Training takes time: Plasticity in adults’ dyslexic brains

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Introduction

• Impaired auditory processing: critical role in dyslexia
  ➢ as indexed in dyslexic adult MMN and MMF studies:
    - Baldeweg et al. (1999): decreased & delayed MMN peaks to frequency (not duration) changes in tones
    - Schulte-Körne et al. (1999), (2001):
      ➢ increased MMN to temporal changes in tonal patterns (duration) and decreased (UMMN to synthetic speech (not frequency changes in tones) (2001)
    - Kujala et al. (2003): decreased MMN to sound-order reversal (tones) with following sound (< backward masking interference), no difference to single tones / preceding additional sound
    - Renvall & Hari (2003): diminished left-ear hemispheric MMFs to tones (frequency)
  ➢ controversy discussion:
    basic auditory impairment or specific phonological dysfunction?

Method

Subjects & Setup

• young dyslexic adults, n=10, mean age: 18.6 years, 6 male & 4 female (n=5 in recording session 4, 1 male & 4 female)
• four electrophysiological recording sessions:
  1. baseline (before training)
  2. after 6 months of training
  3. after 3 months of intermission
  4. after another 6 months of training
• 13 Ag/AgCl-electrodes according to the extended 10-20-system:
  Fz, Cz, F3, F4, F7, F8, T3, T4, C3, C4, P3, P4, M1, M2 (DEG & EEG)
• Synamps, Scan (Neuroscan), 1000Hz sampling rate, on-line filters: band-pass 0.5-200Hz, off-line filters: band-pass 0.6-200Hz, on-line reference: FCz, off-line re-referenced: linked mastoids, ocular corrected, artifacts rejected if +/- 150µV

Training & Objectives

• Can an intensive training of deficient auditory discrimination abilities in young dyslexic adults induce neurofunctional changes in non-verbal and verbal auditory perception?
  ➢ Individual Auditory Discrimination Training (IADT®)
    ➢ based on individual audiograms, 10 frequency-rich pieces of music were individually molded (3-5 times during intervention)
    ➢ subjects listened to the compositions for 15 min per day
    ➢ 15-months-long period, incl. 3 months of intermission
    ➢ aim: strengthening of the auditory sensitivity in speech-relevant frequencies

Stimuli

• passive odflb: constant ISI 500ms, at a constant 75dB (sine tones), n=400 stimuli (incl. two deviants, p=10% each) / block
• duration: tones = 100ms (incl. 10ms rise & fall) & verbal = 400ms
• three conditions:
  1. sine tones (optimal hearing range)
     std: 1800Hz, dev1: 2000Hz, dev2: 2200Hz
  2. sine tones (decisive in consonant discrimination)
     std: 3600Hz, dev1: 4000Hz, dev2: 4400Hz
  3. verbal (naturally spoken)
     std: AMA, dev1: ANA, dev2: ALA

Results

Non-verbal: 1800Hz vs. 2200Hz (Grand Average)

Non-verbal: 3600Hz vs. 4400Hz (Grand Average)

Verbal: AMA vs. ALA (Grand Average)

Discussion

• IADT® induced a substantial reorganization in basic central auditory functions
• a transfer effect of this reorganization was observed also for the auditory processing of verbal stimulation
• this suggests an auditory impairment of very basic processes to play a decisive role also in disturbed phonological processing in dyslexia
• despite IADT® being based on frequency modulations in musical pieces, it induced neurofunctional changes in the processing of verbal and non-verbal conditions
• durable plastic changes in auditory functions are evocable, if IADT® is insistently undertaken for a long-lasting intervention under controlled conditions

Literature & Framework

This study was supported by:
Finland’s Slot Machine Association, RAY
awarded to the Dysexia Assosiation in YtS-Savo, Finland

Kujala T. et al. (2003). Auditory sensory memory disorder in dyslexic adults as indexed by the mismatch negativity. European Journal of Neuroscience 17, 1243-1257

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