

# THE DEVELOPMENT OF COGNITIVE FUNCTIONING INDICES IN EARLY CHILDHOOD: FINDINGS FROM GROWING UP IN NEW ZEALAND

## COMPASS Seminars 2019

Denise Neumann

PhD Candidate

Supervisors: A/P Karen Waldie,

Dr Elizabeth Peterson

School of Psychology

The University of Auckland - Te Whare Wānanga o Tāmaki Makaurau



THE UNIVERSITY  
OF AUCKLAND  
NEW ZEALAND

Te Whare Wānanga o Tāmaki Makaurau



# The Development of Cognitive Functioning Indices in Early Childhood

## Outline

1. Background
2. The *Growing up in New Zealand* study (GUiNZ)
3. Methods
4. Results
5. Conclusion



# 1. Background

- Early childhood years: Rapid changes in development of cognitive abilities → brain development, environmental input
- Brain development prolonged process, important changes taking place during the preschool years (Mungas et al., 2013)
- Early cognitive disadvantages associated with poorer behavioural, socio-emotional and academic outcomes later in life (Beitchman et al., 1996)



# 1. Background

- Limitations of previous studies: Focus on narrow age ranges; few attempts to observe developmental trajectories of cognitive functioning; cross-sectional
- Challenges of longitudinal assessment of the development of cognitive constructs, i.e.
  - Tasks that are developmentally appropriate for one age are not necessarily appropriate for another
  - Great variability in child performance during early periods in development (Best & Miller, 2010)
  - Lack of established measures that are suitable across the entire age range (Mungas et al. 2013)
  - Funding and time restrictions in large population-based longitudinal studies



# 1. Background

## Aims and objectives

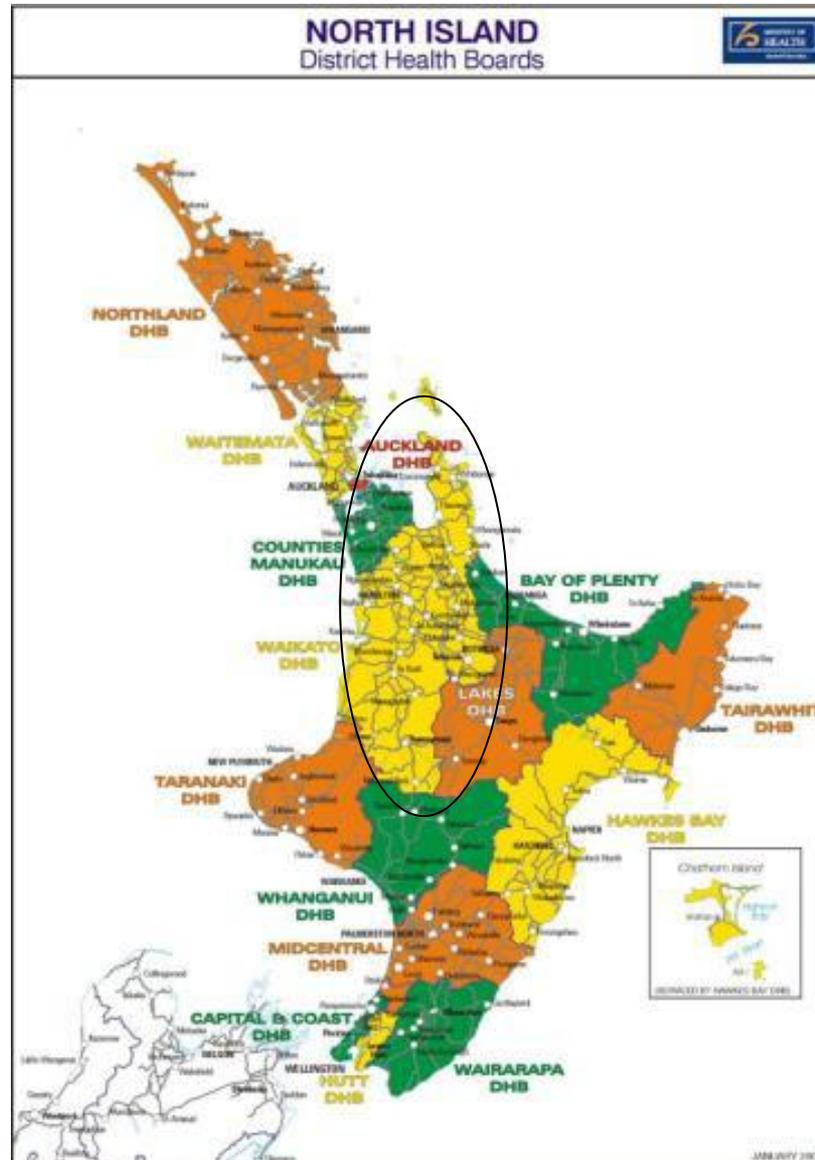
- Developing cognitive composite indices (CCIs) at 9 months, 2 years and 4.5 years
- Using data from an up-to-date longitudinal population-based New Zealand birth cohort: *Growing Up in New Zealand* study
- Investigation of trajectories of cognitive functioning in early childhood
- Identification of predictors promoting or hindering cognitive abilities



