The Development of Cognitive Functioning Indices in early Childhood: Findings from Growing up in New Zealand

COMPASS Seminars 2019

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Growing Up in New Zealand

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

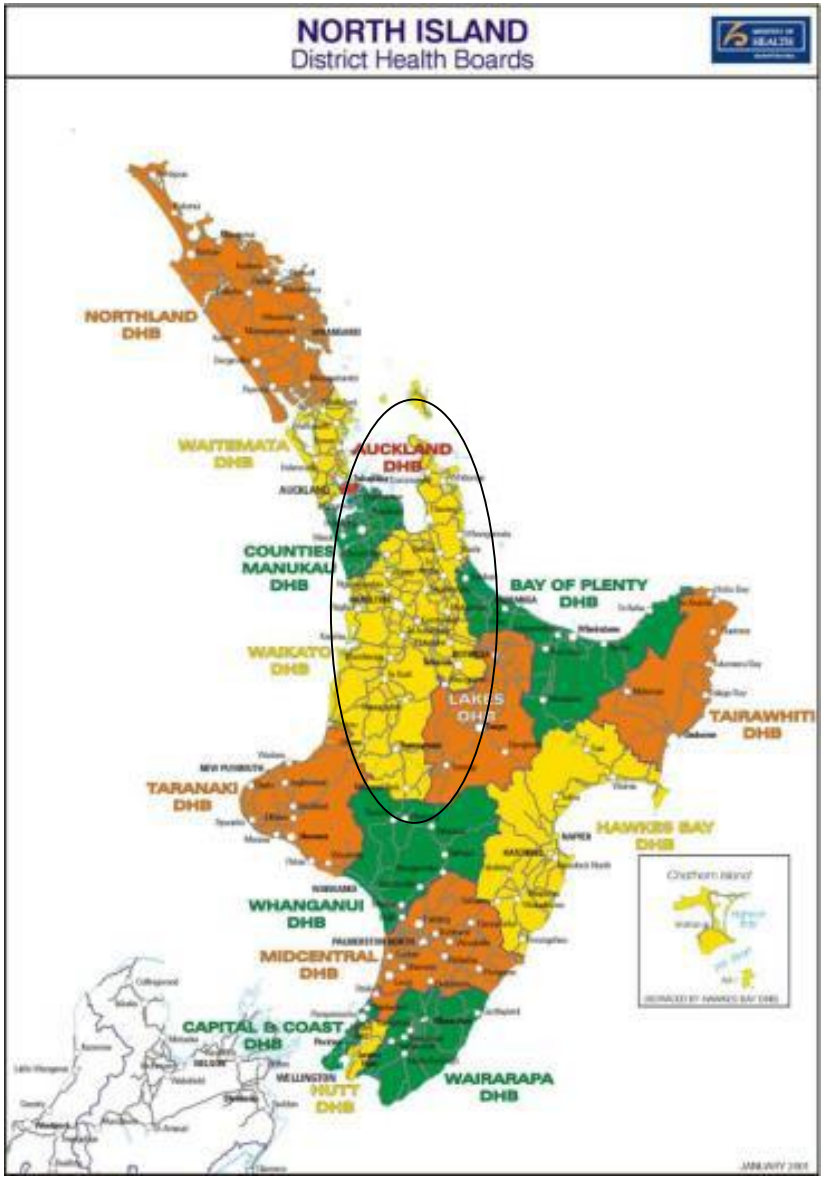
- Investigation of trajectories of cognitive functioning in early childhood
- Identification of predictors promoting or hindering cognitive abilities

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

Growing Up in New Zealand

What were the *GUiNZ* recruitment areas?



