Intervention induced reconfiguration of functional brain networks in dyslexic readers

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1. Quantify changes in structural and functional brain networks within dyslexic readers, induced by an intervention with known and established behavioural effects.2. Examine whether short brain activity acquisition (5-8 minutes) of the resting state...

Ethical review	Approved WMO
Status	Will not start
Health condition type	Other condition
Study type	Observational invasive

Summary

ID

NL-OMON35622

Source
ToetsingOnline

Brief title
Developmental dyslexia, intervention and the adaptive brain

Condition

- Other condition

Synonym
Developmental dyslexia, wordblindness

Health condition

specific learning disability

Research involving
Human

Sponsors and support

Primary sponsor: Radboud Universiteit Nijmegen
Source(s) of monetary or material Support: Ministerie van OC&W,Regionaal Instituut voor Dyslexie

Intervention

Keyword: Complex network analysis, Complexity science, Developmental dyslexia, Fractal physiology

Outcome measures

Primary outcome

1. Measures derived from complex network analysis, spectral analysis of

different frequency bands, and recurrence quantification analysis are generally

expected to converge on:

- less scale-free organization in dyslexic readers' brain networks when

compared to average reading peers.

- deviations from 1/f noise (f.i. towards white noise or Brownian noise) in the

time series of dyslexic readers' brain activity when compared to average

reading peers.

- more random or laminar attractor dynamics of the functional network of

dyslexic readers when compared to average reading peers.

2. The expected organization characteristics sketched in 1 are hypothesized to

be present most clearly in the tasks that require most integration of component

processes.

3. Within-subject analyses over the three measurement occasions are expected to

reveal more scale-free organization in those participants who benefit from the intervention. Moreover, for those participants the observation of scale-free organization is expected to increase in tasks that require highest level of integration of component processes.

Secondary outcome

na

Study description

Background summary

The study is set up against the background of three emerging theoretical fields in neuroscience: complex network analysis of brain activity, the brain as part of a complex dynamical system (brain-body-environment system) and the analysis of resting state brain activity. Related to developmental dyslexia the following

1. Variability in repeated measures of cognitive performance in developmental dyslexia are indicative of impaired coordination dynamics at the micro-scale level of emergent (neuro-)physiological synchronization.

2. A wide range of structural anomalies in the organization of brain networks have been associated with developmental dyslexia. Intervention induced changes in structural connectivity have been reported.

3. A wide range of functional anomalies in patterns of activation of brain networks have been associated with developmental dyslexia. Intervention induced changes in functional connectivity have been reported.

4. Synchronization and coordination of physiological processes in body and brain have been shown to develop naturally from independent component dynamics towards interdependent scale-free, interaction dominant dynamics. Such dynamics signify health and wellbeing of body and mind, fuency and proficiency of (cognitive) performance. Change towards metastable dynamics can be induced by means of medical and behavioural intervention. Change away from metastable dynamics can be induced by disease and constraints of structural system organization and the environment.

5. Studying the changes in structural and functional complex brain networks

induced by an intervention program known to cause behavioural changes in developmental dyslexia allows for the study of micro-to-macro scale emergence of behavior, as well as the macro-to-micro constraining of structural and functional networks induced by an intervention program: An inquiry into learning and plasticity.

The three major hypotheses derived from the framework above are:

1. Based on results obtained in our fuency and dispersion studies of impaired reading: Complex networks obtained from resting-state activity of dyslexic readers should show deviations from scale-free network organization.

2. Based on our studies showing that practice improves emergent coordination dynamics: Within subject comparison of measurement occasions should reveal network reconfiguration associated to behavioural improvement.

3. Based on our studies showing trade-offs across multiple scales of coordination that depend on low-level principles of energy minimisation and high-level task constraints: A hierarchy of connectivity changes associated with component processes of reading is expected with processes demanding highest integration and coupling between components to be the most resistant to change.

Study objective

1. Quantify changes in structural and functional brain networks within dyslexic readers, induced by an intervention with known and established behavioural effects.

2. Examine whether short brain activity acquisition (5-8 minutes) of the resting state can reveal structural differences between dyslexic and average readers.

