Beeps, boops, and beanbags:
A psychologist looks at ‘cures’ for dyslexia

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Psychological studies of developmental disorders

The Holy Grail

Develop a theory of the disorder that

not only explains why it occurs, but also motivates effective intervention

methodological problems

Sir Galahad

ethical problems

commercial vested interests

Ethical problems

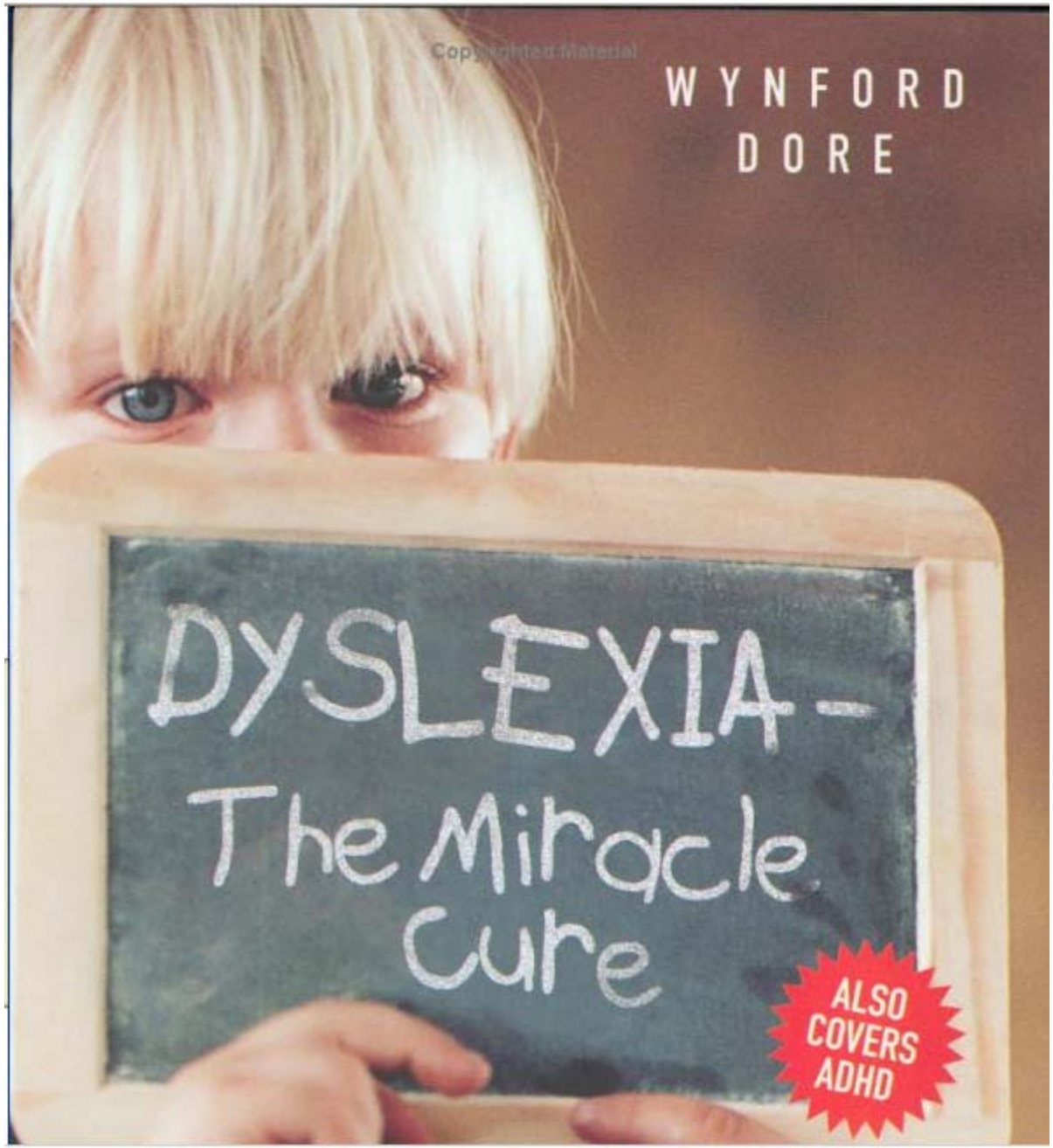
- Reluctance of practitioners to have untreated (or placebo) control group
- But only logical if you already know that there are benefits to treatment that outweigh costs
- Parallels in physical medicine suggest dangerous to assume this – e.g. congestive heart failure treatment; home care thought unethical, but worked better than intensive care!