Research domains and themes for *GUiNZ*

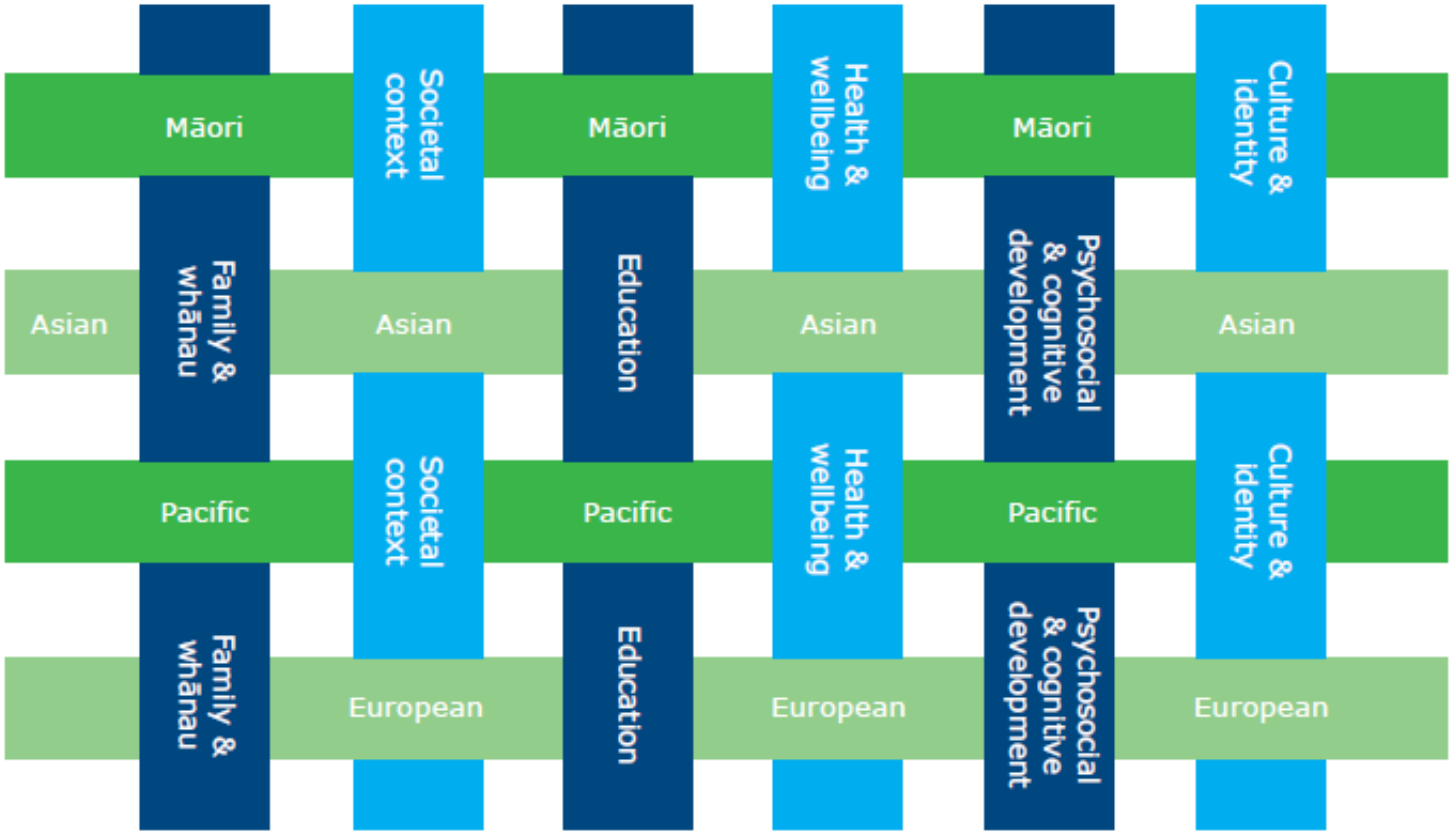


Figure 02. Domains and Themes informing *Growing Up in New Zealand*

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)