3. Examine whether a characterisation of the structure*function interaction or coupling of such networks within dyslexic readers provides insight into differences in resistance to intervention between dyslexic readers.

4. Examine bi-directional association of micro-scale changes in brain networks to macro-scale behavioural changes.

Study design

Three groups of 15 participants aged 10-12 years of age, will take part in the study:

1. ListEnter: Clients who enter the waiting-list, that have just been diagnosed with developmental dyslexia.
2. ListLeave: Clients who are leaving the waiting-list and are about to start the intervention program.
3. Classroom: A control group of children sampled from the classrooms of the participants diagnosed with developmental dyslexia.

All groups (total N=45) will be measured at least three times, the ListLeave group ideally start the first measurement within the same month as the ListEnter group and thus serves as a natural *no-intervention* control group to the ListLeave group. As soon as a client in the ListEnter group leaves the waiting-list to start the intervention program, their second measurement will be performed.

Records of brain activity will be acquired using Magneto Encephalo Graphy (MEG). After each measurement occasion a structural image will be acquired (for co-registration purposes), using Magnetic Resonance Imaging (MRI). This is warranted by the developing brains of the young participants in this study.

Structure: Resting-state
Analysis of resting state brain-activity enabled a majority of the reported complex brain network studies to distinguish between experimental groups (hypothesis 1). The proposed design allows for the first time assessment of within subject structural changes induced by intervention (hypothesis 2). Acquisition of resting-state activity is straightforward and involves the participant closing his or her eyes for 5 to 8 minutes. The present study will sample resting-state MEG at the beginning of each experimental session, at all three measurement occasions. Additionally, a functional
MRI resting state will be acquired. This involves little additional burden, as it can be obtained after acquisition of the structural MRI and does not involve any activity on behalf of the participant. These measurements will be used to analyze the structural brain connectivity with greater spatial resolution than that of MEG. MEG on the other hand has superior temporal resolution allowing for accurate analysis of functional connectivity.

Function ~ Behaviour: Phonology, reading and spelling
Recent studies of complex brain networks compare qualitatively different states of activity, or associate cognitive performance to resting-state network characteristics. The proposed study will do both in that resting-state network characteristics will be associated with behavioural measures recorded during diagnosis and various stages of the intervention. Additionally, measurements of four important component processes that are also part of differential diagnosis and progress assessment. These are the reading of a short story; the reading of words and pseudo words; letter-sound identification and speech sound manipulation by deletion. Each task will be performed inside the MEG scanner

and takes about 5 minutes to complete. The tasks have been adapted to enable performance during brain activity acquisition and require a button press, or no response at all.
The total duration of the experiment amounts to less than 30 minutes in the MEG, followed by a 10 minute MRI scan to acquire a structural volume and functional resting-state measurements.

Study burden and risks

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Contacts

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Trial sites

Listed location countries

Netherlands

Eligibility criteria

Age
Children (2-11 years)

Inclusion criteria

Diagnosed with developmental dyslexia by a professional accredited institute and on a waiting list to start intervention at a professional accredited institute. (i.e. following criteria set by the Dutch Ministry of Health, 2nd of July, 2008 that would include coverage by basic public health insurance)

Exclusion criteria

Other learning disabilities, comorbidity with ADHD, Dyscalculia (i.e. following criteria set by the Dutch Ministry of Health, 2nd of July, 2008 that would exclude coverage by basic public health insurance);Exclusie criteria gerelateerd aan metingen met een MRI en MEG scanner.

Study design

Design

Study type:	Observational invasive
Intervention model:	Other
Allocation:	Non-randomized controlled trial
Masking:	Open (masking not used)
Control:	Active
Primary purpose:	Basic science

Recruitment

NL

Recruitment status:	Will not start
Enrollment:	45
Type:	Anticipated

Ethics review

Approved WMO Date:	08-03-2012
Application type:	First submission
Review commission:	CMO regio Arnhem-Nijmegen (Nijmegen)

Study registrations

Followed up by the following (possibly more current) registration

No registrations found.

Other (possibly less up-to-date) registrations in this register

No registrations found.

In other registers

Register	ID
CCMO	NL37502.091.11