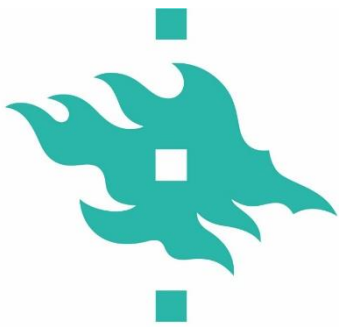


# Speech processing deficits in newborns with a familial risk of dyslexia

Thiede, A., Virtala, P., Ala-Kurikka, I., Partanen, E., Huotilainen, M., Mikkola, K., Leppänen, P., & Kujala, T.

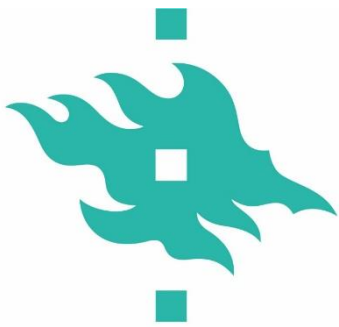
*Presented at Symposium „Dyslexia, brain and cognition – current questions“, University of Helsinki, November 2017*



# Motivation

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- Developmental dyslexia is heritable
  - Elevated risk for infants with affected parents to develop dyslexia
- familial risk can lead to deficient speech sound processing (Leppänen et al., 2002; van Leeuwen et al, 2008)
- These ERPs in early infancy have been associated with future language development (Leppänen et al, 2012; Schaadt et al, 2015; Cantiani et al., 2016)
- Abnormalities in ERPs could help to identify infants at highest risk for future adverse outcomes
  - **investigation of the neural basis of speech sound processing in predisposed infants at birth**



# Background

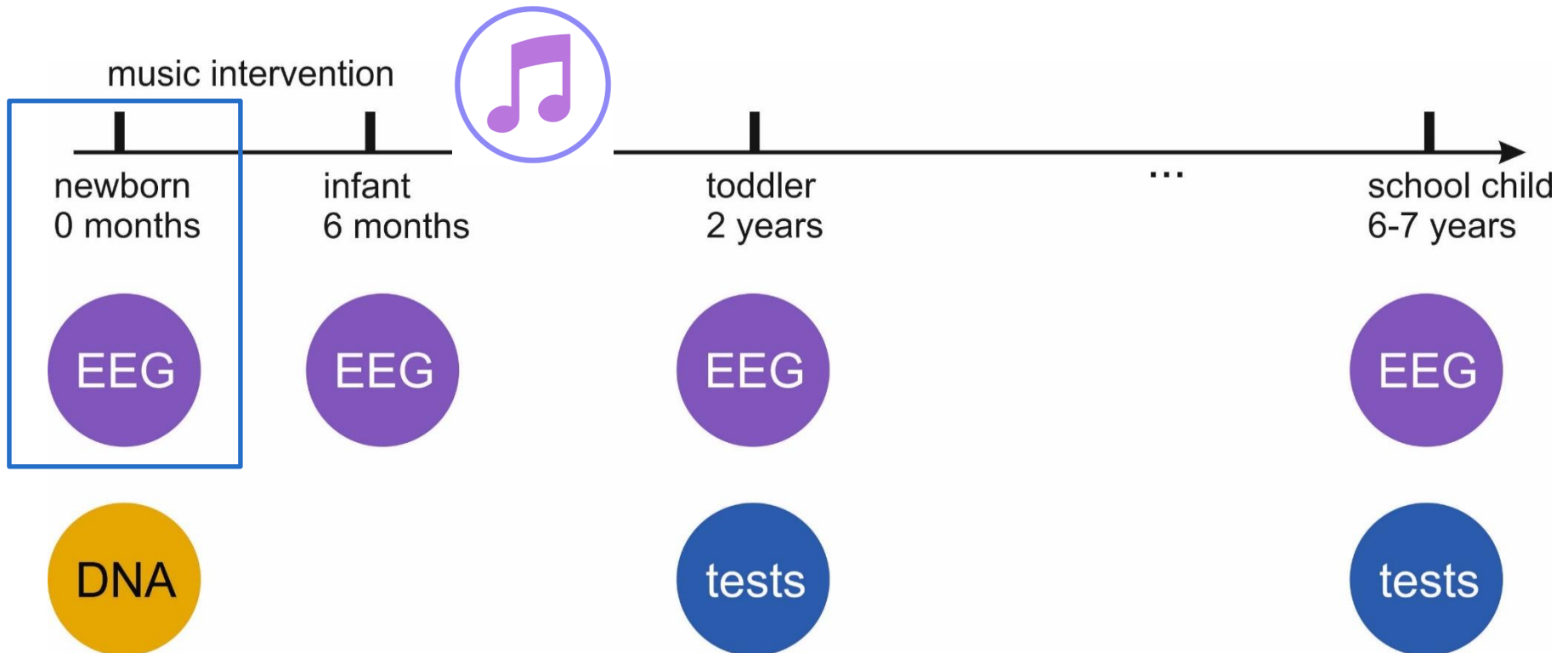
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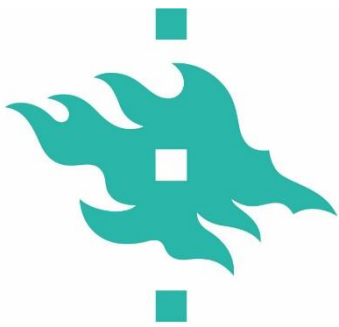
- Newborn infants are able to discriminate auditory and speech sound features
  - frequency and duration deviations in tones (Leppänen et al., 1997; Čeponiene et al, 2002)
  - duration deviations in pseudowords (Kushnerenko et al, 2001; Partanen et al, 2013)
  - vowel identity (Cheour-Luhtanen et al, 1995; Cheour-Luhtanen et al, 1996; Partanen et al, 2013)
- Dyslexic adult individuals have shown diminished MMNs to speech sound changes, indicating deficient auditory discrimination (Kujala & Näätänen, 2001)
- Infants with a familial risk have exhibited atypical MMRs to speech sound changes (Leppänen et al, 2002; van Leeuwen et al, 2008)