## 2. The Growing up in New Zealand Study (GUINZ)

- A longitudinal study following a group of New Zealand children, in the context of their families, from pre-birth to early adulthood
  - 6846 babies (52% male)
  - born in 2009/2010
  - interviews in homes antenatally, at 9 months, and 2 years, 4.5 years, 8 years

# What were the *GUiNZ* recruitment areas?



# Research domains and themes for *GUiNZ*

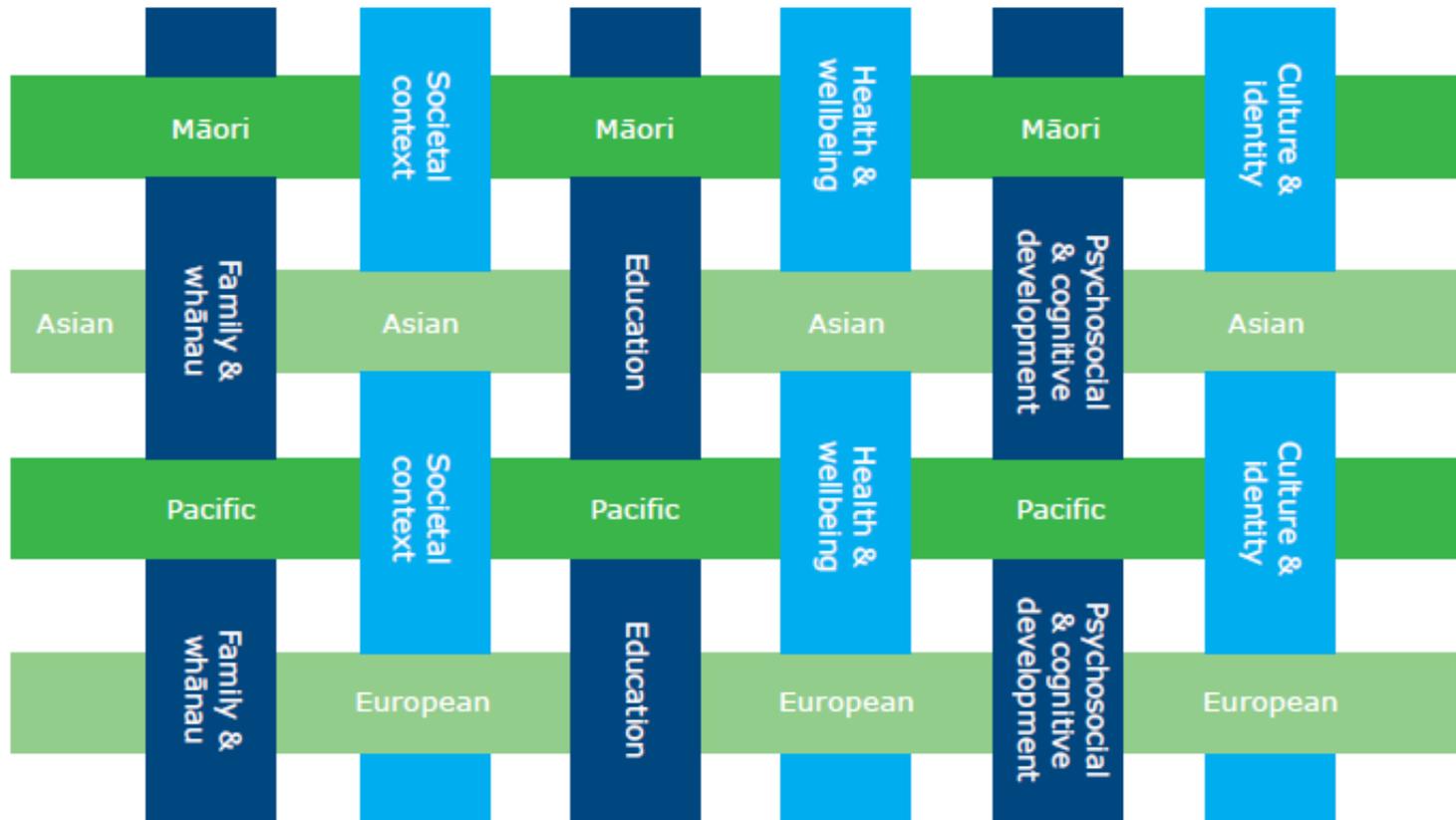


Figure 02. Domains and Themes informing *Growing Up in New Zealand*

# Why create a Cognitive Composite Index (CCI)?

- Global picture → global level of delay
- Different cognitive measures/cognitive abilities at each data collection wave
- Longitudinal study: Examine cognitive trajectories over time
- Avoids problem of multiple testing
- Accounting for interrelations between cognitive outcomes



## 3. Methods

### Measures: Cognitive Outcomes

- **9 months:** Pre-linguistic communication (Mac Arthur CDI: Words and Gestures); Verbal communication (CSBS); Motor milestones (parent-report)
- **2 years:** Expressive verbal communication (Mac Arthur CDI-II); Inhibitory control, Attention, Motor abilities (Stack & Topple interaction task)
- **4.5 years:** Receptive language (PPVT); Phonological awareness (DIBELS); Executive control (Luria Clapping Task); Writing, Numeracy and Symbols (Who am I? Name and Numbers task, Count up, Count down task)