Methodological problems

- Difficulties of demonstrating efficacy of intervention
- Many other factors can influence outcomes:
  - maturation
  - placebo effects
  - practice effects
  - regression to the mean
  - drop-out from study

Two illustrative examples

- DDAT (Dyslexia, Dyspraxia, and Attention Deficit training)
- Fast Forword (FFW)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DORE
DYSLEXIA -
The Miracle
Cure
ALSO
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ADHD

DDAT

- Developed by Wynford Dore – British millionaire with dyslexic daughter
- Basic idea is that cerebellum is implicated in dyslexia
- Cerebellum also implicated in motor learning/balance/co-ordination
- Motor/balance training will improve dyslexia

http://www.dore.co.uk/

What does DDAT involve?

- Hard to be sure because “commercially sensitive”
- Claim that exercises were developed by NASA for astronauts – claim denied by NASA*
- Simple exercises with wobble boards, beanbags, etc. to train co-ordination and balance; 5-10 mins, 2 x day

**http://www.guardian.co.uk/uk_news/story/0,,1939287,00.html*

2 papers published in Dyslexia (peer-reviewed journal)

- Paper 1: Reynolds, et al (2003). *Dyslexia, 9*(1), 48-71.
  - Accompanied by 8 critical commentaries; led to resignation of one member of editorial board
- Paper 2: Reynolds & Nicolson
  - Appeared on-line Nov 06; at least one critical commentary to be published; publication led to resignation of 5 more members of editorial board

Study 2: Reynolds & Nicolson, 2006

Participants: all score .4 or more on Dyslexia Screening Test

First intervention (group I)

- 10 male; 8 female
- age 7;11 to 10;06

Pre-existing diagnoses

- 4 dyslexia
- 1 dyspraxia
- 0 ADHD
- 7 had extra help

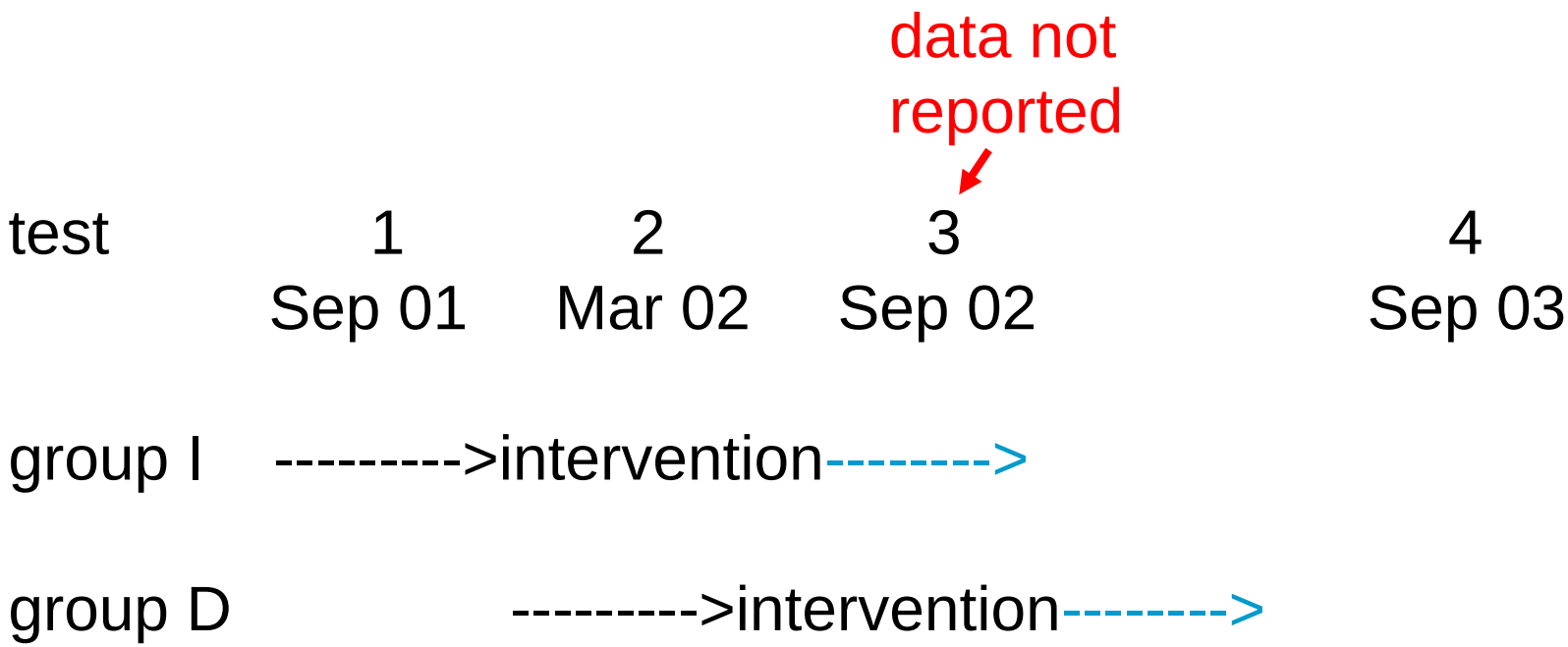
Delayed intervention (group D)

