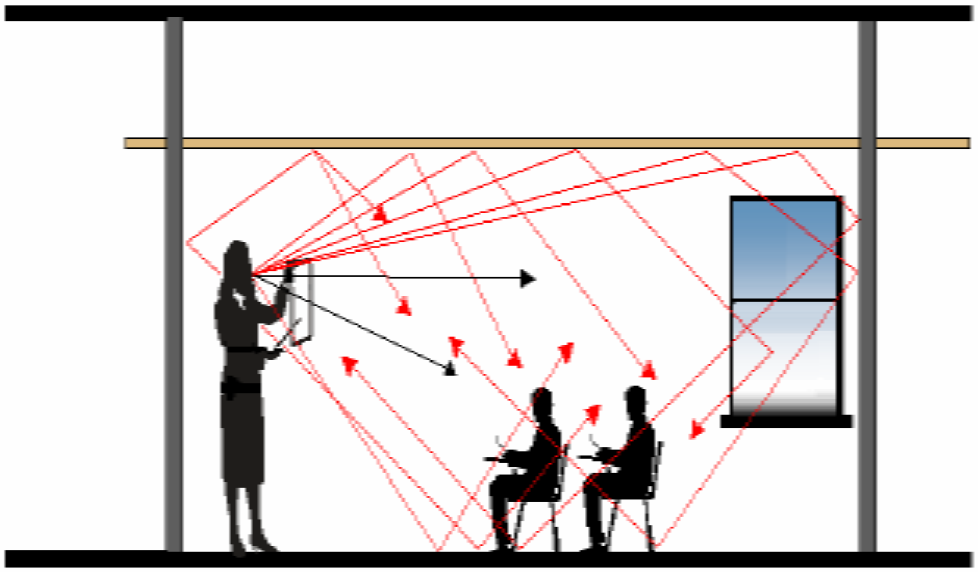
Communication Channel - Reverberation

- **Reverberation** is the persistence of sound after the original sound has stopped.
- **RT60** is the time required for reflections of a direct sound to decay by 60 dB below the level of the direct sound.

RT60 Measurements

- Classrooms typically vary from 0.4 to 1.5seconds

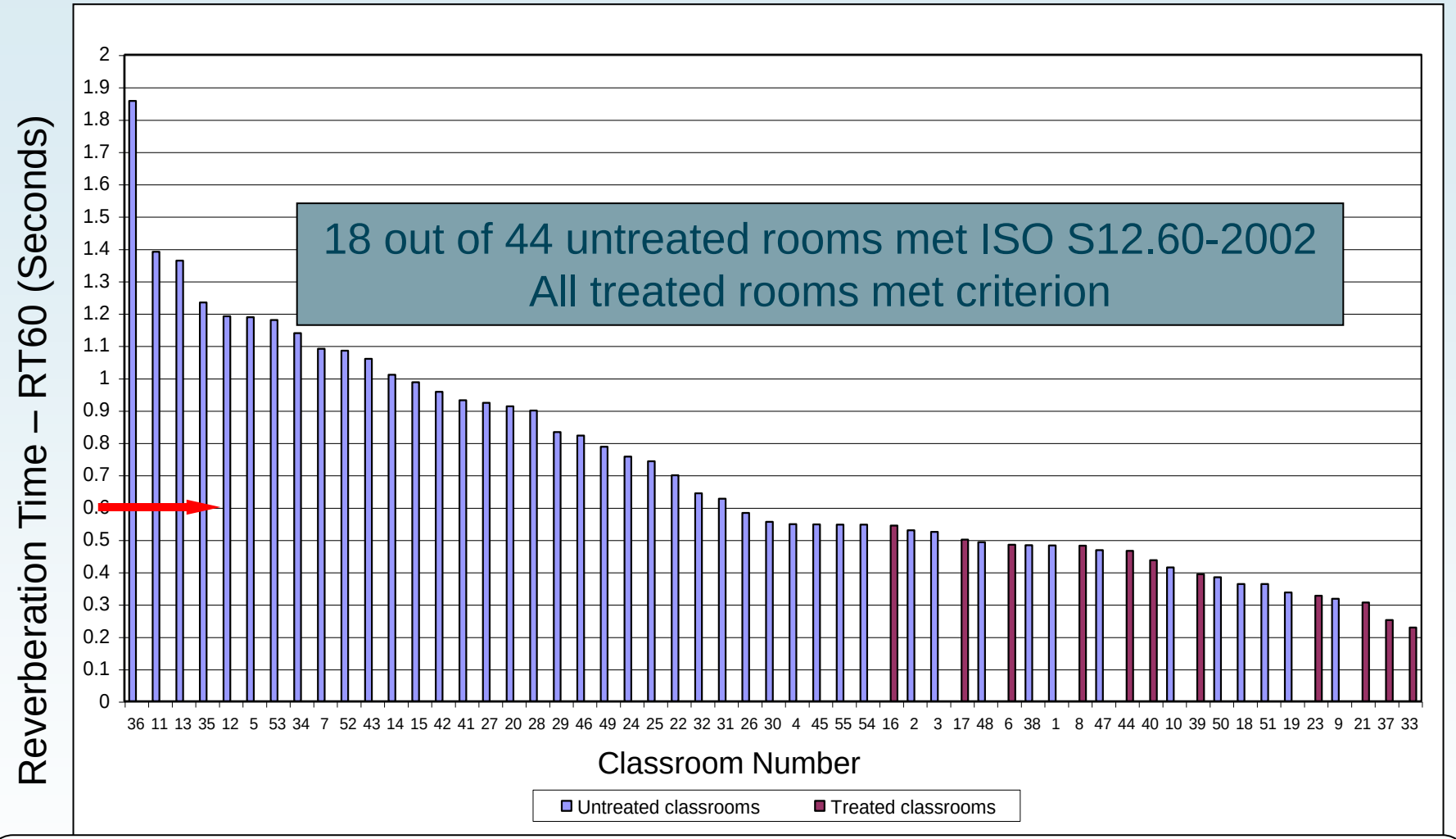
- High ceilings in old classrooms one of biggest problems



ANSI Standard S12.60-2002 for classrooms

- Background noise levels should be below 35dBA
- Maximum RT_{60} is 0.6 seconds
- SNR should be +15dB
- Reported in the UK that this increases the cost of building by 1% to meet these requirements

Acoustic survey of 55 classrooms in 25 schools:

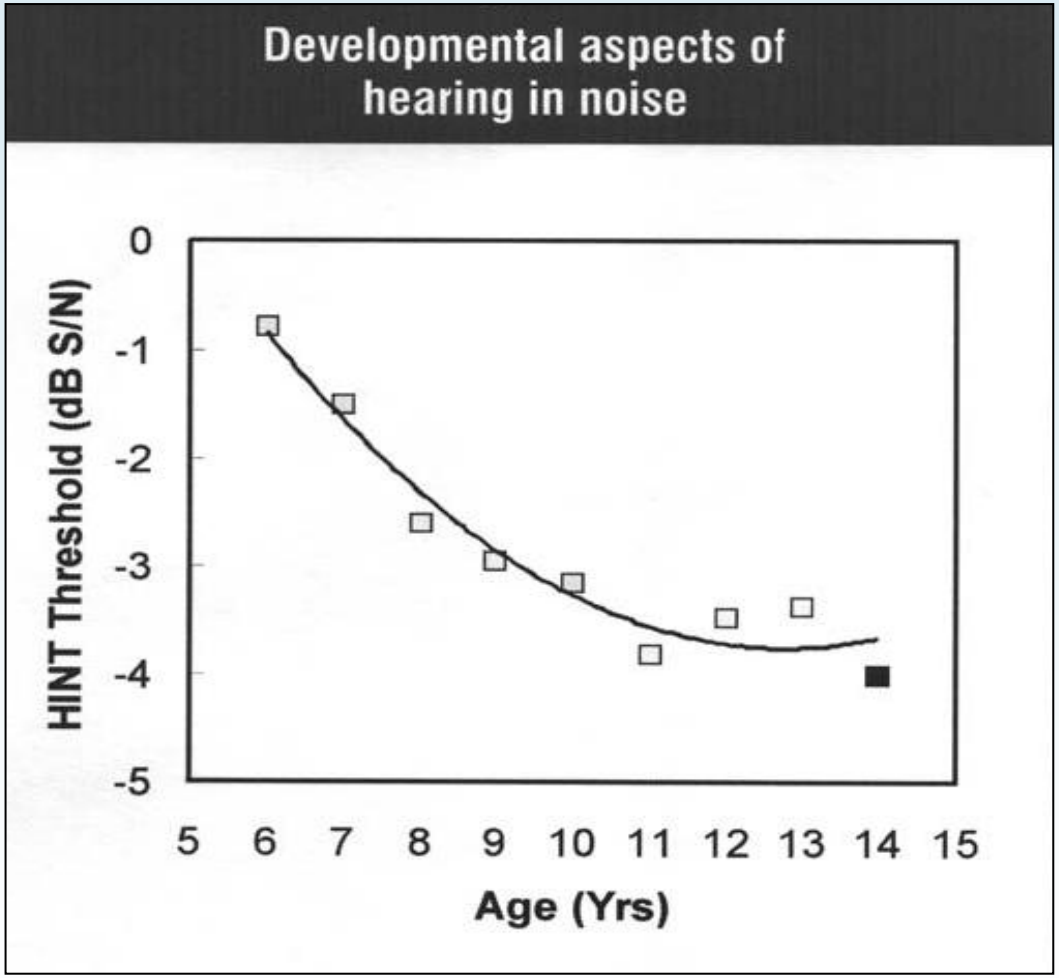


How to improve classroom listening?

- Increasing acoustic absorption to reduce reverberation time
- Using amplification/sound field systems in the classroom

Dockrell J E, Sheild B M. (2006). Acoustical Barriers in Classrooms: The Impact of noise on performance in the classroom. British Educational Research journal. 32(3) 509-525.

Individual Factors – e.g. Developmental Age



- **6-13 year old normal hearing typically developing listeners**
- **Speech Reception Thresholds (SRT) for Hearing in Noise Test (HINT)**
- **Adult SRTs shown by filled square**

Soli, S. D., & Sullivan, J. A. (1997). Factors affecting children's speech communication in classrooms. *Journal of the Acoustical Society of America, 101, S3070.*

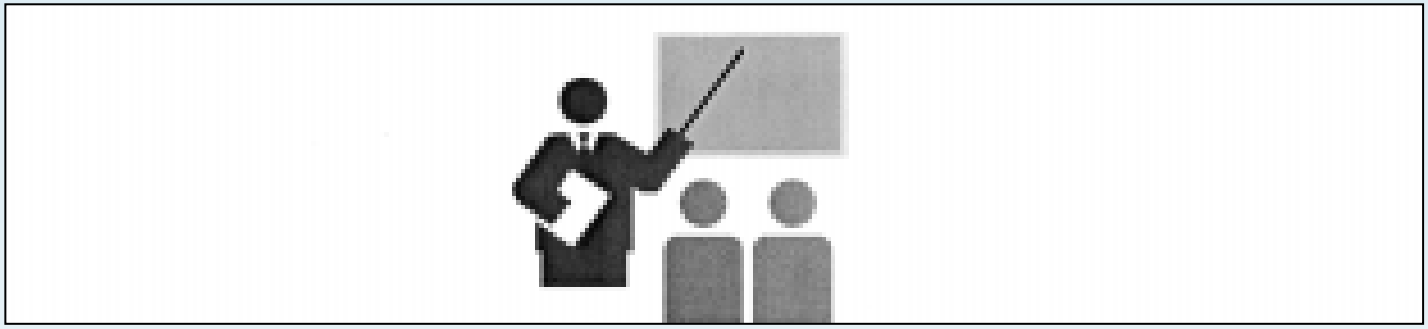
Goal of Sound Field Amplification (SFA)?

Provide a **cost-effective** way to **evenly distribute** the teacher's voice around the classroom to **enhance** the **delivery of the speech signal** to all children

It is difficult to truly determine efficacy of SFA

- Some researchers have used spelling tests
- Some tested speech perception with two children at a time
- Subjective evaluations, questionnaires and monitoring behaviour

Our study Goal



Talkers (Teacher and Other Students) → Communication Channel (Classroom) → Listeners (Students)

Recorded Speech to Simulate a teacher

- RT_{60}
- SFA (on or off)
- Background noise (on or off)

Assess
- Vocabulary Age
- Hearing Status
- English Proficiency
- Special Educational Needs

- Look at individual results

Stimuli Screen – Chear Auditory Perception Test (CAPT)