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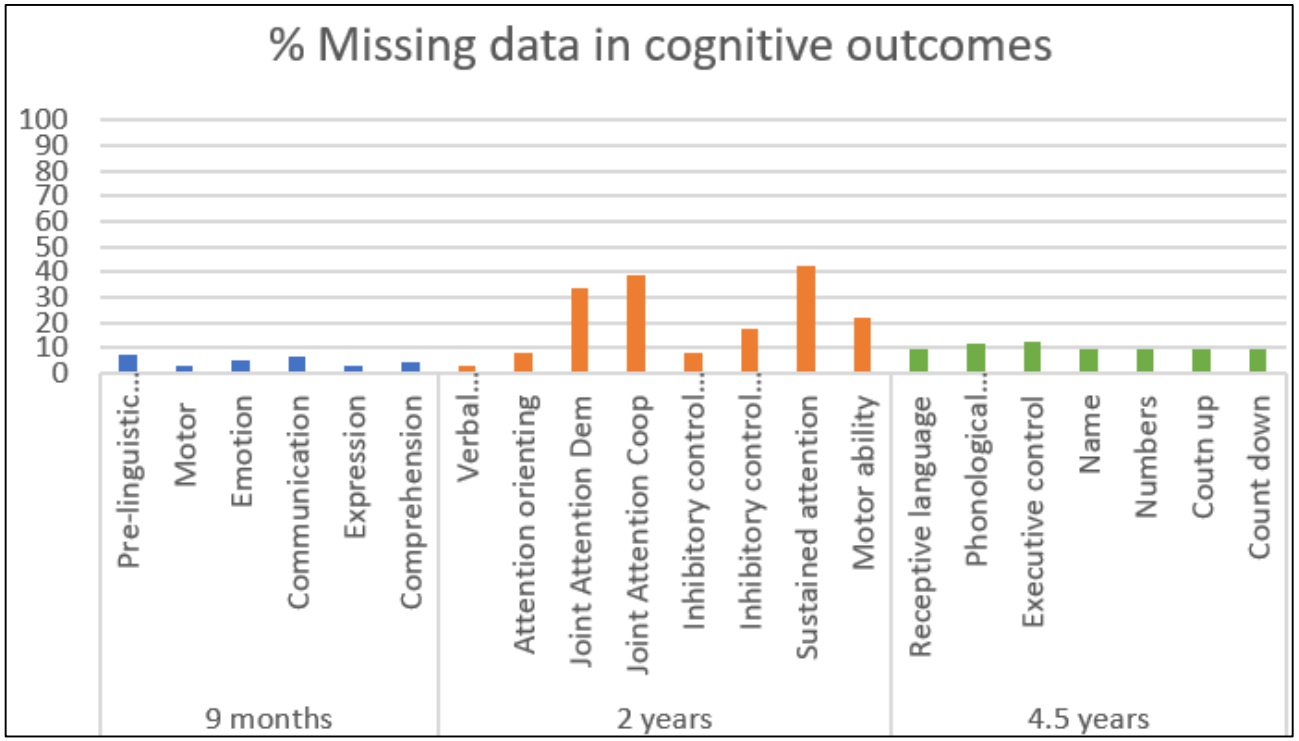
- Mixture of continuous and categorical variables
- → age-adjustment if correlation with age

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

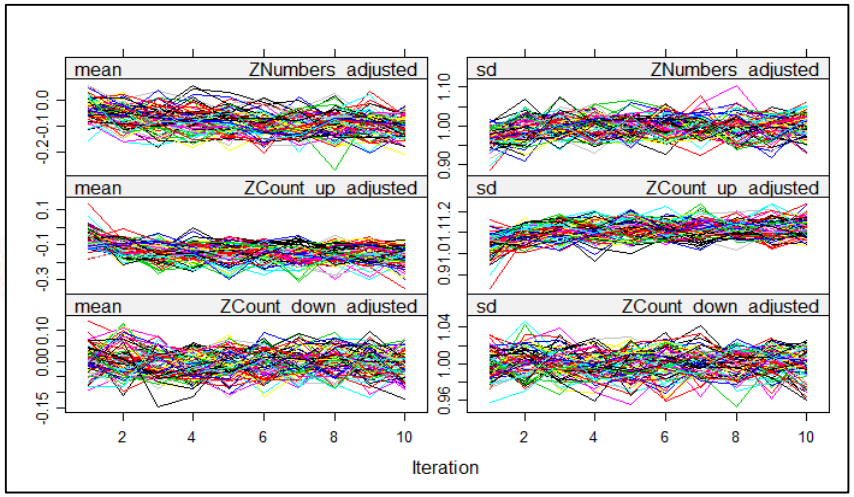
Missing data pattern:

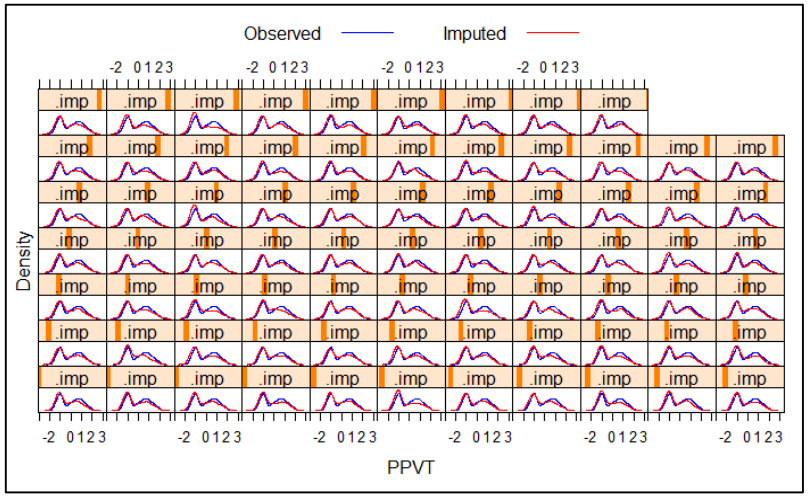
- Little's MCAR test: $p<.001$ → data not missing completely at random
- Missing at random: Variety of variables associated with variables with missing data, differences between complete cases and cases with missing data
- Auxiliary variables (sociodemographic and behavioural data, low to moderate correlations)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

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





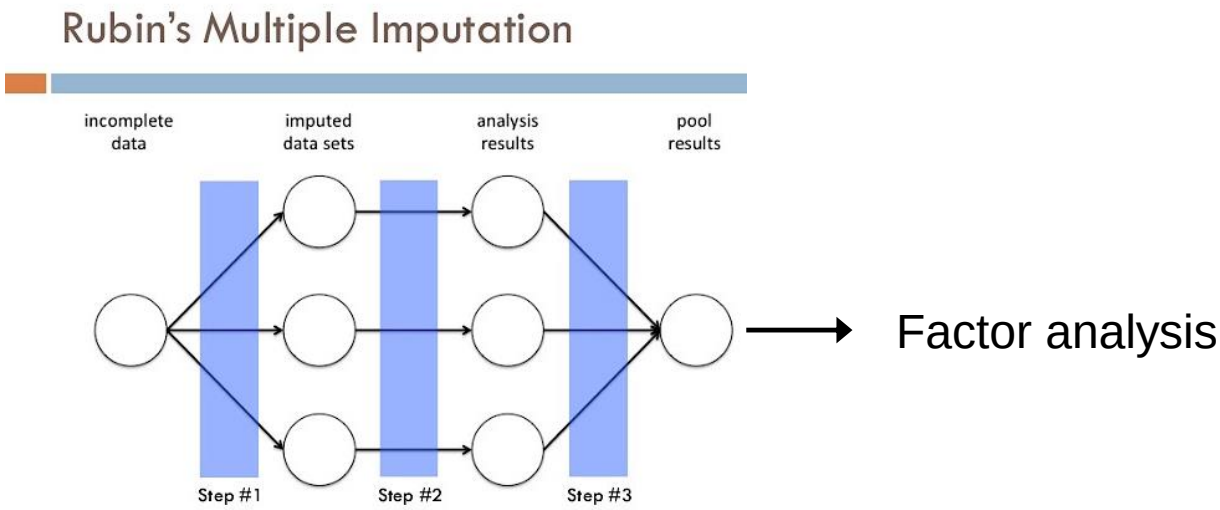
Multiple Imputation

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)



