DIFFERENTIAL EFFECTS OF SPELLING AND READING DEFICITS IN THE PHONOLOGICAL BRAIN NETWORK

Agnieszka Dębska, Katarzyna Chyl, Gabriela Dzięgiel, Agnieszka Kacprzak, Magdalena Łuniewska, Joanna Plewko, Artur Marchewka, Anna Grabowska, Katarzyna Jednoróg
Laboratory of Psychophysiology, Nencki Institute of Experimental Biology, Warsaw Poland
DYSLEXIA
READING AND SPELLING IMPAIRMENT

"Wuh-huh-I-lE"
"Wuh-huh-ly"
"Wuh-hilly"

"WHILE"

I have dis...
dislok...
disloc

I can't spell

© Sarah Major
Phoneme-to-grapheme conversion necessary for reading and spelling

Ability to recognize phonemes in the words: phonological awareness
Phonological deficit – as a powerful developmental dyslexia predictor
ABNORMALITIES IN THE PHONOLOGICAL BRAIN NETWORK ASSOCIATED WITH THE SPELLING AND READING DEFICITS

Pugh et al. 2001
Beeson et al. 2004
Gebauer et al. 2012
PURPOSE OF THE STUDY:

TO SEPARATE NEURAL AND BEHAVIOURAL SIGNATURES OF SPELLING AND READING DEFICITS
Battery of normalised tests for dyslexia diagnosis

- Controls: N = 65, age = 10.26
- Spelling deficit: N = 30, age = 10.40
- Reading deficit: N = 20, age = 10.05
- Reading and Spelling Deficit: N = 55, age = 10.29

3 phonological auditory tasks

SPELLING DEFICIT EFFECT

READING DEFICIT EFFECT

TWO-WAY ANOVA
THE GROUPS DISTRIBUTION IN READING AND WRITING SKILLS

**Reading**: factor score from four reading tests (sight word, pseudoword, with lexical decision, text reading)

**Spelling**: Accuracy percent from the spelling test (dictation)
1. **PSEUDOWORDS MATCHING**
e.g.: TOL – TOL  LIK – LAM

2. **RHYMING**
e.g.: BOWANE - GAPANE  PUTKA - KOFAK

3. **INITIAL PHONEME MATCHING**
e.g.: TERKO – TERFAT  KORFA - LIKFA
DRAGONS: BEHAVIOURAL RESULTS

PSEUDOWORDS MATCHING
MAIN SPELL, ** $\eta^2=0.07$

RHYMING
MAIN SPELL, *** $\eta^2=0.1$

INITIAL PHONEME MATCHING
MAIN SPELL, *** $\eta^2=0.1$
GROUPS WITH SPELLING DEFICIT PERFORMED WORSE IN A SIMPLE PHONOLOGICAL TASKS

**PHONEME DELETION**

Main spell, \( \eta^2 = 0.04 \)
Main read, \( \eta^2 = 0.14 \)
Comparison of the main reading deficit and main spelling deficit effects in phonological tasks.

Main READING DEFICIT EFFECTS

L IPL
L SMG/PostC
R MTG

FIRST PHONEME MATCHING

Main SPELLING DEFICIT EFFECTS

R IFG
L VOT
(Visual Word Form Area)

No deficit Reading > Deficit Reading
Deficit Reading > No deficit Reading
No deficit Spelling > Deficit Spelling
Deficit Spelling > No Deficit Spelling

p<0.005, cluster corrected
Supramarginal, PostCentral
Inferior parietal
Superior temporal
Ventral occipito-temporal

Inferior frontal
Middle temporal
Inferior parietal
Supramarginal, PostCentral
Superior temporal
Ventral occipito-temporal

UNDERACTIVATIONS: MAIN READ DEFICIT EFFECTS
UNDERACTIVATIONS: MAIN SPELL DEFICIT EFFECTS
OVERACTIVATIONS: MAIN READ DEFICIT EFFECTS
OVERACTIVATIONS: MAIN SPELL DEFICIT EFFECTS
Conclusions:

1. **Spelling deficit**: underactivation of the left ventral occipito-temporal region (orthographic representations)

2. **Reading deficit**: underactivation of temporoparietal regions (phoneme-to-grapheme conversion)

3. Different compensatory areas in the right hemisphere for spelling and reading deficits

4. **Behavioural**: Spelling is more vulnerable to the phonological deficit than reading

Limitations & future research:

Cognitive basis of isolated spelling and reading impairment – more research needed in different orthographies
THANK YOU!
WORD READING

MAIN SPELL, *** $\eta^2=0.08$
MAIN READ, *** $\eta^2=0.49$

SPELLING

MAIN SPELL, *** $\eta^2=0.26$
MAIN READ, *** $\eta^2=0.09$

PHONEME DELETION

MAIN SPELL, ** $\eta^2=0.04$
MAIN READ, *** $\eta^2=0.14$

SYLLABLE ANALYSIS

MAIN SPELL, *** $\eta^2=0.09$
Segmentation: paediatric tissue probability maps (Template-O-Matic toolbox)

Smoothing: 8 mm

Movement correction: movement threshold 3 mm, rotation 0.05 radians (based on Raschle et al., 2012). Subjects were included if a minimum 80% of volumes were artefact-free (ART toolbox)

Significance: results are reported at a significance level of $p < 0.005$ uncorrected, and extent threshold of 50 voxels (correction for multiple comparisons, based on Monte Carlo method)