Test set up in a nutshell

Children trained on vocabulary

Each child given a Personal Response System (PRS) - voting card

Cards explained to the children

Trained with warm up questions

Speech Stimuli presented and children pressed appropriate option

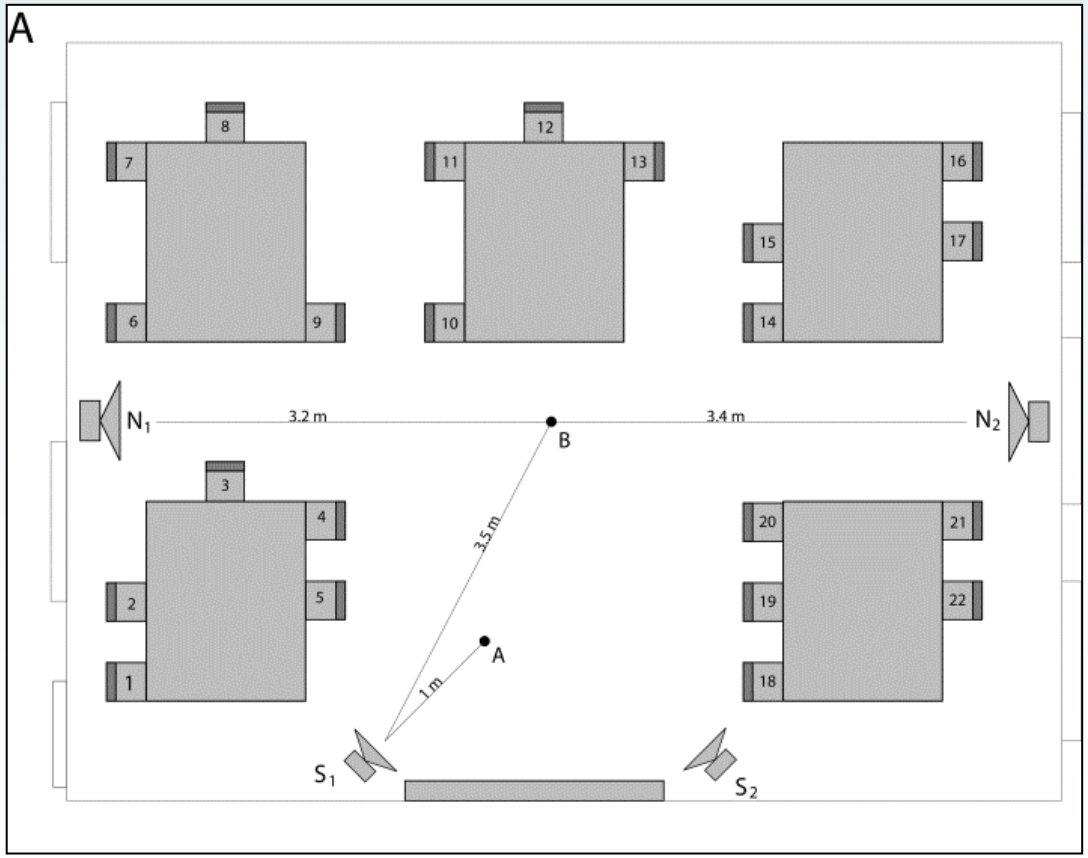
All responses stored by handset code

School Information - Rhyll

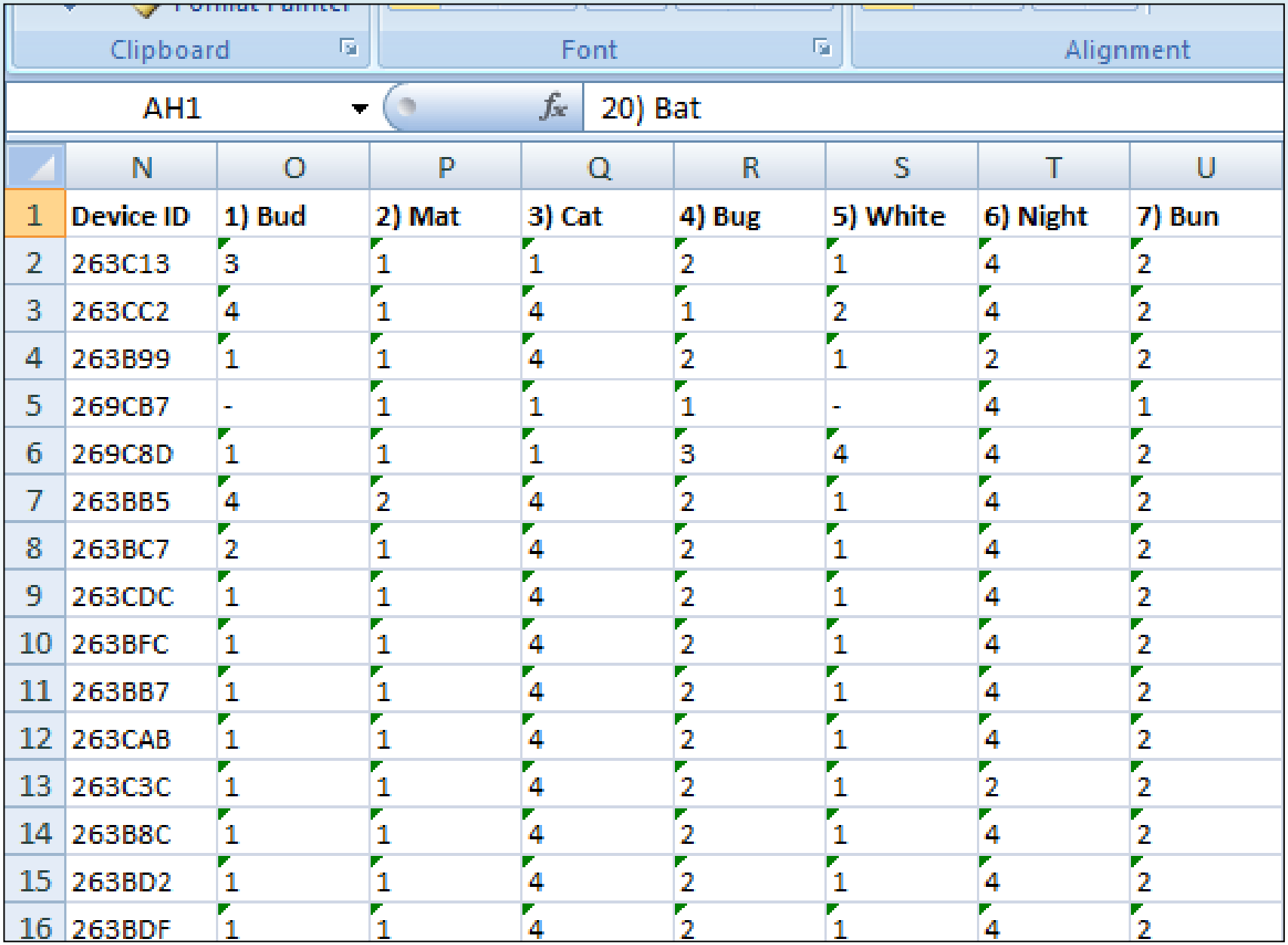
- Inner City 19th Century London School
- 2 classes:
  - 6-7 year olds (Year 2)
  - 7-8 year olds (Year 3)
- RT60 = 1.05s (Year 3s) & .89s (Year 2s)
- 22 children in each class
- In each class only 5 had English as first language
- Assessed expressive vocabulary age
- Otoscopy and tympanometry used with each child
- Testing in quiet and with noise

Classroom Layouts

- Children sat at normal classroom places
- Noises presented from side speakers
  - White noise from window speaker, ISTS noise from hallway side
- Calibrated at 46dBA at centre of room



Listeners – Responses stored by card id



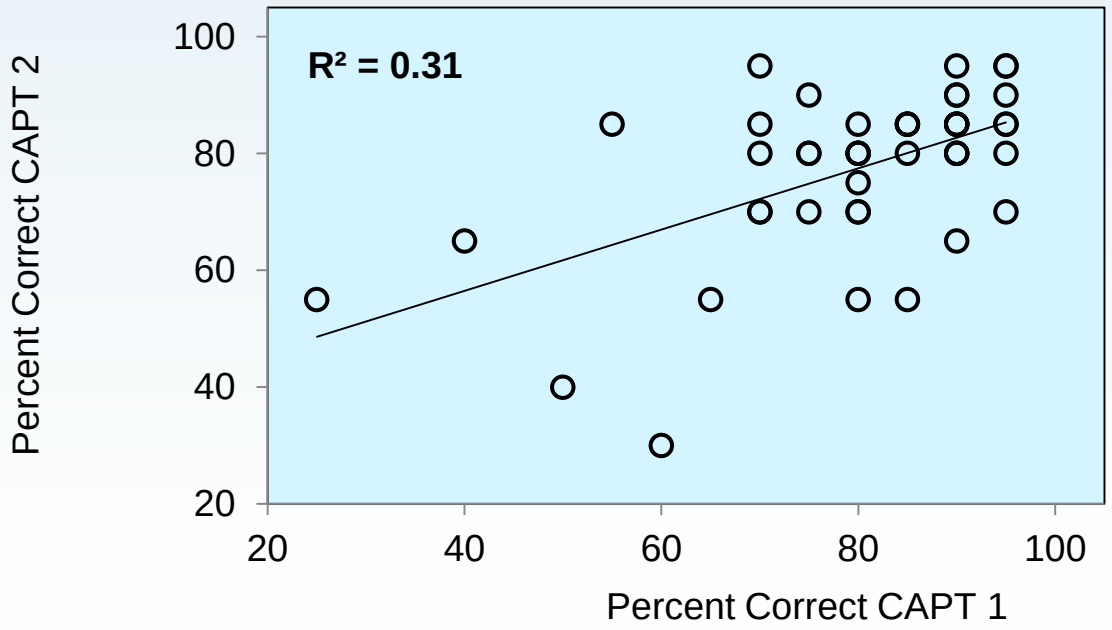
Clipboard | Font | Alignment

AH1 | fx | 20) Bat

	N	O	P	Q	R	S	T	U
1	Device ID	1) Bud	2) Mat	3) Cat	4) Bug	5) White	6) Night	7) Bun
2	263C13	3	1	1	2	1	4	2
3	263CC2	4	1	4	1	2	4	2
4	263B99	1	1	4	2	1	2	2
5	269CB7	-	1	1	1	-	4	1
6	269C8D	1	1	1	3	4	4	2
7	263BB5	4	2	4	2	1	4	2
8	263BC7	2	1	4	2	1	4	2
9	263CDC	1	1	4	2	1	4	2
10	263BFC	1	1	4	2	1	4	2
11	263BB7	1	1	4	2	1	4	2
12	263CAB	1	1	4	2	1	4	2
13	263C3C	1	1	4	2	1	2	2
14	263B8C	1	1	4	2	1	4	2
15	263BD2	1	1	4	2	1	4	2
16	263BDF	1	1	4	2	1	4	2