## 3. Methods

### Measures: Cognitive Outcomes

- **9 months:** Pre-linguistic communication (Mac Arthur CDI: Words and Gestures); **Verbal communication (CSBS)**; Motor milestones (parent-report)
- **2 years:** **Expressive verbal communication (Mac Arthur CDI-II)**; Inhibitory control, Attention, Motor abilities (Stack & Topple interaction task)
- **4.5 years:** **Receptive language (PPVT)**; **Phonological awareness (DIBELS)**; Executive control (Luria Clapping Task); Writing, Numeracy and Symbols (Who am I? Name and Numbers task, Count up, Count down task)



## 3. Methods

### Measures: Cognitive Outcomes

- **9 months:** Pre-linguistic communication (Mac Arthur CDI: Words and Gestures); Verbal communication (CSBS); Motor milestones (parent-report)
- **2 years:** Expressive verbal communication (Mac Arthur CDI-II); **Inhibitory control**, Attention, Motor abilities (**Stack & Topple interaction task**)
- **4.5 years:** Receptive language (PPVT); Phonological awareness (DIBELS); **Executive control (Luria Clapping Task)**; Writing, Numeracy and Symbols (Who am I? Name and Numbers task, Count up, Count down task)



## 3. Methods

### Measures: Cognitive Outcomes

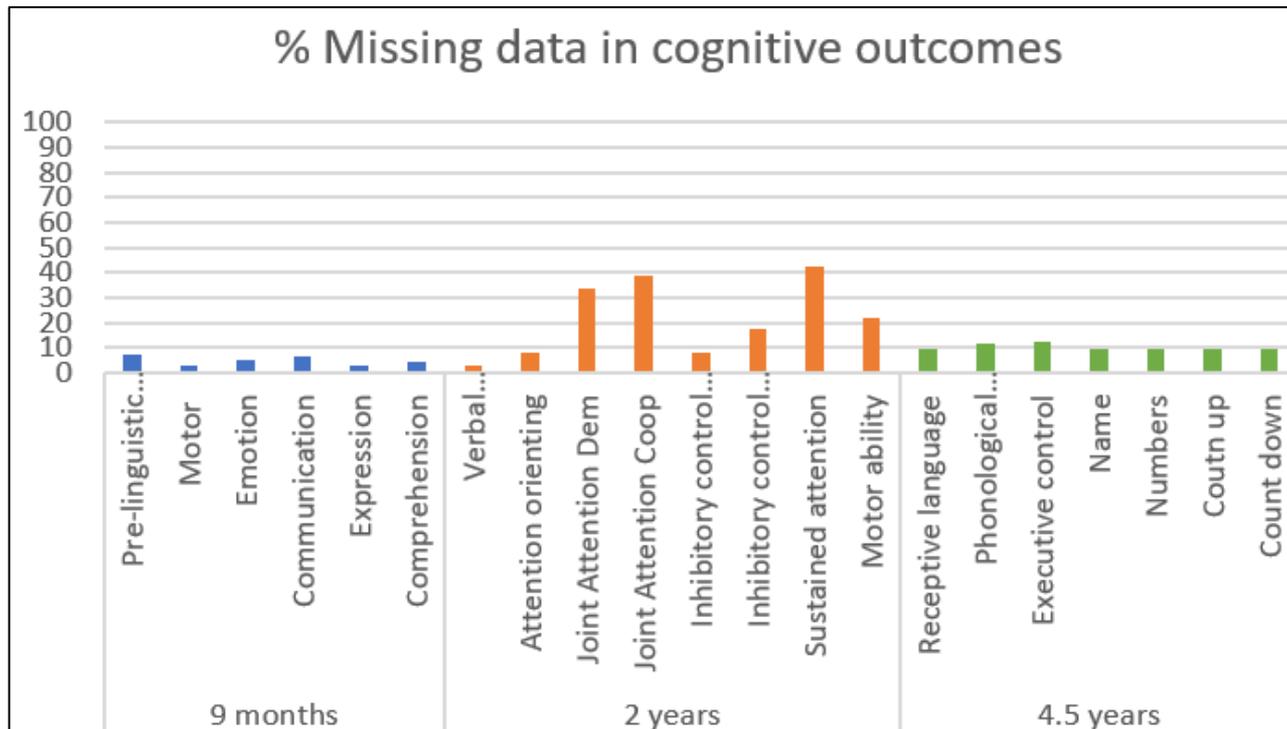
- **9 months:** Pre-linguistic communication (Mac Arthur CDI: Words and Gestures); Verbal communication (CSBS); Motor milestones (parent-report)
- **2 years:** Expressive verbal communication (Mac Arthur CDI-II); **Inhibitory control**, Attention, **Motor abilities** (Stack & Topple interaction task)
- **4.5 years:** **Receptive language (PPVT)**; Phonological awareness (DIBELS); Executive control (Luria Clapping Task); Writing, Numeracy and Symbols (Who am I? Name and **Numbers task**, **Count up**, Count down task)
- Mixture of continuous and categorical variables
- → age-adjustment if correlation with age



# Multiple Imputation

## Missing data pattern:

- Of 6074 cases, 1667 (27%) complete cases
- Cases >50% missing data (n=491) deleted beforehand
- 1.5% - 42.2% missing data per variable