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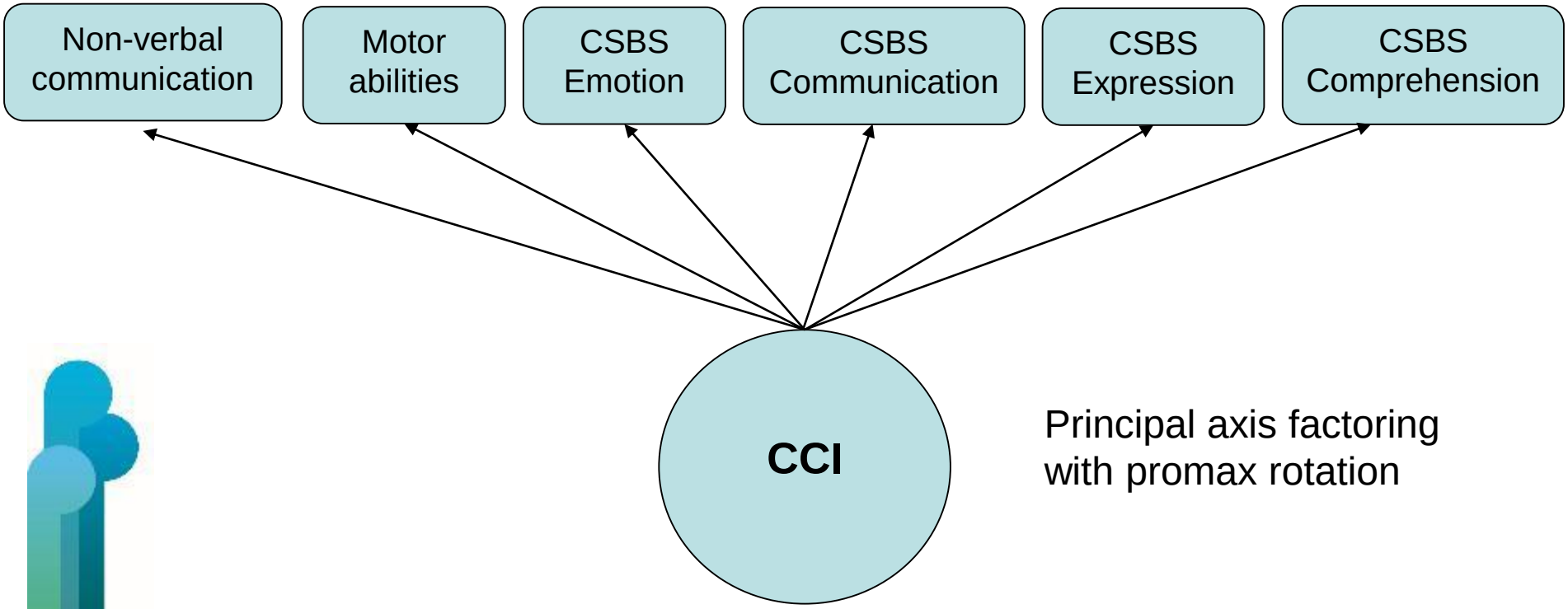
- Nassiri et al. (2018): first estimate the covariance matrix from imputed data sets using *Rubin's rules* (Rubin, 2004)
- Performing factor analysis on a single combined matrix working on the parameter level
- Implemented R package *mifa* to estimate the covariance matrix for each imputed dataset
-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