# Participants

150 newborns with familial risk for dyslexia + 50 controls





# Participants

## 88 newborn infants

### High-risk group (44)

- selected based on parents' questionnaires, interviews, and test performance (Nevala et al., 2006)
  - Text, word, and pseudoword reading & writing speed
  - "Moderate to severe" dyslexia, when below-norm performance ( $-2$  SD) in two or more subtests
  - report of reading- and writing-related difficulties in childhood
- infants at high risk

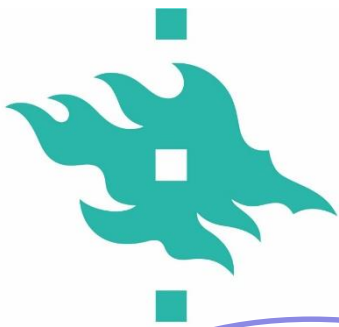
### Control group (44)

- no dyslexic parent
- No childhood anamnesis of reading- or writing-related difficulties



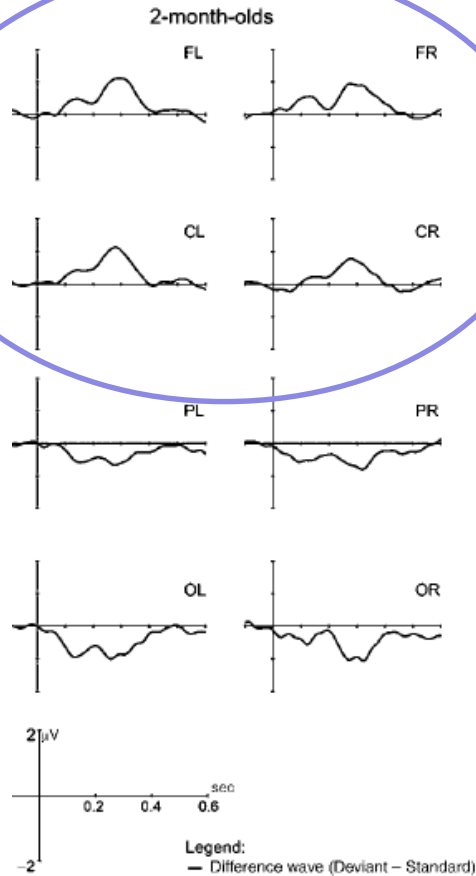
newborn Ebba is recorded with EEG

Groups matched for gender, gestational and measurement age, and mother's education



# Methods

## Infant MMR



He et al., 2007

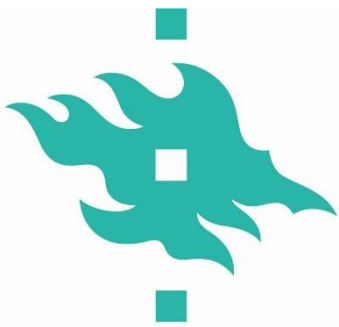
### infant MMR can be positive instead of negative

(Leppänen et al., 1997; He et al., 2007)

- different factors play a role, e.g. sleep stages, maturity, or inter-stimulus presentation rates (Kushnerenko et al., 2013)
- Negative infant MMRs have been suggested to indicate maturity (Mueller et al., 2012)

We obtain:

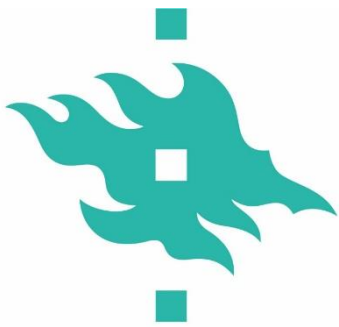
- MMRs to speech sound changes in pseudoword /tata/
- Deviants: duration, frequency, vowel



# Preliminary results

## ERPs to standard stimulus /tata/

- Broad positivity-negativity complex
- Early positivity:
  - central channels larger amplitudes than frontal channels
  - laterality x group interaction effect: positive responses larger over the right than left in control group