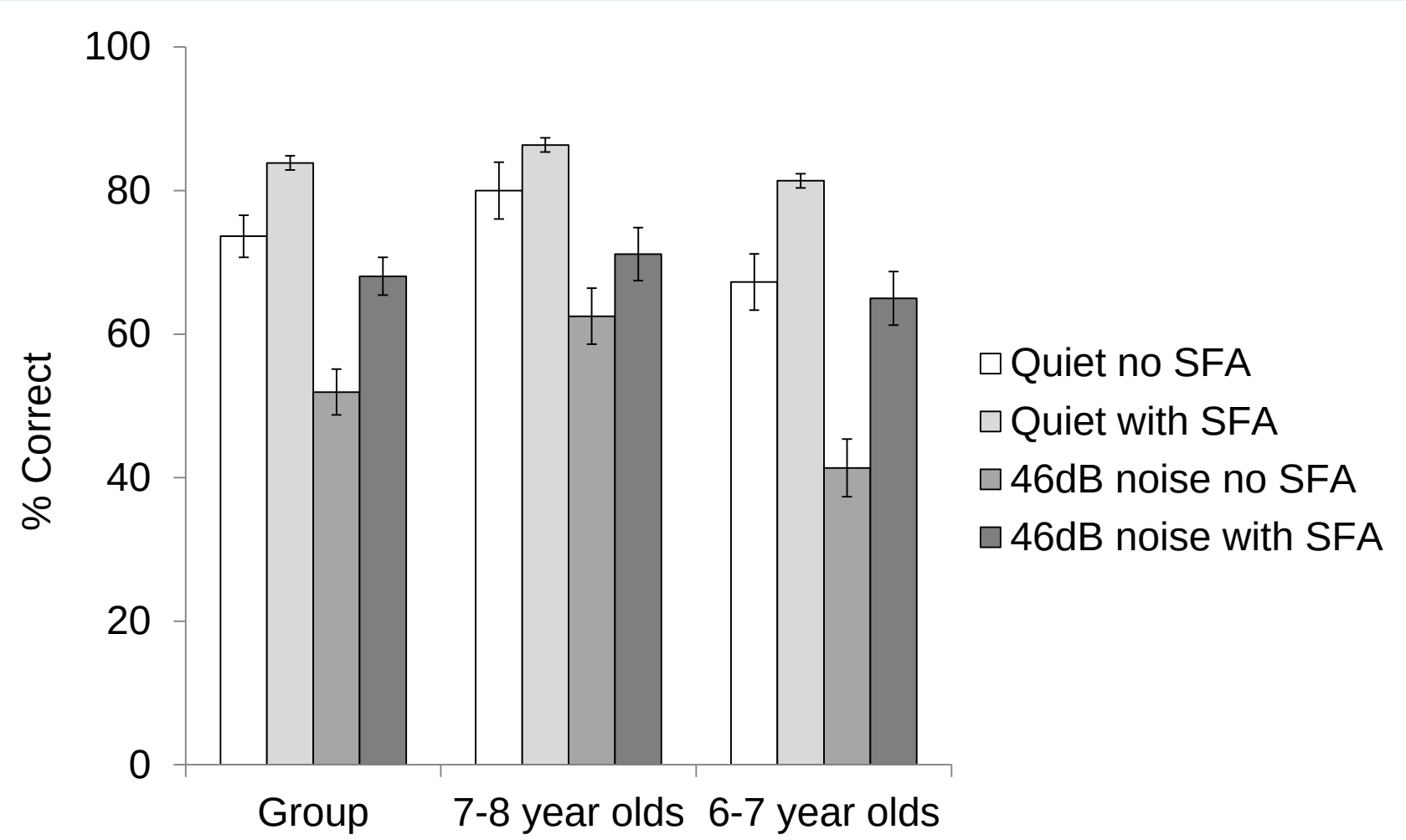
Test re-test for CAPT

Repeatability measure shows that 17.6% indicates a significant difference on a individual level i.e. 3 or 4 out of 20