13%  
missingness



# Multiple Imputation

## Missing data pattern:

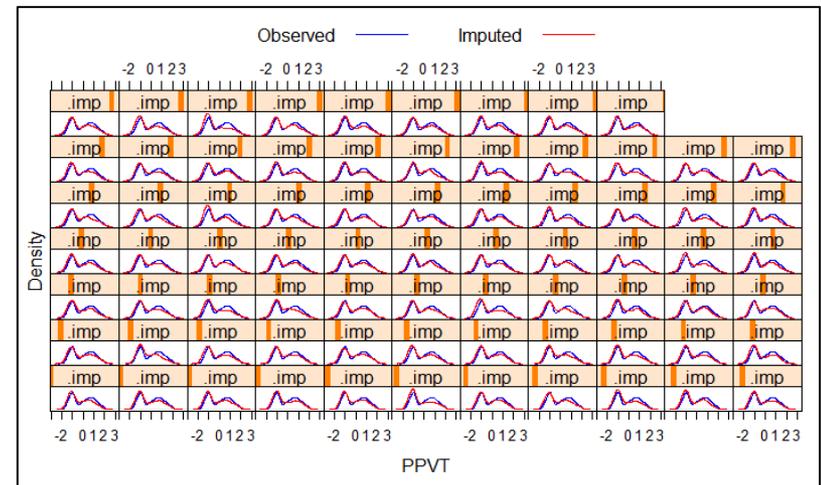
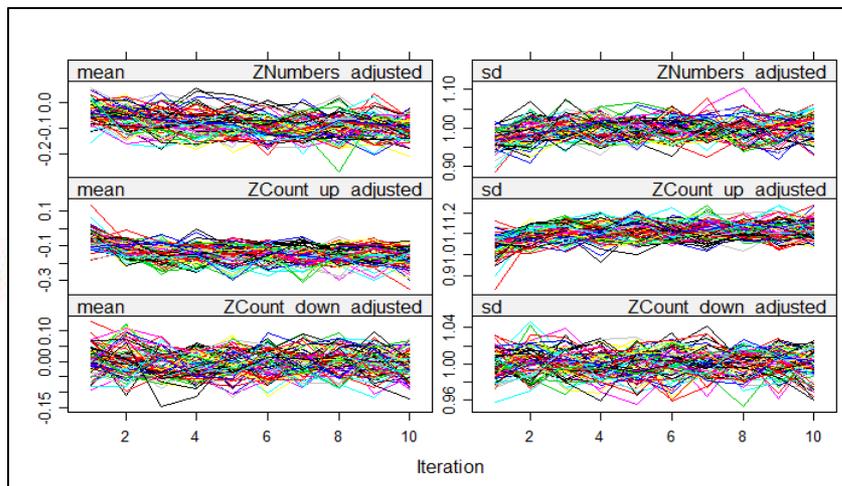
- Little's MCAR test:  $p < .001$  → data not missing completely at random
- Missing at random: Variety of variables associated with variables with missing data, differences between complete cases and cases with missing data
- Auxiliary variables (sociodemographic and behavioural data, low to moderate correlations)
- Categorical and continuous variables



# Multiple Imputation

## Multivariate Imputation by Chained Equations (MICE)

- Software imputing incomplete multivariate data by fully conditional specification approach (Van Buuren, 2007)
- R package (mice) in RStudio
- *Bodner's rule of thumb*: number of imputations in accordance to percentage of incomplete cases (White et al., 2011) → 73 imputations with 10 iterations



# Multiple Imputation

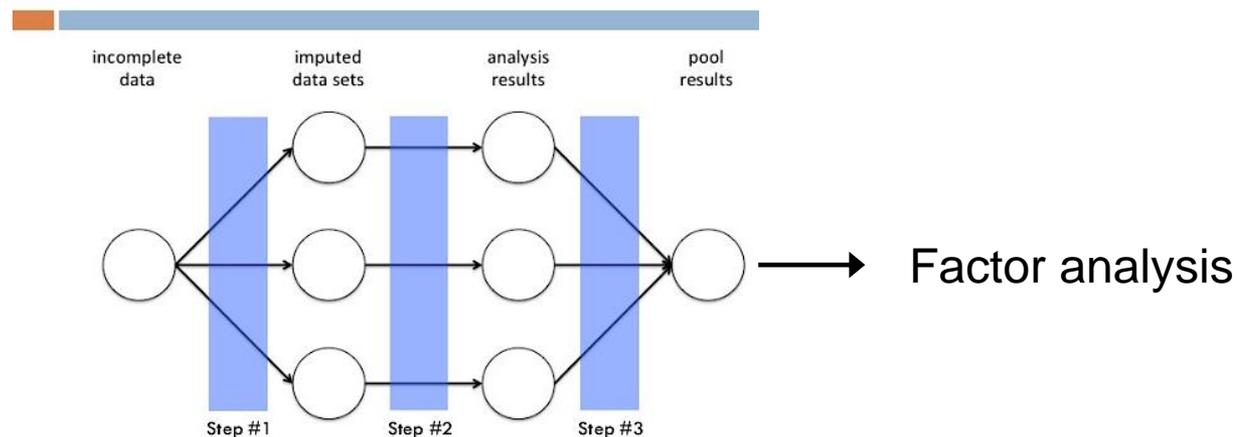
## Problem

- Combining multiple imputation and factor analysis due to the issue of combining the results from different imputed data sets → merely averaging not appropriate