4. Results

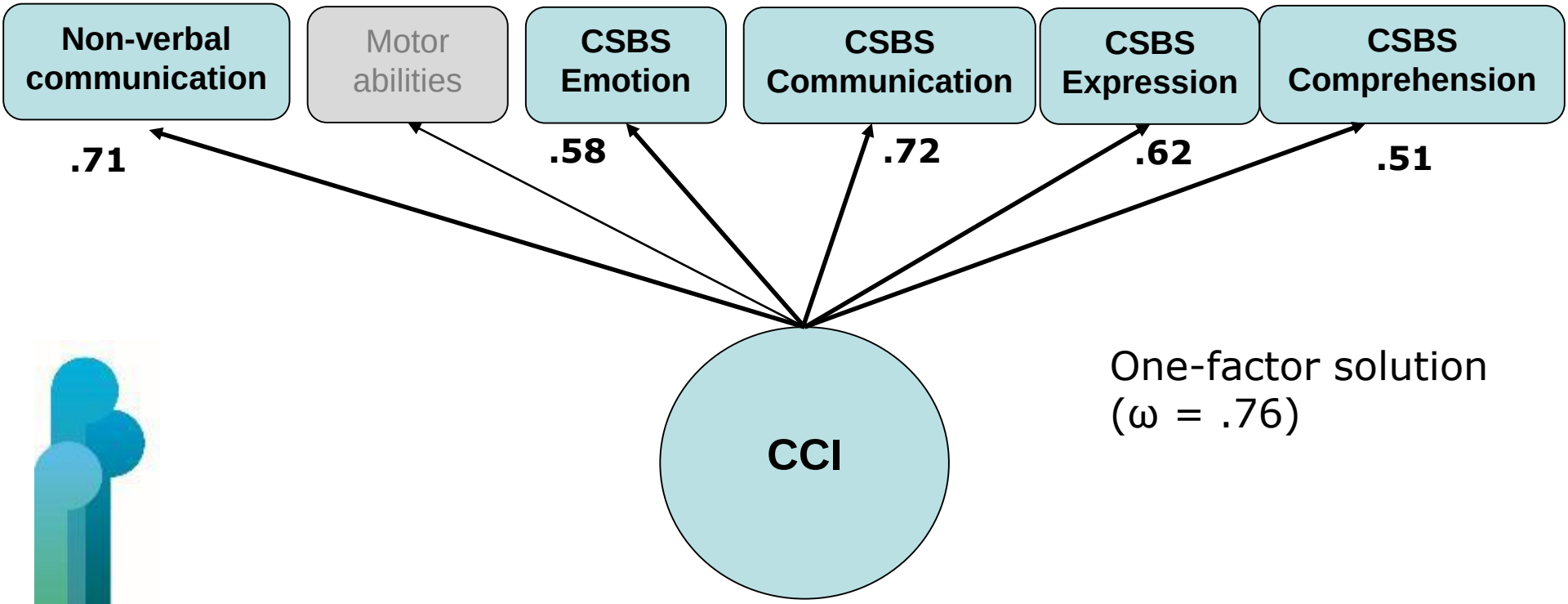
Creating a cognitive composite index at 9 months