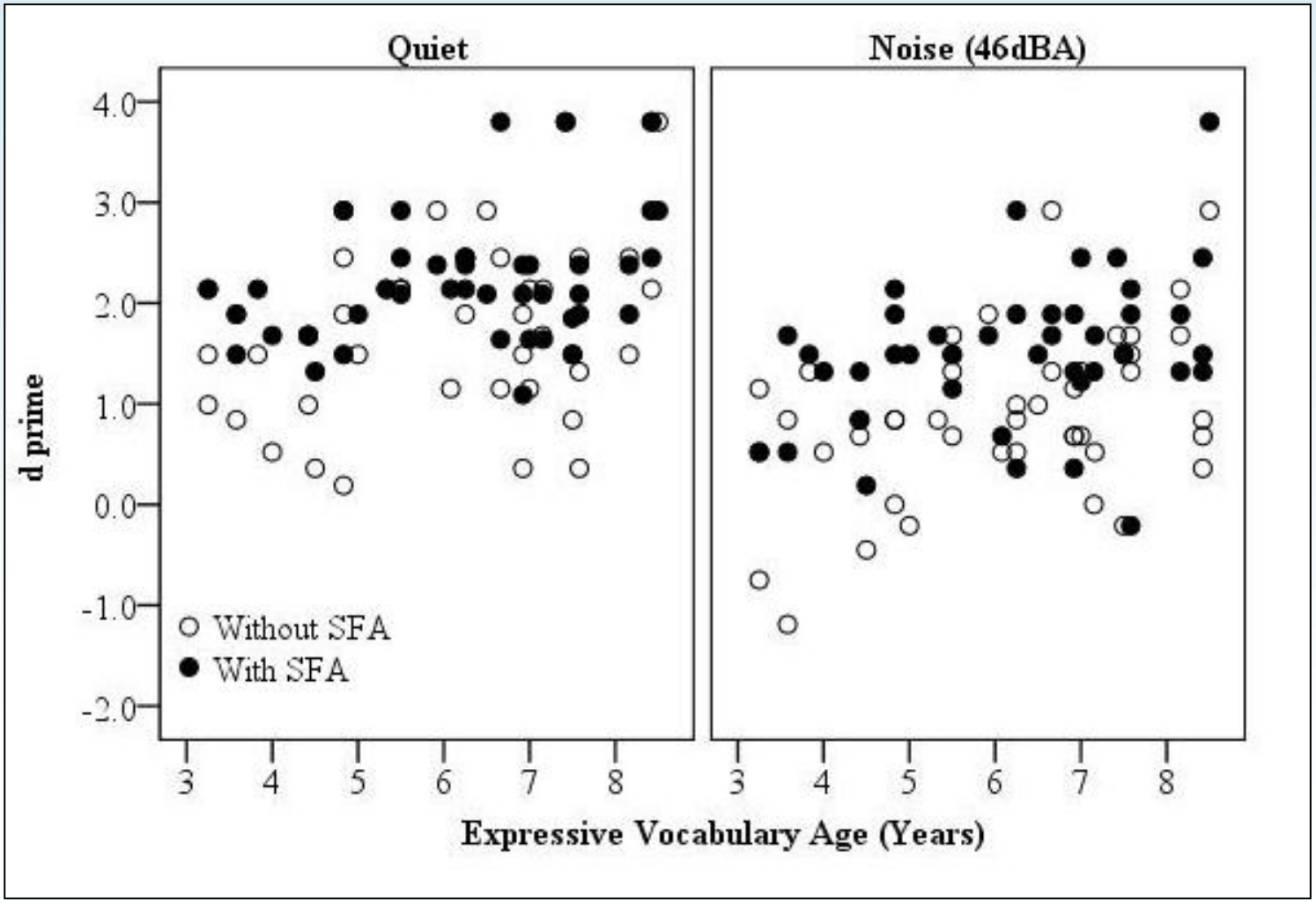
Rhyll results

Significant effect of Age, SFA and presence/absence of noise



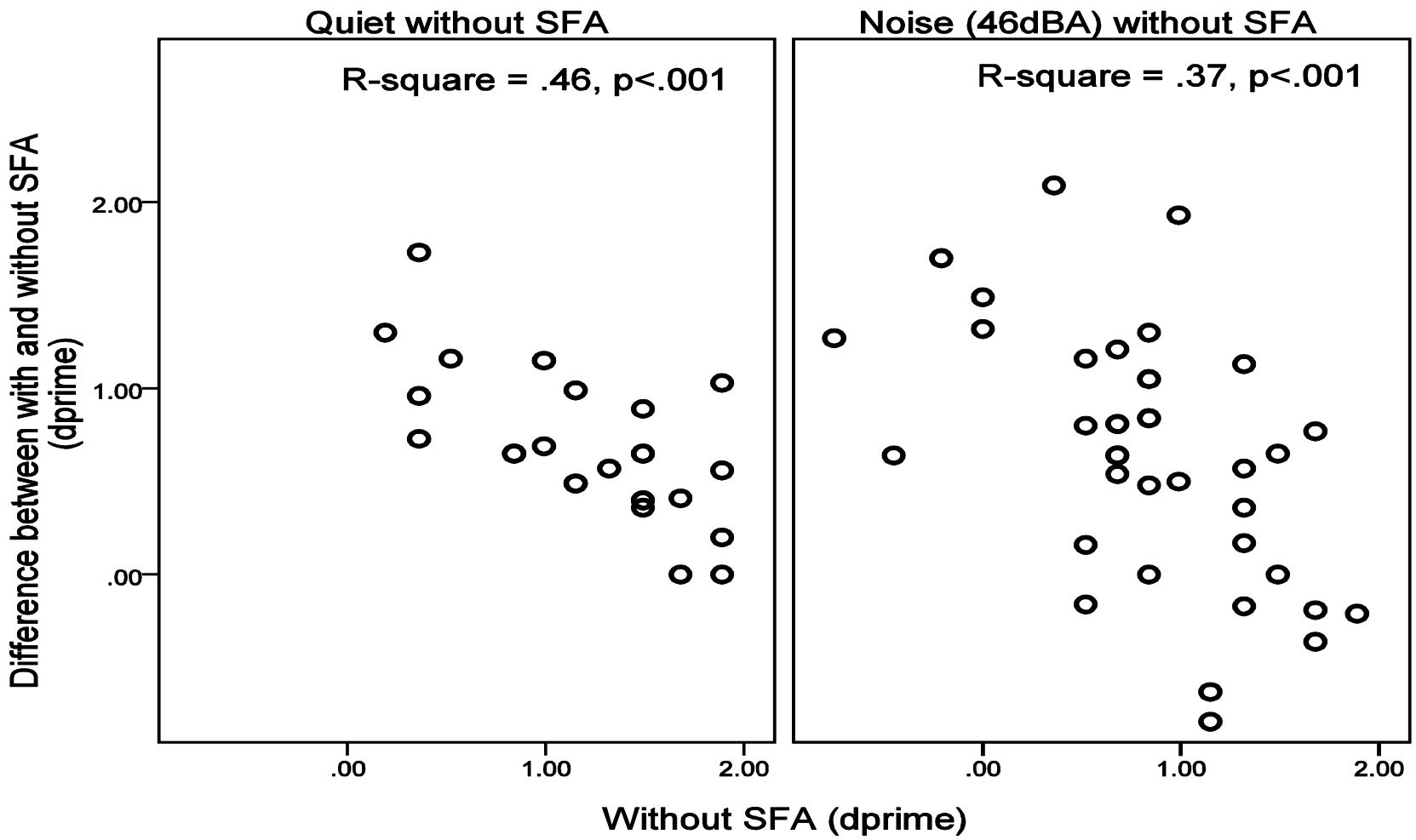
Rhyll results

Significant relationship between Vocab Age and CAPT in quiet and noise without SFA, BUT **not** with SFA



Rhyll results

Significant correlation between score without SFA and the benefit obtained from SFA



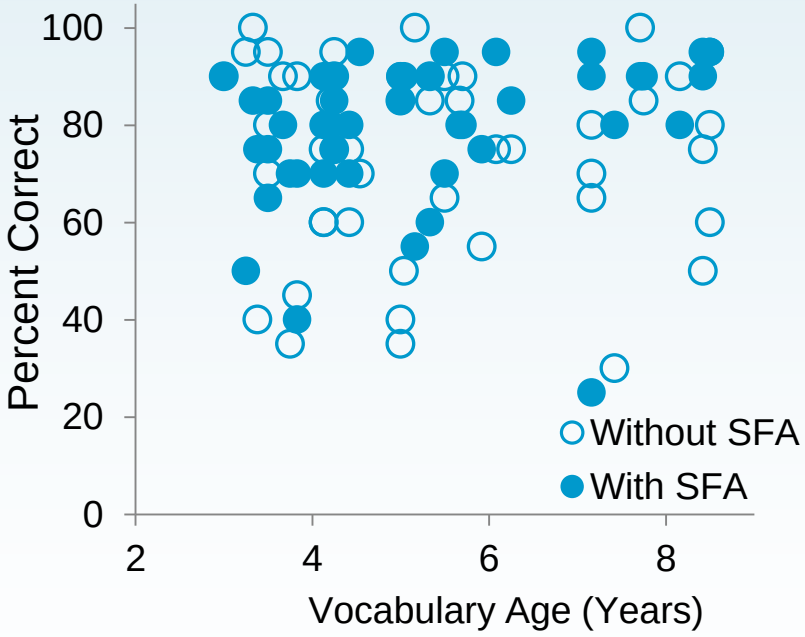
School Information - Meadowbrook

- Bristol suburban new build
- 2 classes:
  - 5-6 year olds (Year 1)
- RT60 = .33s well within .6s recommendation
- 30 in first class and 29 in second class
- In each class 5 didn't have English as first language
- Assessed expressive vocabulary age
- Otoscopy and tympanometry used with each child
- Testing in quiet and with noise

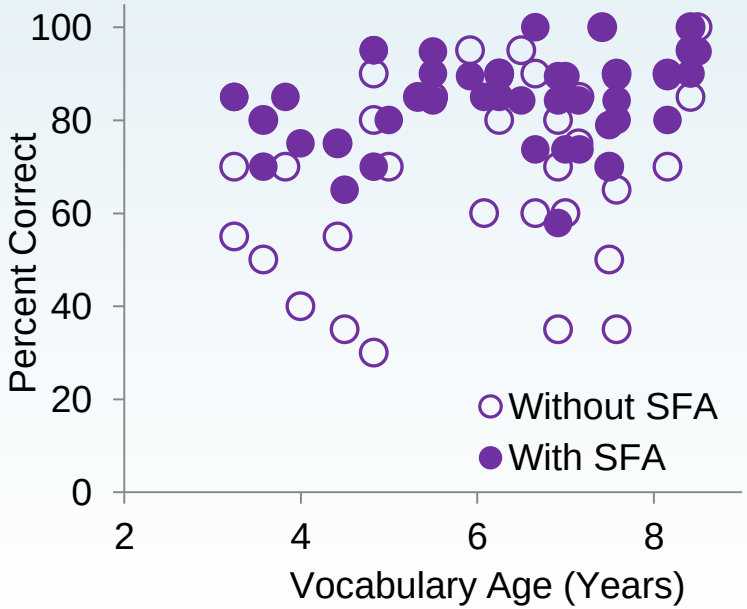
Vocabulary Age versus Speech Score

More children at Meadowbrook with lower vocab ages accessed speech
Both schools greater improvement for poorer performers