## Solution

- Nassiri et al. (2018): first estimate the covariance matrix from imputed data sets using *Rubin's rules* (Rubin, 2004)

### Rubin's Multiple Imputation



# Multiple Imputation

## Problem

- Combining multiple imputation and factor analysis due to the issue of combining the results from different imputed data sets → merely averaging not appropriate

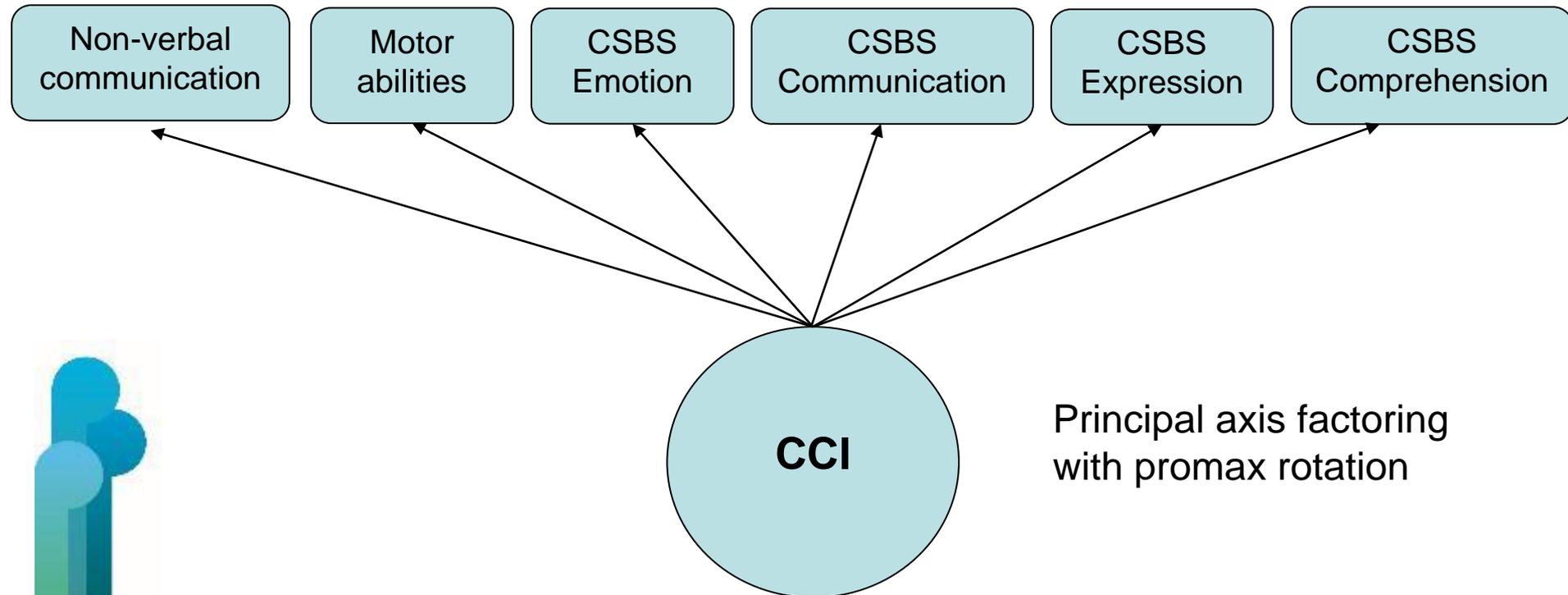
## Solution

- Nassiri et al. (2018): first estimate the covariance matrix from imputed data sets using *Rubin's rules* (Rubin, 2004)
- Performing factor analysis on a single combined matrix working on the parameter level
- Implemented R package *mifa* to estimate the covariance matrix for each imputed dataset
- → *mifa* function adjusted for estimated mixed correlation matrix used for analysis