Principal axis factoring
with promax rotation

4. Results

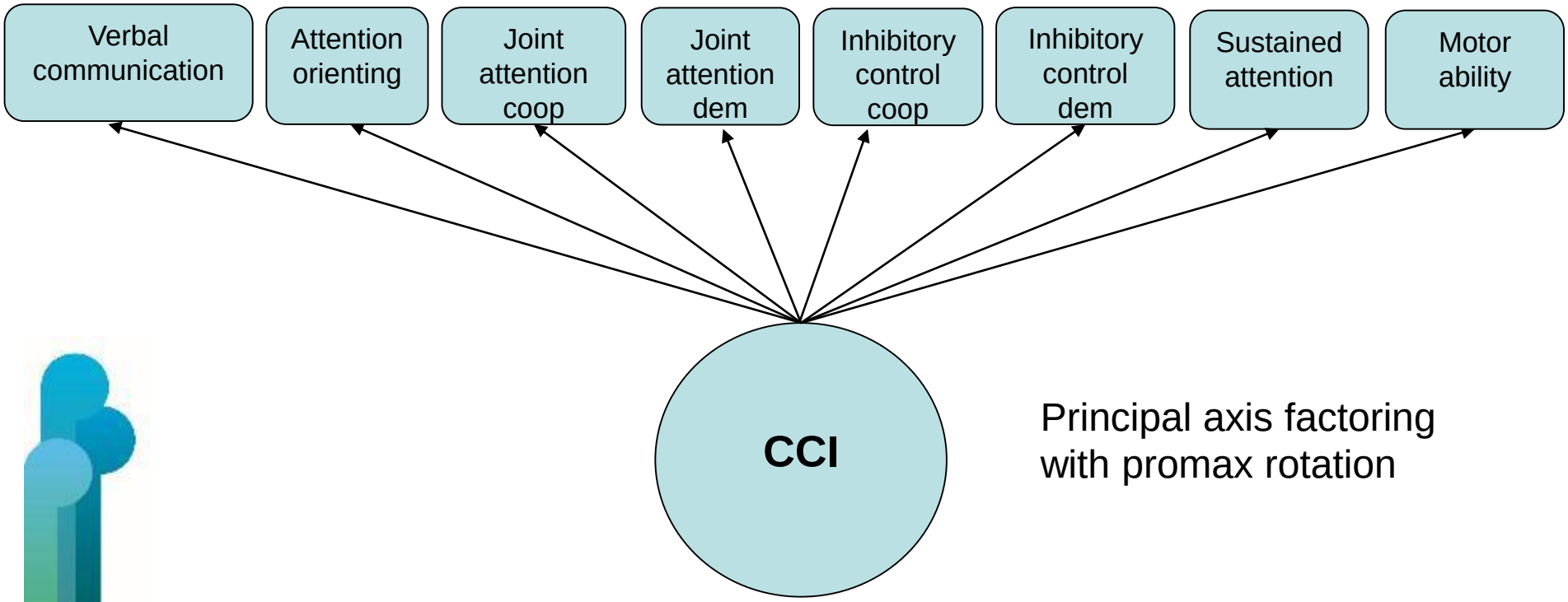
Creating a cognitive composite index at 9 months



One-factor solution
(ω = .76)

4. Results

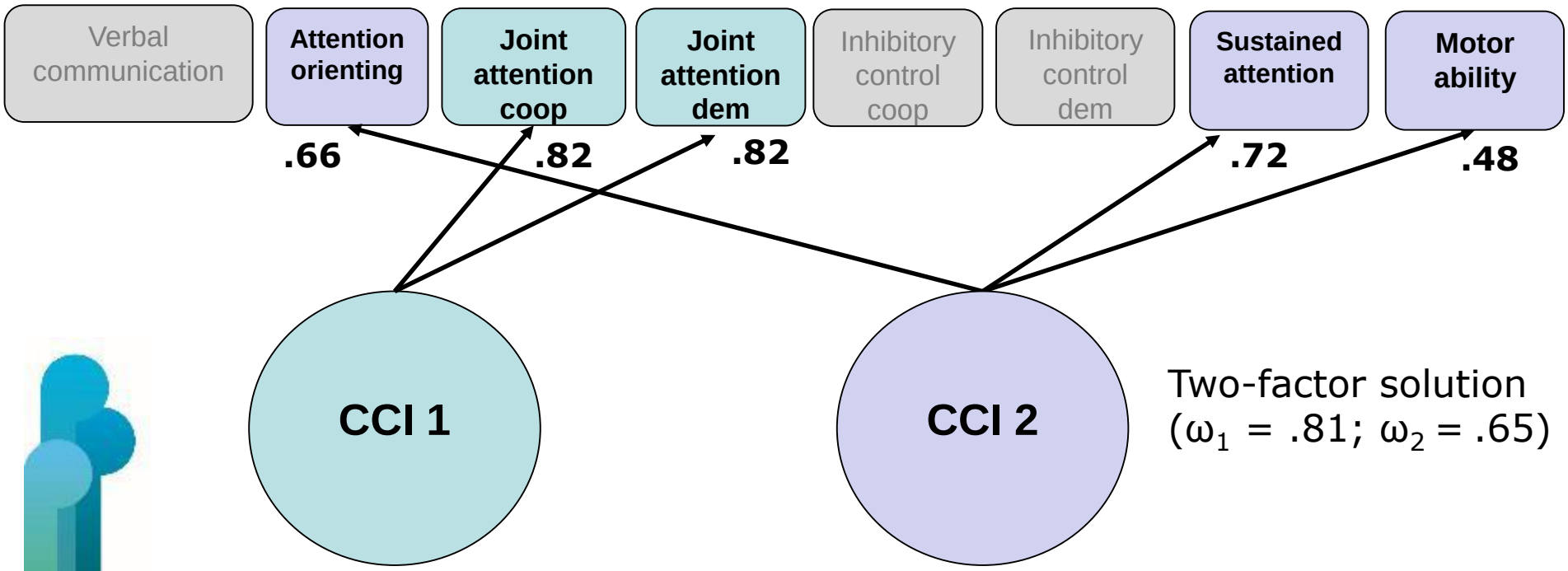
Creating a cognitive composite index at 2 years