- 9 male; 8 female
- age 8;0 to 10;05

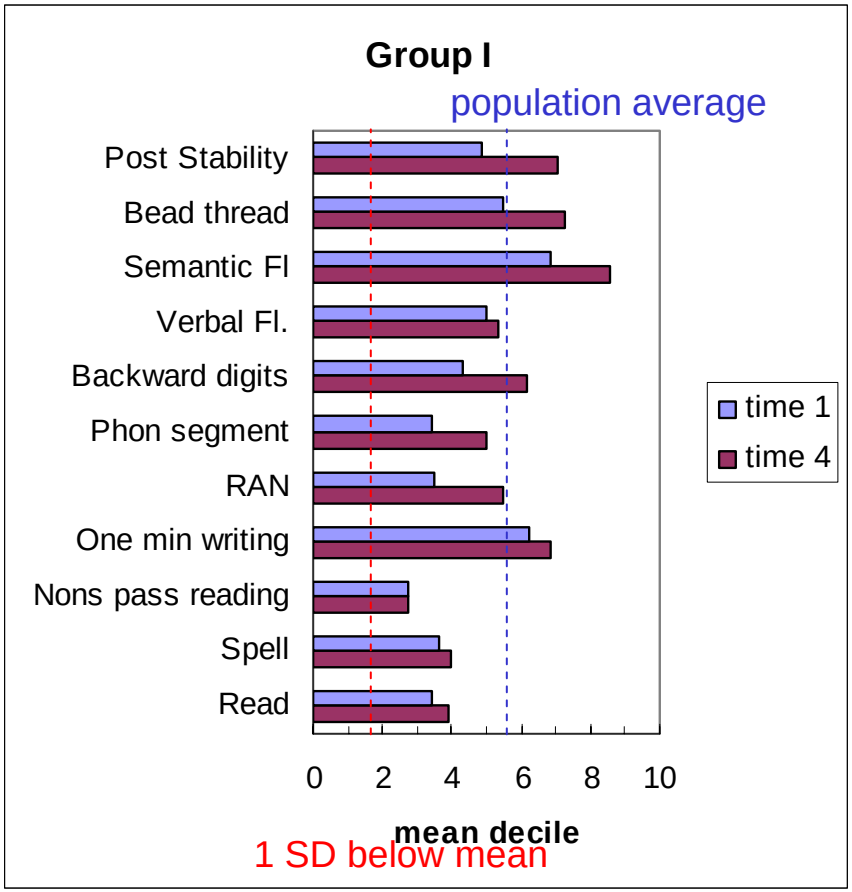
Pre-existing diagnoses

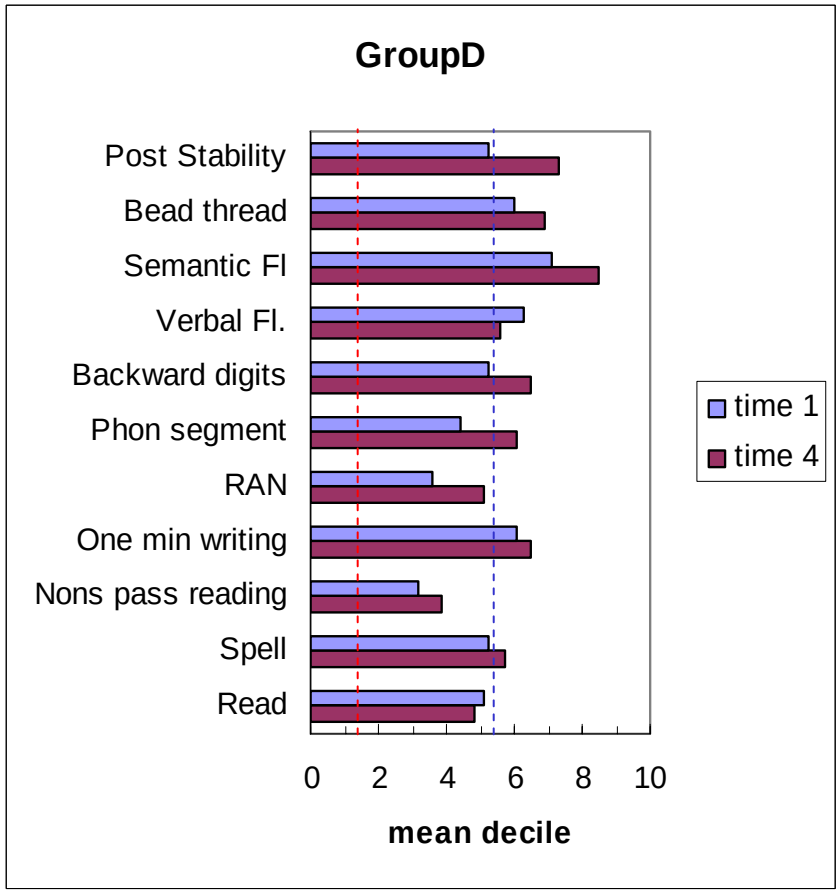
- 2 dyslexia
- 1 dyspraxia
- 1 ADHD
- 5 had extra help