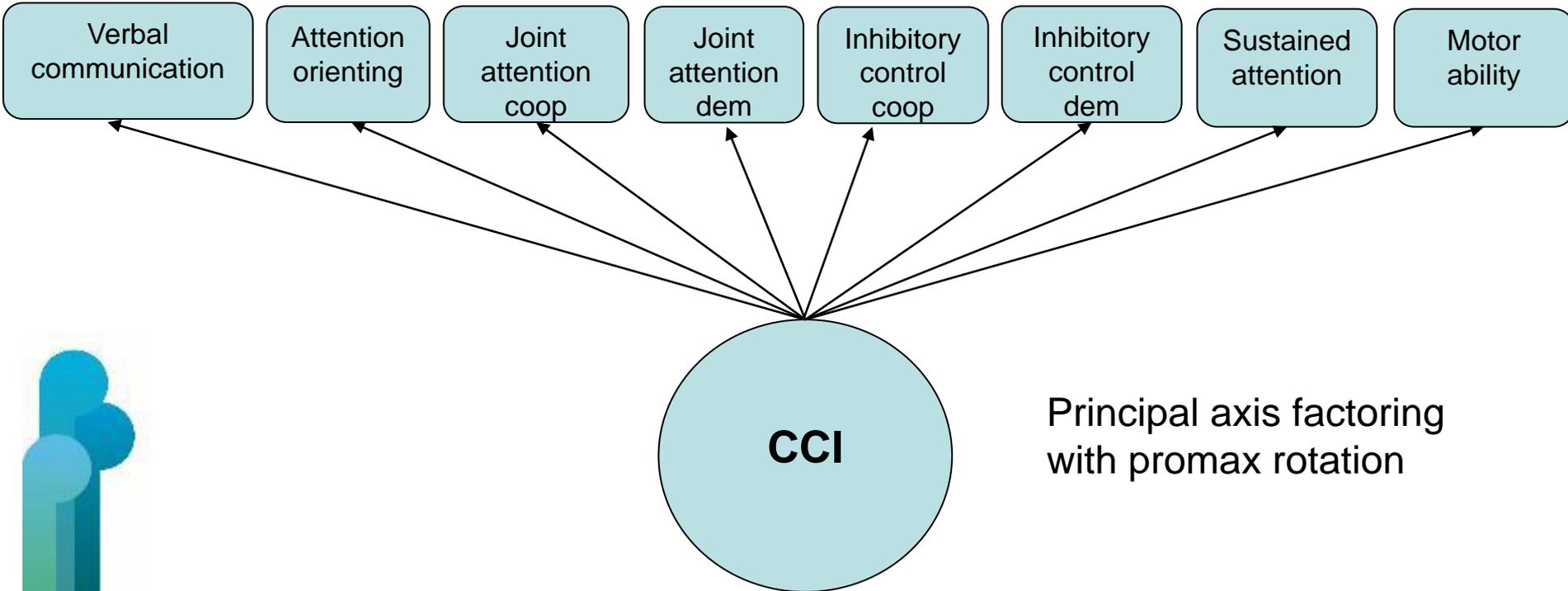
# 4. Results

## Creating a cognitive composite index at 9 months



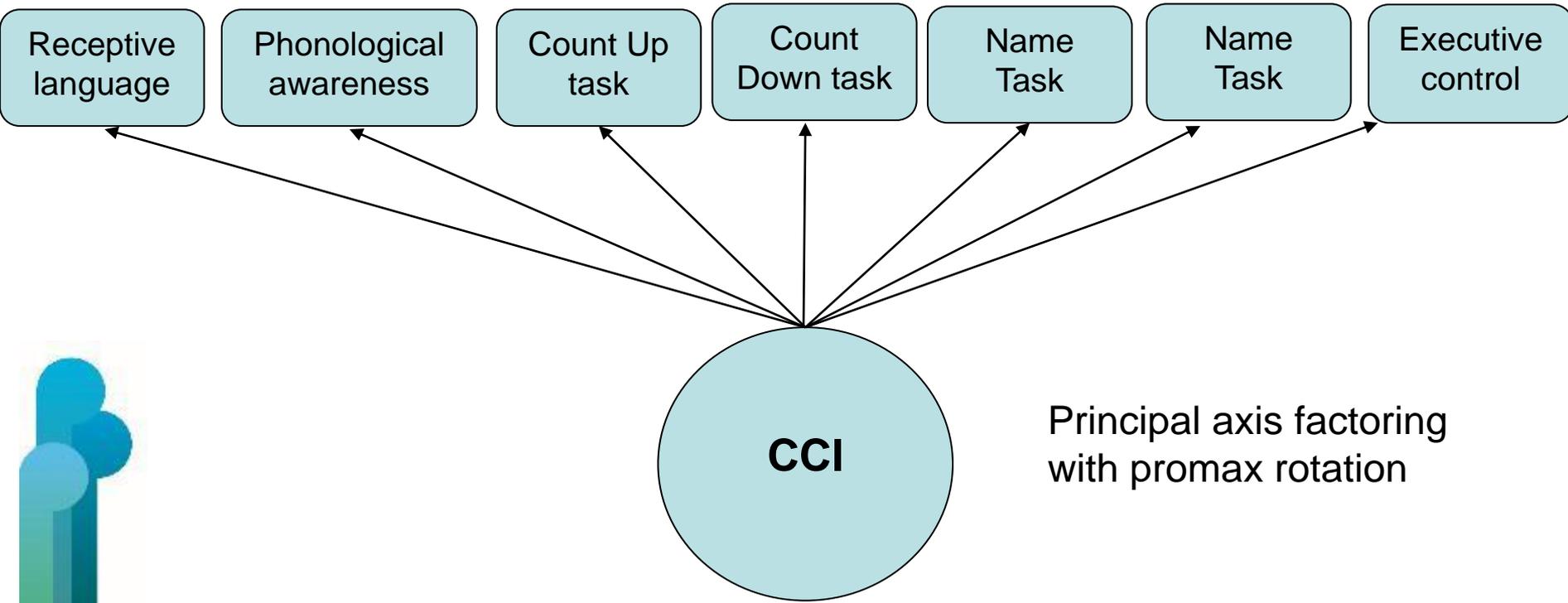
# 4. Results

## Creating a cognitive composite index at 2 years



# 4. Results

Creating a cognitive composite index at 4.5 years



## 5. Conclusion

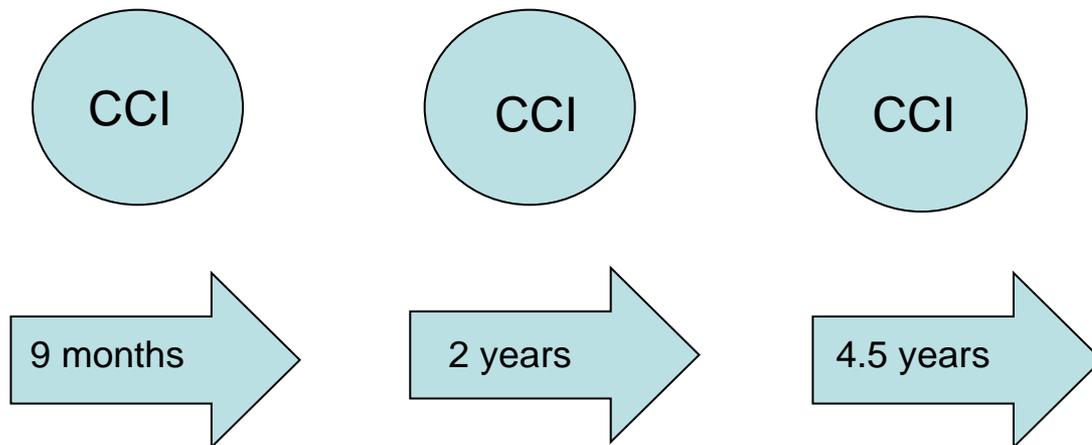
### Conclusion

- Identification of valid CCIs at 9 months and 4.5 years