Meadowbrook – Good Acoustics



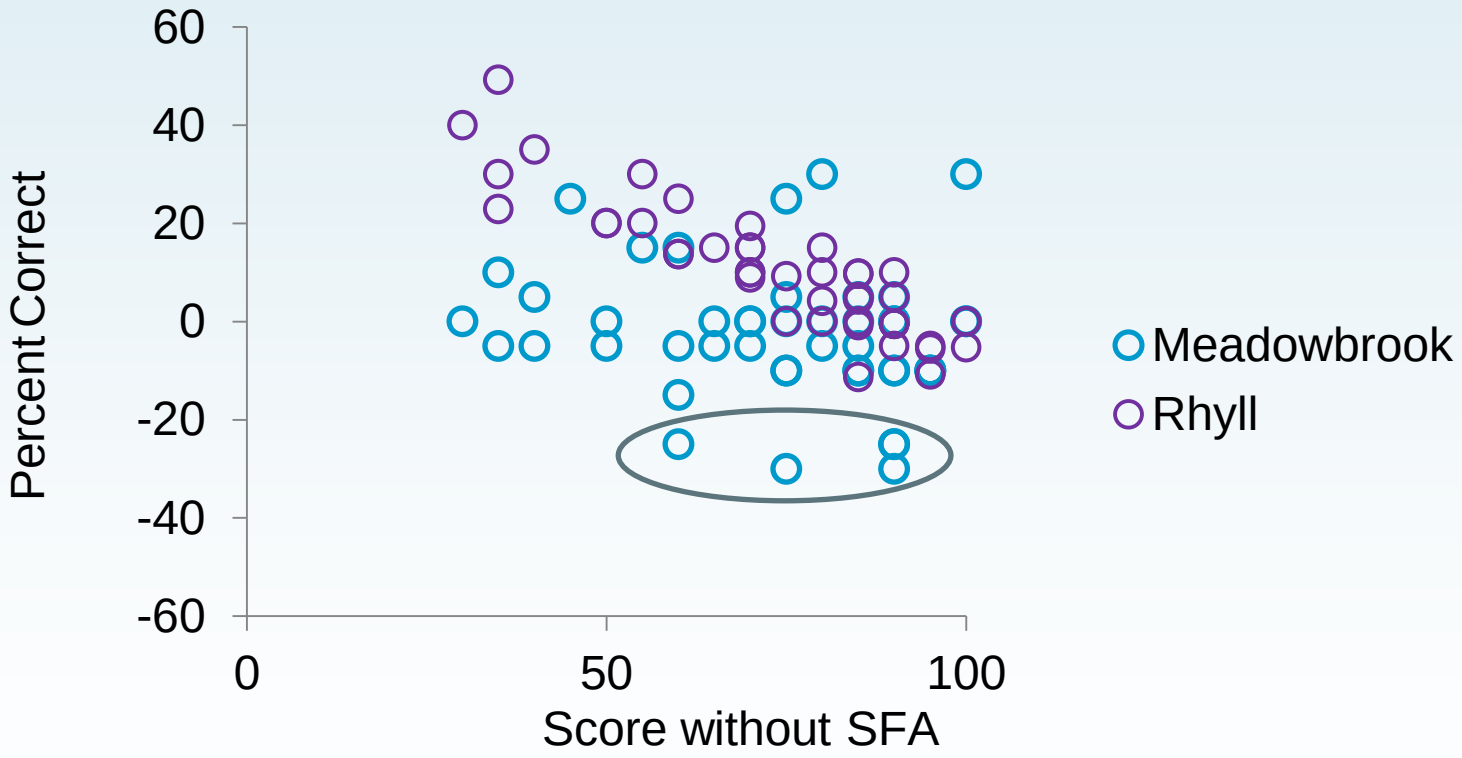
Rhyll – Poor Acoustics



Benefit greater for school with poorer acoustics

Small number of children got worse with SFA at Meadowbrook

Could Acute Testing be the problem – Rhyll were older children

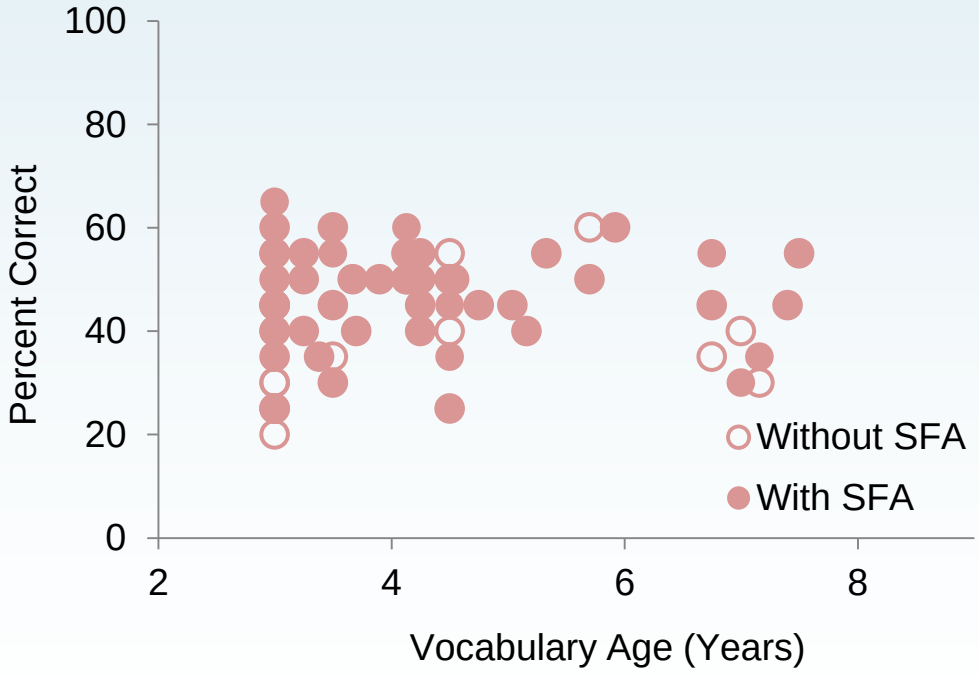


School Information - Selwyn

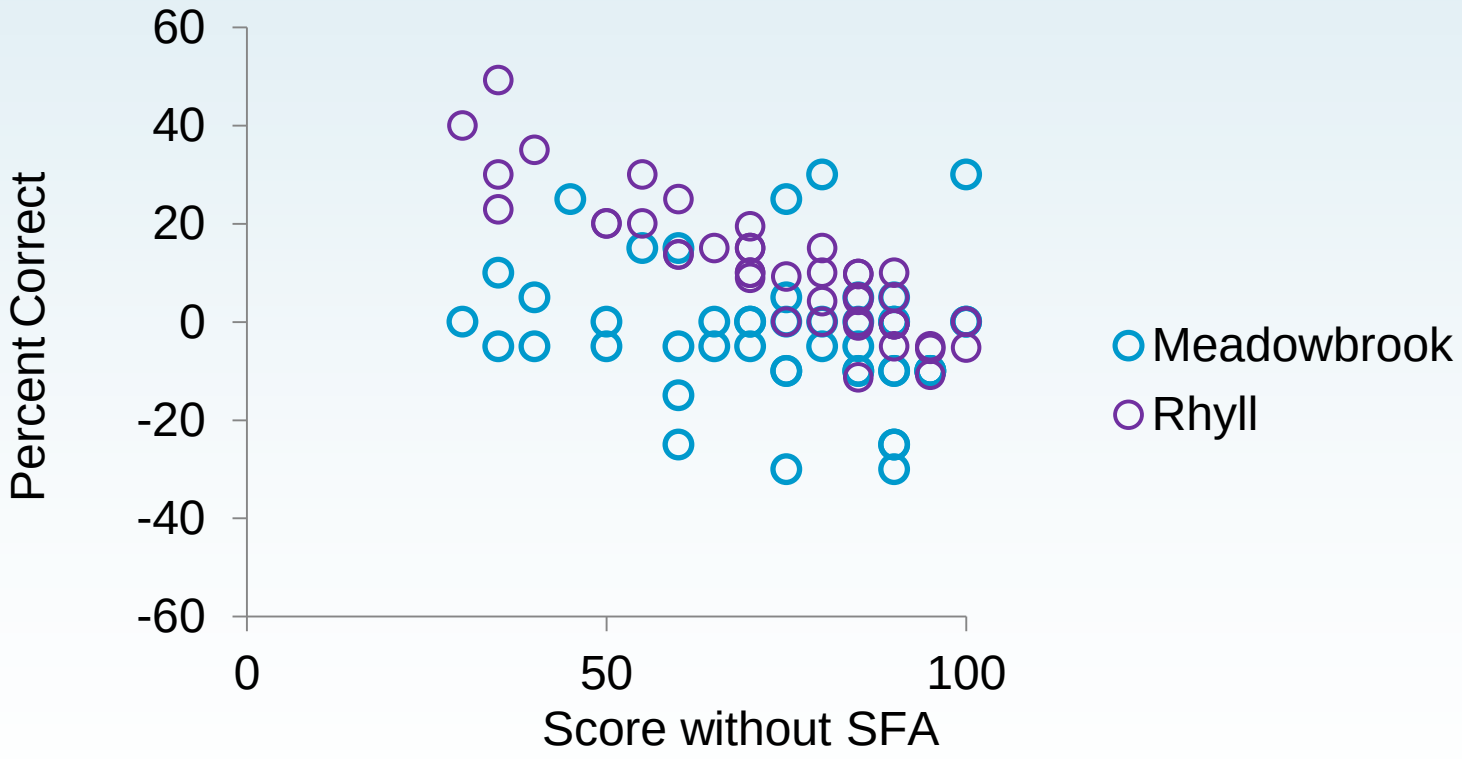
- Inner City London School – New build
- 2 classes:
  - 5-6 year olds (Year 1)
- RT60 = 1.05s (Year 3s) & .89s (Year 2s)
- 22 children in each class
- In each class only 5 had English as first language
- Assessed expressive vocabulary age
- Otoscopy and tympanometry used with each child
- Testing in quiet and with noise