Timeline of study



Results on dyslexia screening test, time 1 and time 4

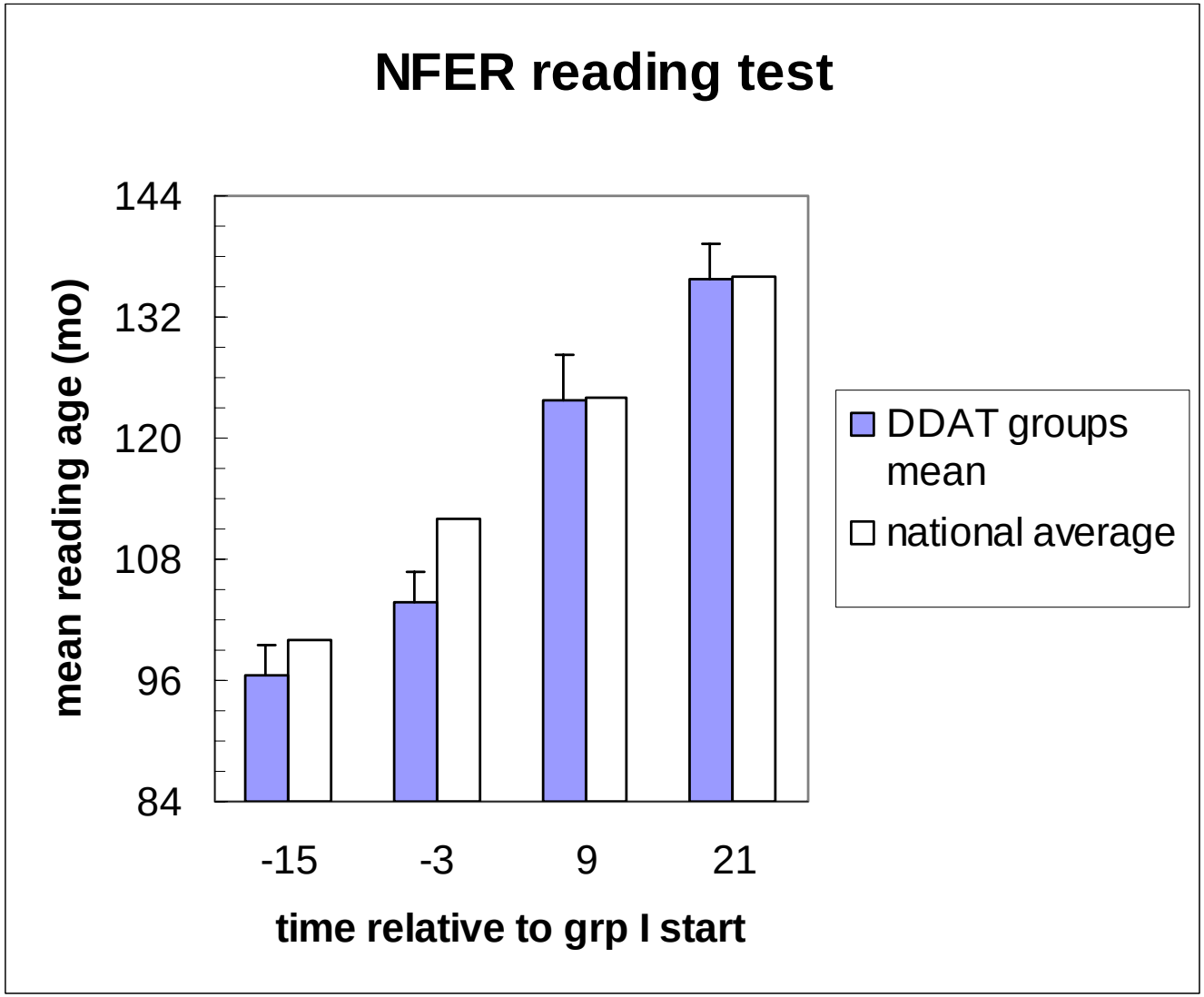




Note:

Lack of progress on literacy tests

Anomalous deciles (population mean 5.5)



NB. No control for: practice effects, placebo effects, regression to the mean