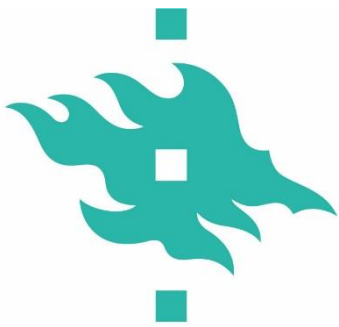


# Preliminary results

## MMRs to speech sound changes

- Negativity-positivity complex to both duration and frequency changes
- Broad positive MMR to vowel changes

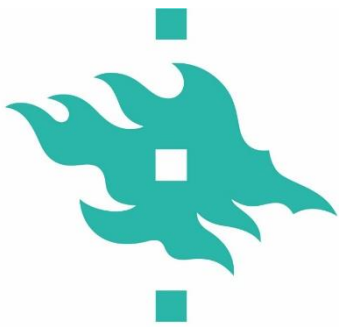




# Preliminary results

## MMRs to duration changes

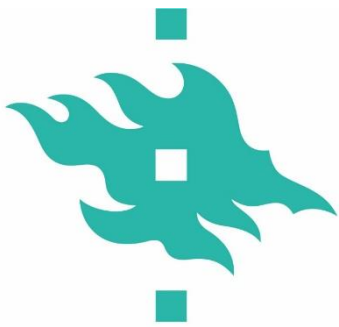
- Group differences:
  - Early negativity larger in control than high-risk group
- Hemispheric effects:
  - Late positivity larger on left than right channels in high-risk group



# Preliminary results

## MMRs to frequency changes

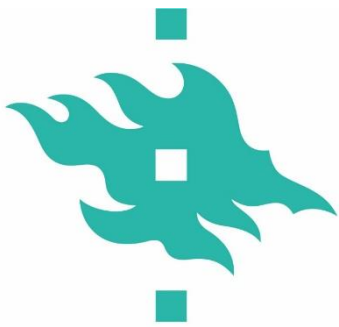
- Group differences:
  - Early negativity larger in control than high-risk group
  - Late positivity larger in high-risk than control group over left hemisphere
- Hemispheric effects:
  - Late positivity in high-risk group larger over left than right
  - Late positivity in control group larger over right than left



# Preliminary results

## MMRs to vowel changes

- Group differences:
  - Positivity larger in control than high-risk group
- Hemispheric effects:
  - Positivity larger at right than left channels in control group



# Summary

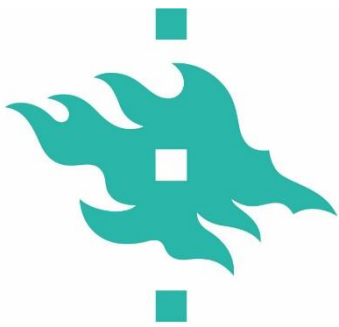
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## Group differences

- Early negativity to duration and frequency changes diminished in high-risk infants
- Late positivity to frequency changes larger in high-risk than control group
- Positivity to vowel changes diminished in high-risk infants

## Hemispheric effects

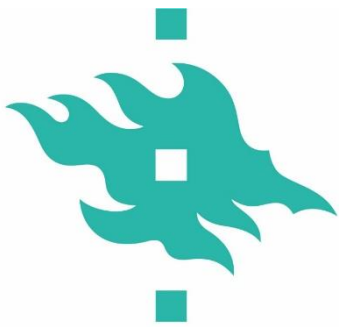
- right-lateralized processing of pseudoword in control infants
- right-lateralized discrimination of frequency and vowel changes in speech sounds in control infants
- left-lateralized discrimination of duration and frequency changes in high-risk infants



# Discussion

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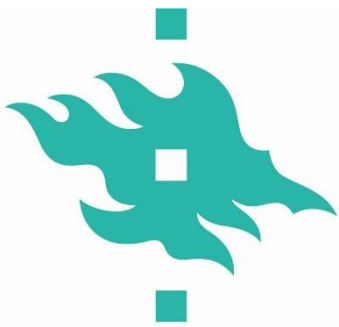
- Diminished or absent negative MMRs could indicate less mature processing of duration and frequency changes in high-risk infants (Mueller et al., 2012)
- Vowel changes elicit positive MMRs in both groups
  - possibly indicating that it is a more difficult change to discriminate overall
  - high-risk infants have diminished responses
- Frequency changes do elicit a negative MMR in control group and a positive MMR in high-risk infants
  - sign of more mature discrimination in no-risk infants
- Hemispheric effect: right-lateralized discrimination in control group, left-lateralized discrimination in high-risk group
  - later typical readers showed right-lateralized MMRs and later reading impaired left-lateralized MMRs to frequency changes at newborn age (Leppänen et al., 2010)
  - later typical readers showed right-lateralized MMRs to CVC syllables at 2 months of age (van Zuijen et al., 2013)



# Take home

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- Familial risk of dyslexia manifests itself in deficient speech sound processing already at birth.
- MMRs to speech sound changes of high-risk newborns were diminished, absent, or of different polarity.
- The MMR of high-risk newborns was stronger on the left, while that of controls was stronger on the right.
- These results may contribute to the development of infant interventions supporting language-related skills.



# Thank you *Lukivauva* team!



<https://lukivauva.com/>



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