Little group effect with SFA

No child got significantly worse
Small number of children did improve

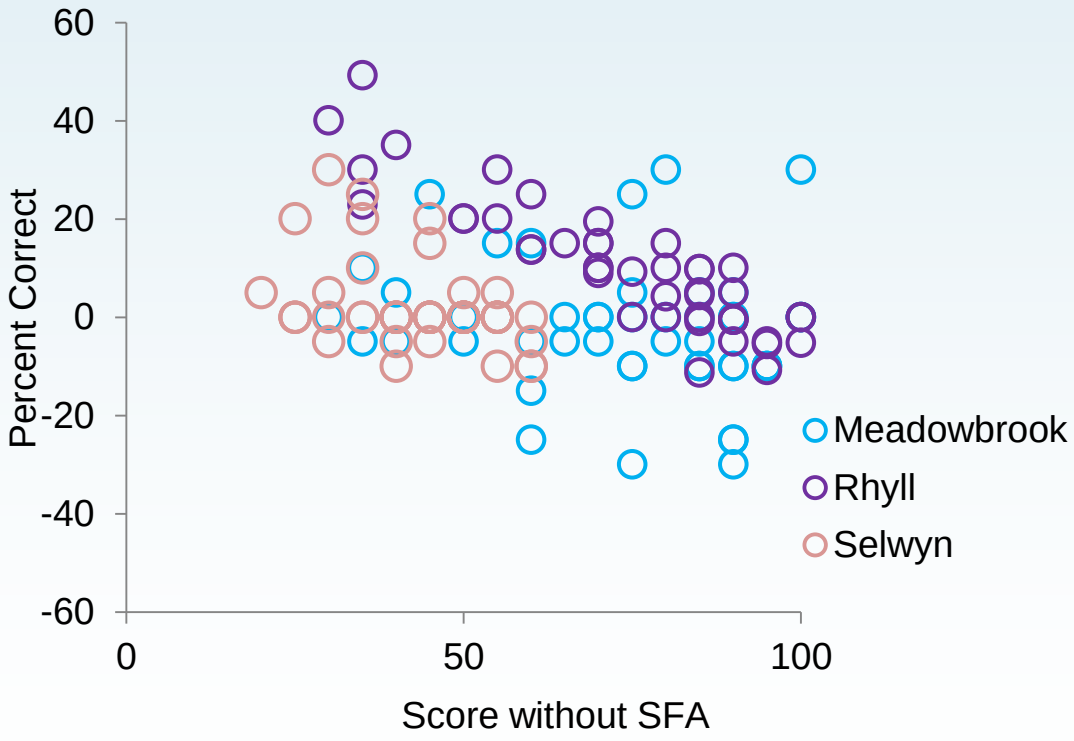


Benefit for different schools



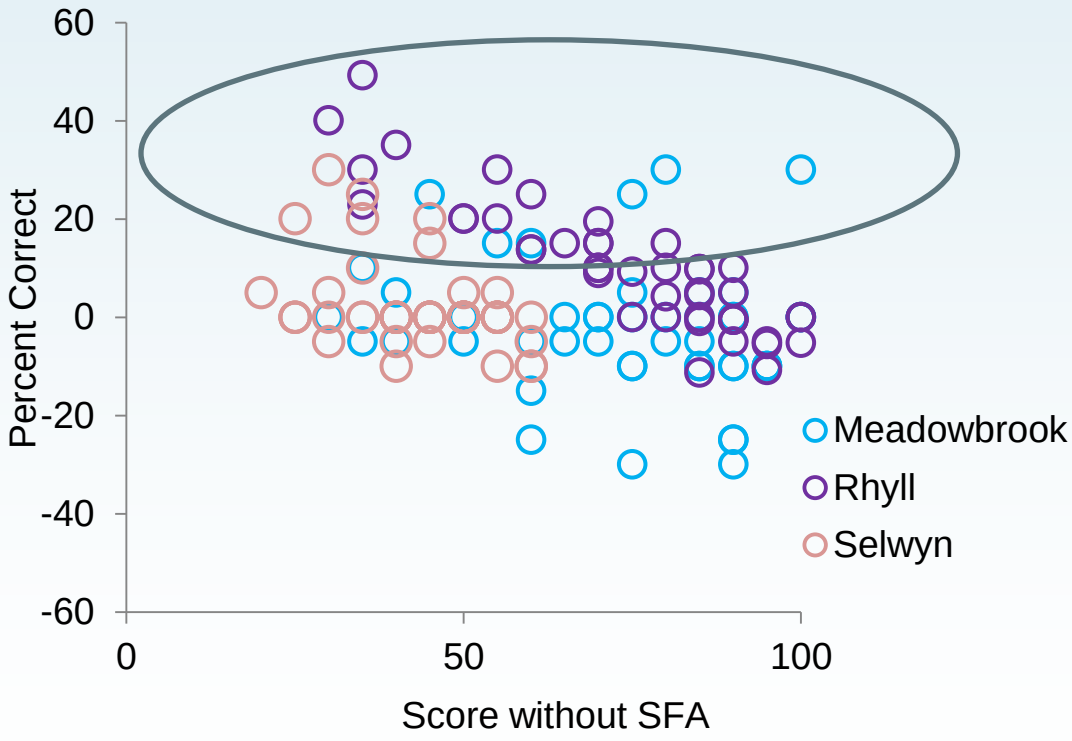
Benefit for different schools

Selwyn have poorer scores but younger than Rhyll and majority have EAL
Children don't get worse with SFA



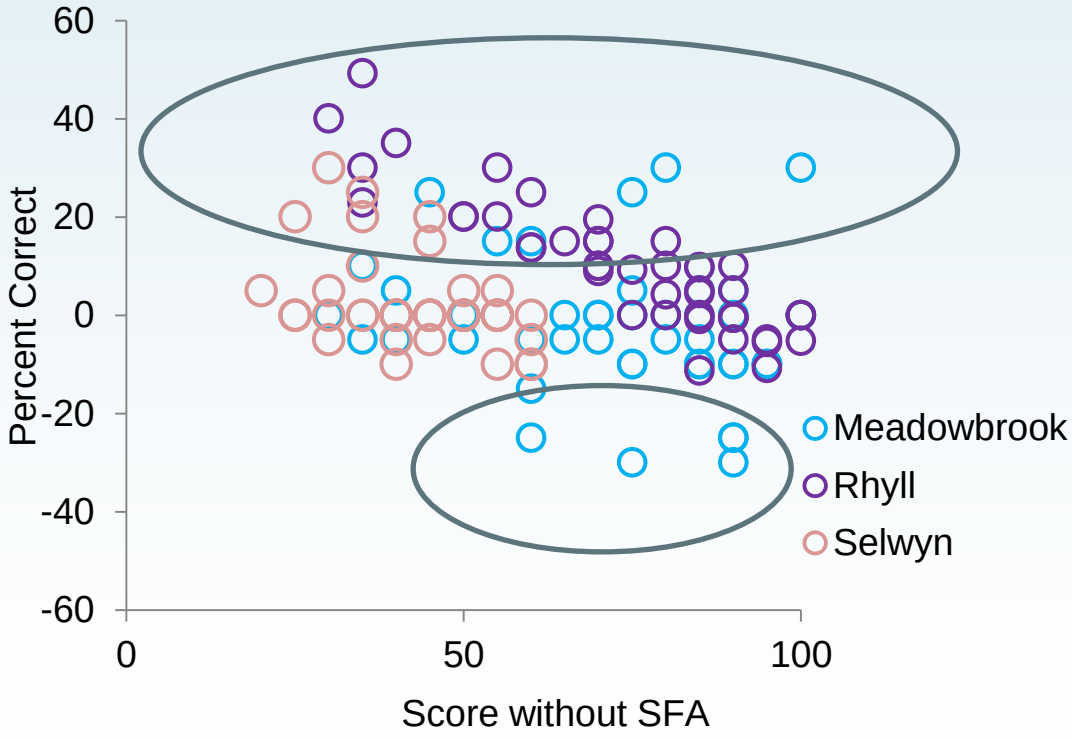
Benefit for different schools

Selwyn have poorer scores but younger than Rhyll and majority have EAL
Children don't get worse with SFA
Some children improve with SFA