Those with diagnoses of dyslexia/dyspraxia shown separately

D. Reynolds and R.I. Nicolson

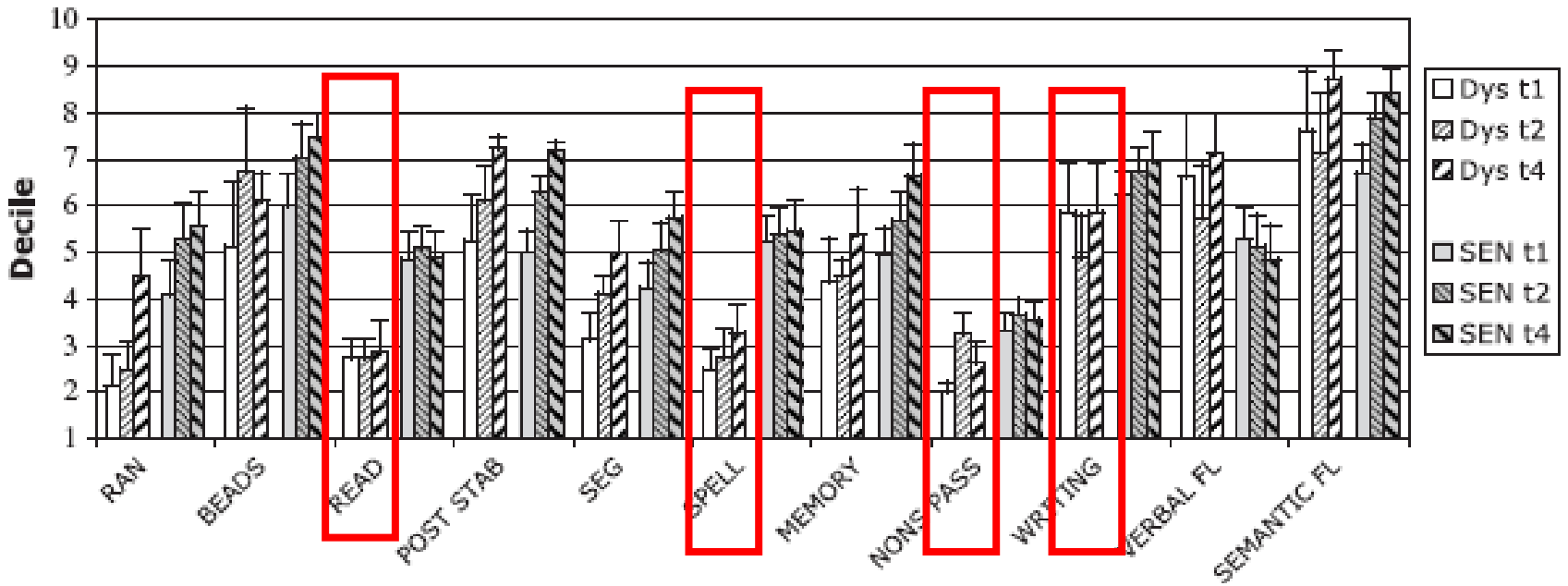


Figure 2. Changes over time of the DST sub-tests as a function of formal diagnostic category (error bars are standard errors)