- At age 2 years, only the language component related to later literacy and school readiness → may partially reflect the measures used
- CCIs provides the opportunity to potentially examine early cognitive trajectories along with factors that promote or hinder cognitive functioning in early childhood



# Outlook

## Use of CCIs for further analysis

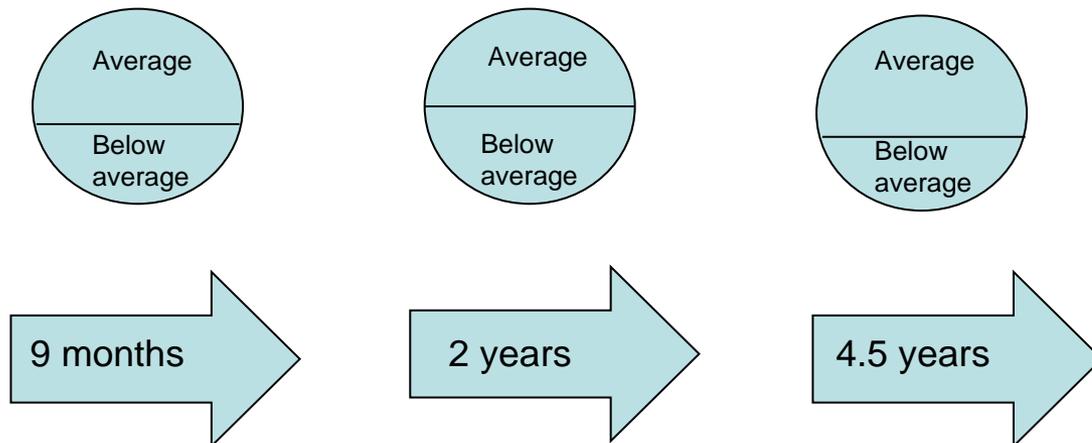


# Outlook

## 1. Categorical indices

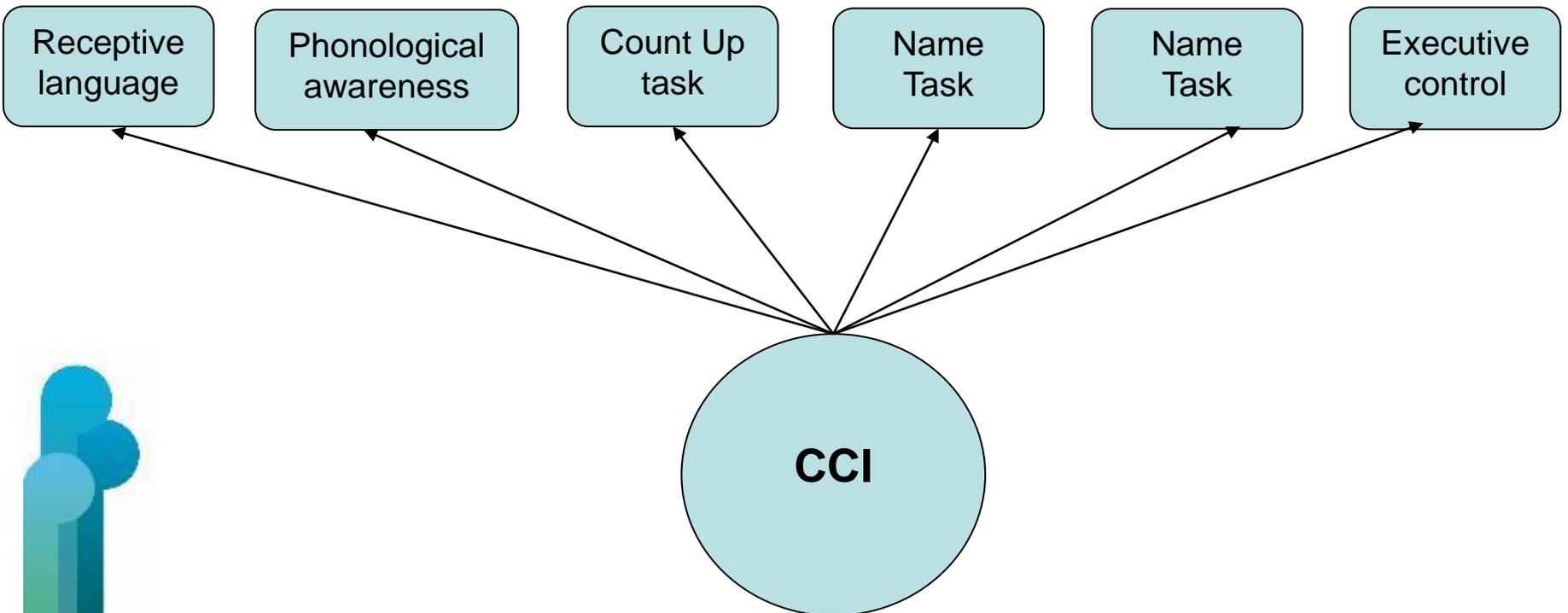
### Trajectories/Movement:

- Stable
- Increase
- Decline

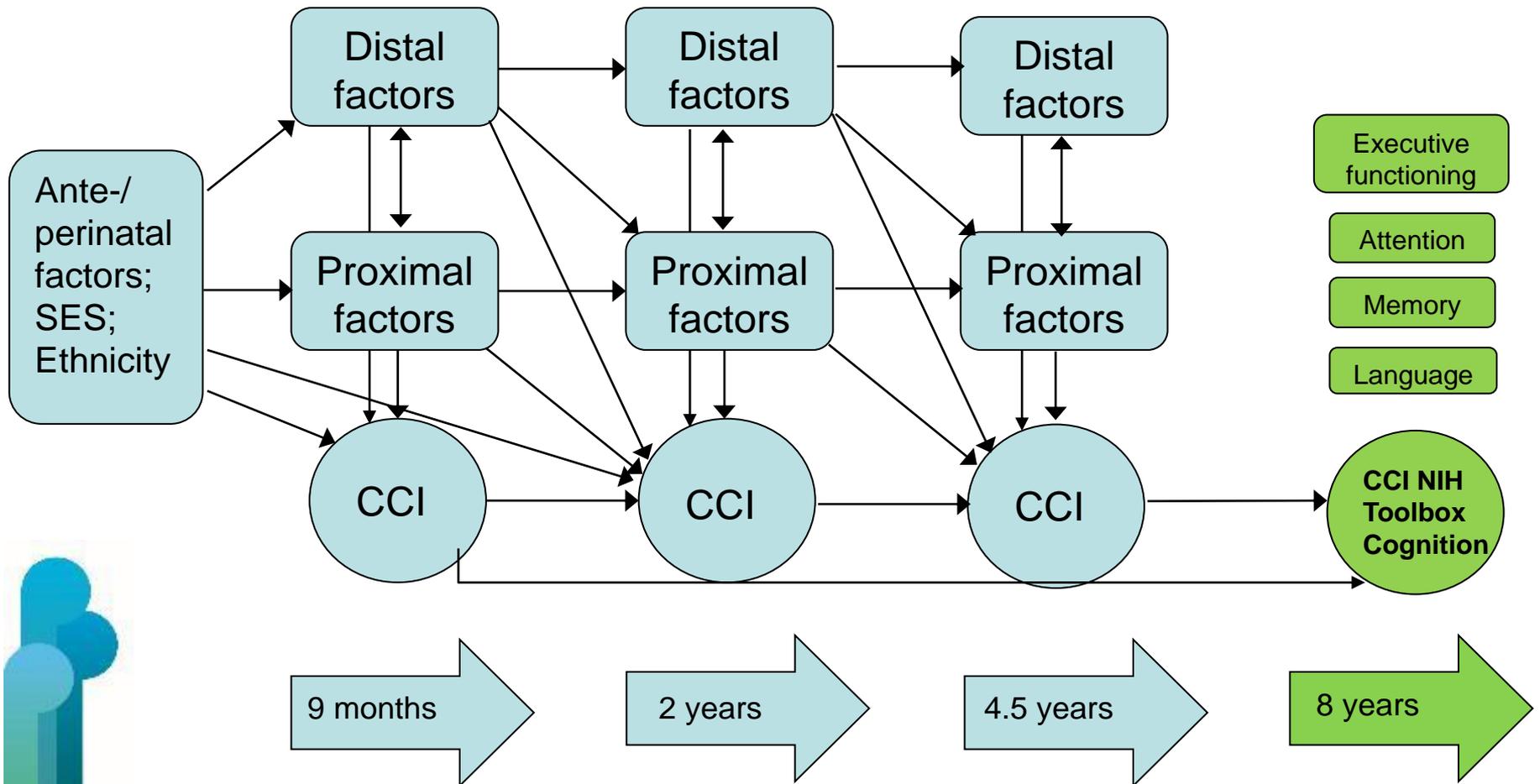


# Outlook

## 2. CCIs as latent constructs in SEM/path modelling



# Outlook



# THE DEVELOPMENT OF COGNITIVE FUNCTIONING INDICES IN EARLY CHILDHOOD

# Thank you!

COMPASS Seminars 2019

Denise Neumann

PhD Candidate

Supervisors: A/P Karen Waldie,  
Dr Elizabeth Peterson

School of Psychology

The University of Auckland - Te Whare Wānanga o Tāmaki Makaurau