Benefit for different schools

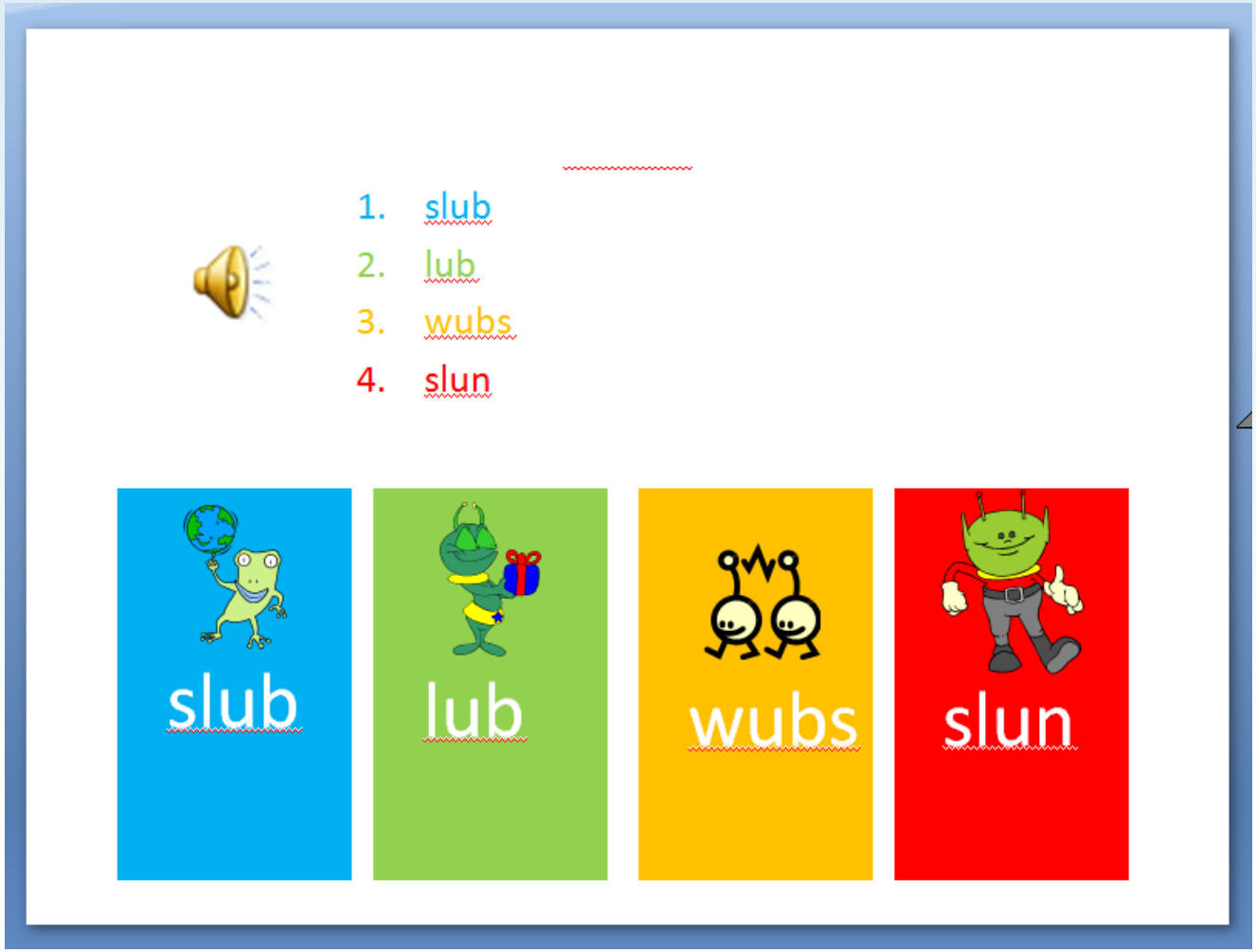
Selwyn have poorer scores, but younger than Rhyll
Children don't get worse with SFA
Some children improve with SFA
Meadowbrook some children got worse in acute testing



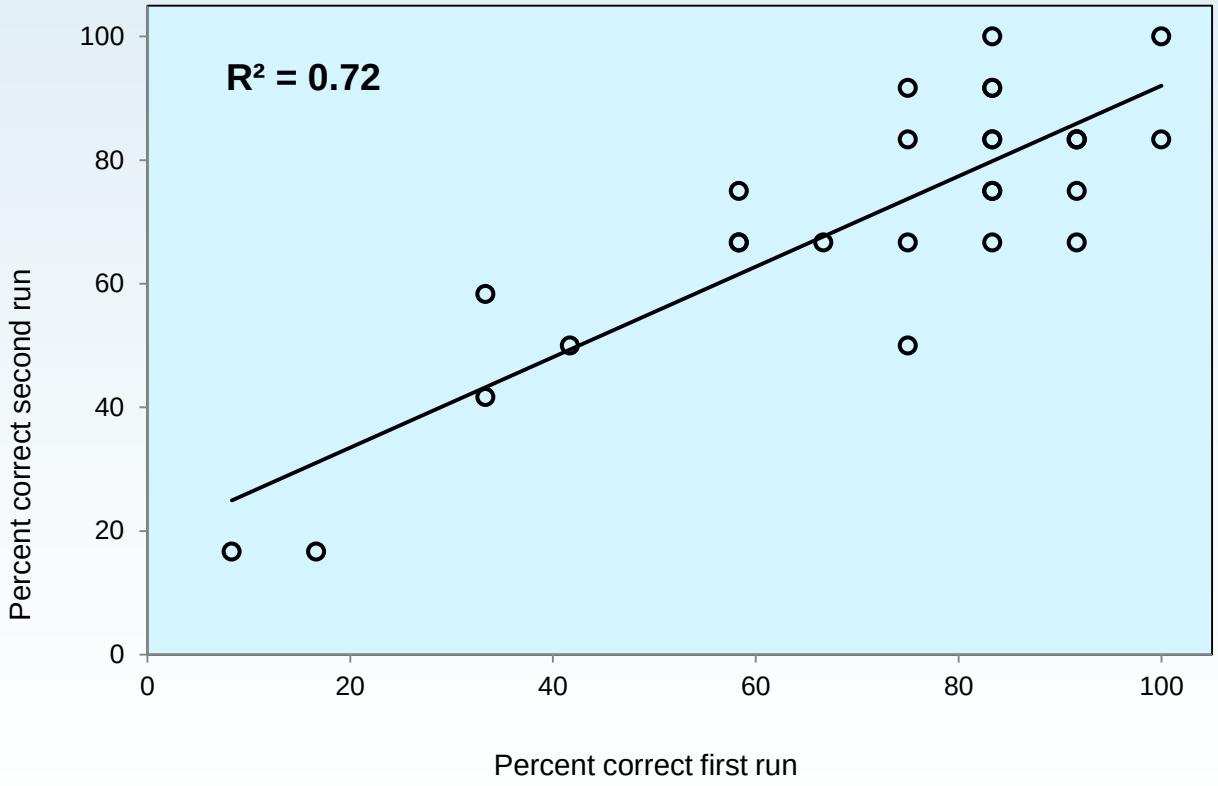
The way forward

- Conduct a large scale study to follow children in schools with different acoustic characteristics, different socio-economic regions to determine if SFA improves access to speech
- Assess hearing status, speech in noise perception
- Compare scores to educational outcomes
  - Spelling
  - Numeracy
  - Phonics screen
- Group testing of British Picture Vocabulary Scale
- Incorporate Nonsense syllables into test battery

Stimuli Screen – Nonsense Syllable Test



Test re-test for Nonsense syllables



Conclusions – Testing Approach

- Good test re-test reliability for speech tests (CAPT and Nonsense syllables) using PRS
- Children enjoy the task and it allows observation within a group setting
- Other applications:
  - Testing efficacy of FM systems within a classroom
  - Speech perception testing in freefield
    - Individual or group
  - Observe perception of children with dyslexia, APD and other special educational needs

Conclusions – SFA

- SFAs provide improvements for speech perception in poor acoustic environments
- In general the poorer performers gain the most
- In good acoustic environments some children gain benefit but majority are unaffected
- Some children deteriorated in good acoustic environments with the SFA – most likely due to acute testing
- Need large scale study to explore individual factors

Vickers, D. et al. (in press). *Using personal response systems to assess speech perception within the classroom: an approach to determine the efficacy of sound field amplification in primary school classrooms*. Ear and Hearing

Please contact me for further details

Thank you

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