Parent/teacher attention ratings (data reported in discussion)

- 9 item questionnaire to teachers and parents
- Score of 6 or more ‘indicative of ADHD’
- Mean score at T1 4.67, T4 1.93
- 46% scored 6+ at T1 cf. 8% at T4.
- “Clearly there was a very marked (and continuing) improvement in attentional abilities following the treatment”

Reynolds and Nicolson, conclusions

- “The exercise treatment was indeed associated with significant and lasting improvements that were maintained (and in some cases strengthened) even after the formal exercise programme terminated.”
- “There was little relative improvement on the ..reading and spelling tests on the DST. This is perhaps puzzling in that there were strong improvements in the NFER reading test”.

Reynolds and Nicolson, conclusions

- “If it is indeed the cerebellar deficits that are causing the literacy problems, and the exercise programme eliminates those cerebellar problems, why do not the dyslexic group improve more than the non-dyslexic group? The data seem to suggest that the exercise treatment is beneficial even for those without manifest cerebellar problems.”

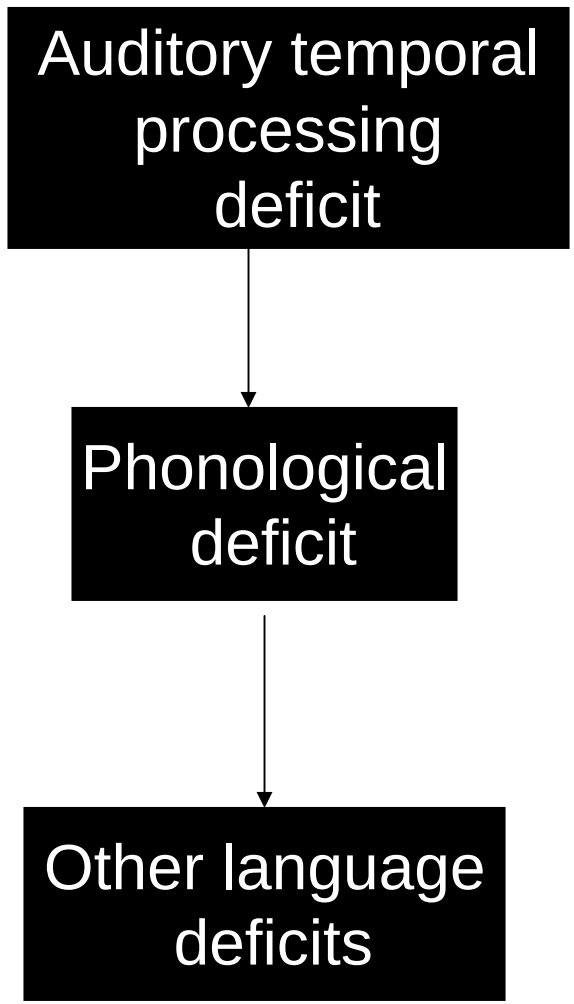
Points to note

- Lack of control group means it is impossible to know if any improvement caused by intervention
- And in any case, remarkably little change in literacy test scores when expressed as deciles

FastForword

FFW: based on Tallal's theory:

Specific language impairment (SLI) as downstream consequence of low-level perceptual deficit



N.B. Theory also extended to developmental dyslexia

Implications for intervention

- May be able to remediate higher-level language problems AND literacy problems by training auditory perceptual skills
- FastForWord® - computerised training
  - developed by Tallal and colleagues;
  - very intensive; 90 min x 5 day/wk x 6 wk
  - uses speech that is modified to make brief/low intensity portions more salient

Initial trials of FFW prototype

- Merzenich, M. M., Jenkins, W. M., Johnston, P., Schreiner, C., Miller, S. L., & Tallal, P. (1996). Temporal processing deficits of language-learning impaired children ameliorated by training. *Science, 271*, 77-81.
- Tallal, P., Miller, S. L., Bedi, G., Byma, G., Wang, X., Najarajan, S. S., Schreiner, C., Jenkins, W. M., & Merzenich, M. M. (1996). Language comprehension in language-learning impaired children improved with acoustically modified speech. *Science, 271*, 81-84

Merzenich/Tallal 1996: Study 1

- Seven children aged 5 to 9 years
- Two types of training:
  - i) sound discrimination
  - ii) language training with modified speech

Sound training

- 1. Sequence game: child had to reproduce order of 2-sound sequences
  - Sounds were glides that moved up or down (analogous to formant transitions)  
- 2. Phonetic element recognition
  - e.g. /be/ vs /de/ in rapid sequence; had to identify position of /be/; varied consonant duration and intensity

Correct performance rewarded; task made harder as child improves

Modified speech

- duration of signal prolonged by 50% while preserving spectral content
- fast transitional elements amplified by up to 20 dB
- gives speech envelope that is more sharply segmented

Modified speech

- training 3 hr/day 5 day/week in lab
- plus 1-2 hr/day 7 day/week at home
- exercises involved computer games plus listening to stories that were acoustically modified

Results

- comparison of pretraining and post-training 6 weeks later
- all 7 children “approaching or exceeding normal limits for their age in speech discrimination and language comprehension”

Merzenich/Tallal: Study 2

- 22 language-impaired children aged 5 to 10 yr
- divided into 2 matched groups on nonverbal IQ and receptive language
- ‘control’ group did not do sound discrimination training
- both groups did language exercises, but control group had unmodified speech

Study 2: results

- trained on 7-22 session of 20 mins
- 10/11 improved on sound discrimination
- language improved pre- to post-test in all, but greater improvement in those who had modified speech

More recent developments

- FFW now recommended for:
  - children with reading difficulties
  - children with autistic disorder
  - children with ADHD
  - typically-developing children
  - the elderly
  - acquired aphasia

don't have the auditory deficits FFW designed to treat

Is auditory training effective?

- Difficult to know because
  - FFW involves complex battery of tasks; unclear which are crucial
  - Could be intensity of the intervention, rather than auditory aspect, that is critical
  - Published reports in Science not a randomised controlled trial (RCT)

CONSORT criteria for evaluating intervention studies

- Altman, D. G., Schulz, K. F., Moher, D., Egger, M., Davidoff, F., Elbourne, D., Gotzche, P. C., & Lang, T. (2000). The revised CONSORT statement for reporting randomized trials: explanation and elaboration. *Annals of internal medicine, 134*, 663-604.

Requirements for a clinical trial

1. State criteria for inclusion in study

M&T account is vague. Gives some information on IQ, social, and language status of children but does not state how they were recruited. Says they all had "marked temporal processing deficits", but unclear how this defined. N.B. Only a minority of children with SLI/dyslexia have such deficits

Requirements for a clinical trial

2. Need for a control group
   – crucial to check if improvement due to placebo effects or practice effects

   M&T : no control group in study 1;

   do have control group in study 2, but they seem to have had less training than the intervention group (no sound discrimination)

   subsequent reports on FastForword: no control group (e.g. Tallal, 2000)

Requirements for a clinical trial

3. State how participants assigned to groups; important to avoid bias
   - Random allocation preferred
   - Allocation by someone who has not met the child

M&T give no information on this point

Requirements for a clinical trial

4. Testers are blind to group status
   - Pre- and post-testing should not be done by the person doing the training
   - Person doing testing unaware of group the child was in

M&T give no information on this point

Requirements for a clinical trial

5. Provide information on drop-outs
   - – can be a potential source of bias
   - – drop-outs are unlikely to be random;
   - – more likely to be either:
     - children who are not making progress
     - those who don't have much wrong with them to start with
   - – drop-out information also important for evaluating clinical feasibility of method

M&T give no information on this point

Editorial: Nature Neuroscience 2004, vol 7, no 1.

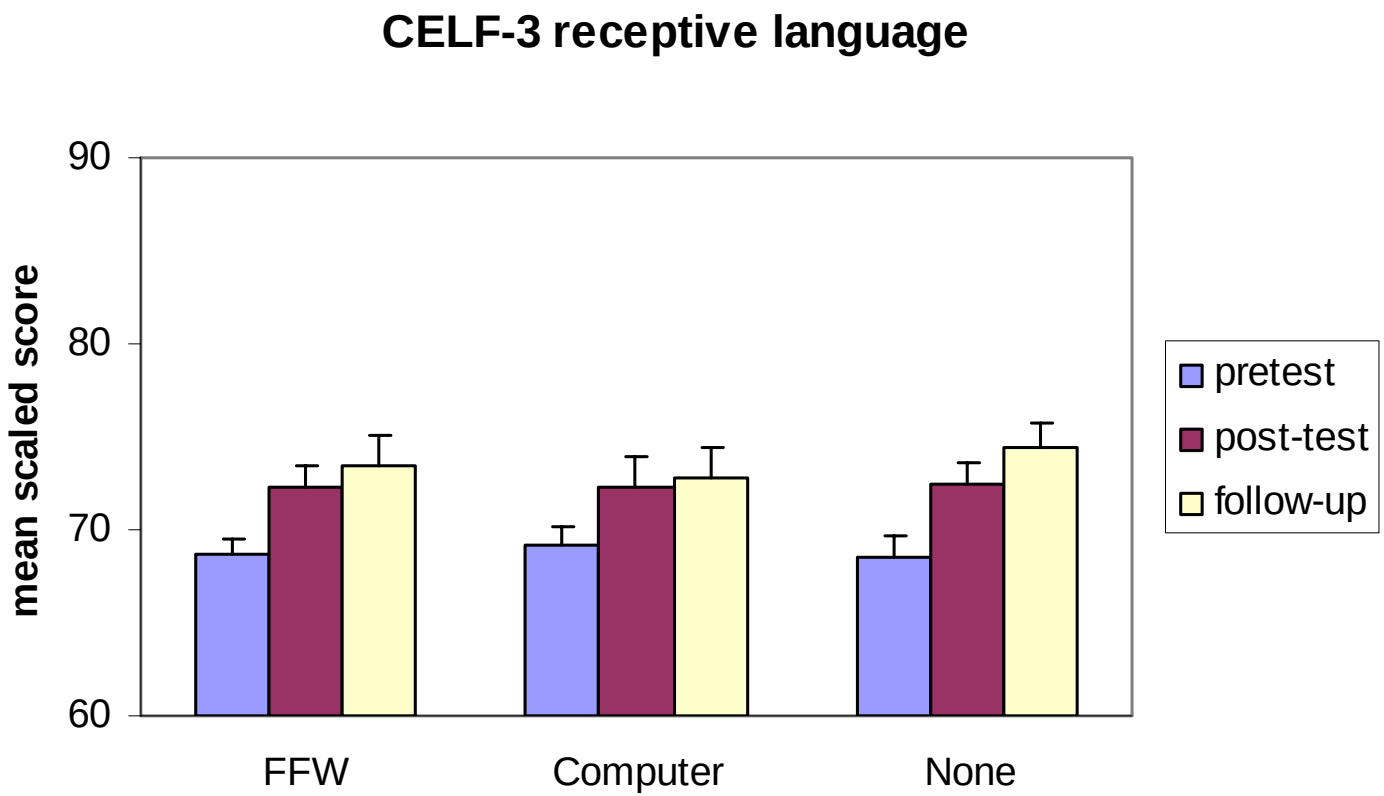
- “Although these are promising results.... studies in peer-reviewed publications have had a relatively small number of subjects compared with those that would be required for a new drug”
- Notes also that revenue of Scientific Learning Corporation in 3rd quarter of 2003 was 8 million US dollars

Controlled studies on FFW

- Cohen, W., et al (2005). Effects of computer-based intervention using acoustically modified speech (Fast ForWord-Language) in receptive language impairment: Outcomes from a randomised controlled trial. *Journal of Speech, Language and Hearing Research, 48*, 715-729.
- Pokorni, J. L., et al. (2004). Phonological awareness intervention: A comparison of three programs-Fast ForWord, Earobics, and LiPS. *Journal of Educational Research, 97*, 147-157.
- Rouse, C., & Krueger, A. (2004). Putting computerized instruction to the test: a randomized evaluation of a 'scientifically based' reading program. *Economics of Education Review, 23*, 323-338.
- also large NIH study by Gillam et al, not yet published

Cohen et al, 2005: RCT

23 children with parent-administered FFW
27 with other computerised training
27 with no additional intervention



Troia and Whitney (2003) Contemporary Educational Psychology, 28: 465-494

- nationally, over 65 000 children have been trained on FastForWord®
- in their school, 24 children did program
  - site licence for school $40 000 per yr
  - $450 per child
  - funds diverted from other priorities
  - 24 computers set aside for FFW
  - 2 staff coaches
  - children missed 2000 min classroom literacy instruction while doing the program

FFW conclusions

- When RCT design used, shows everyone gets better, treated or not
- Tendency to assume gains are real improvements
- Improvement in untreated suggest gains are due to practice or regression to the mean