Principal axis factoring
with promax rotation

4. Results

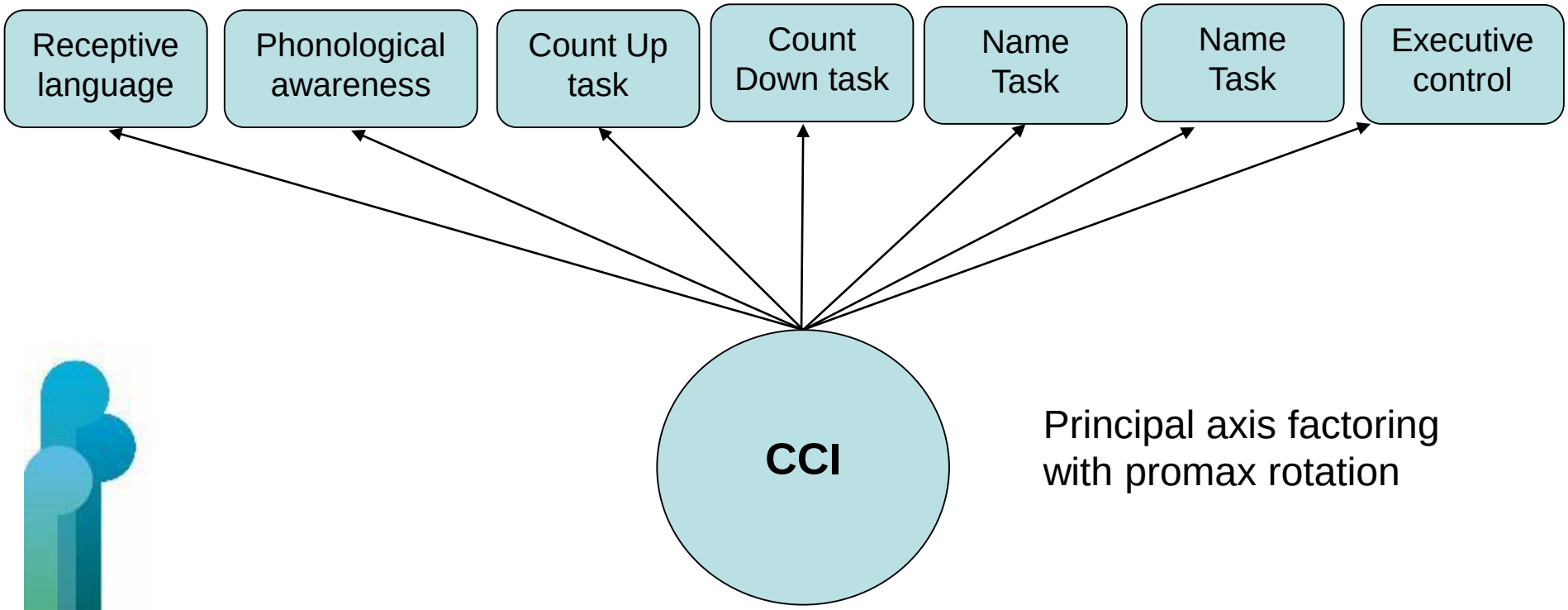
Creating a cognitive composite index at 2 years



Two-factor solution
(ω_1 = .81; ω_2 = .65)

4. Results

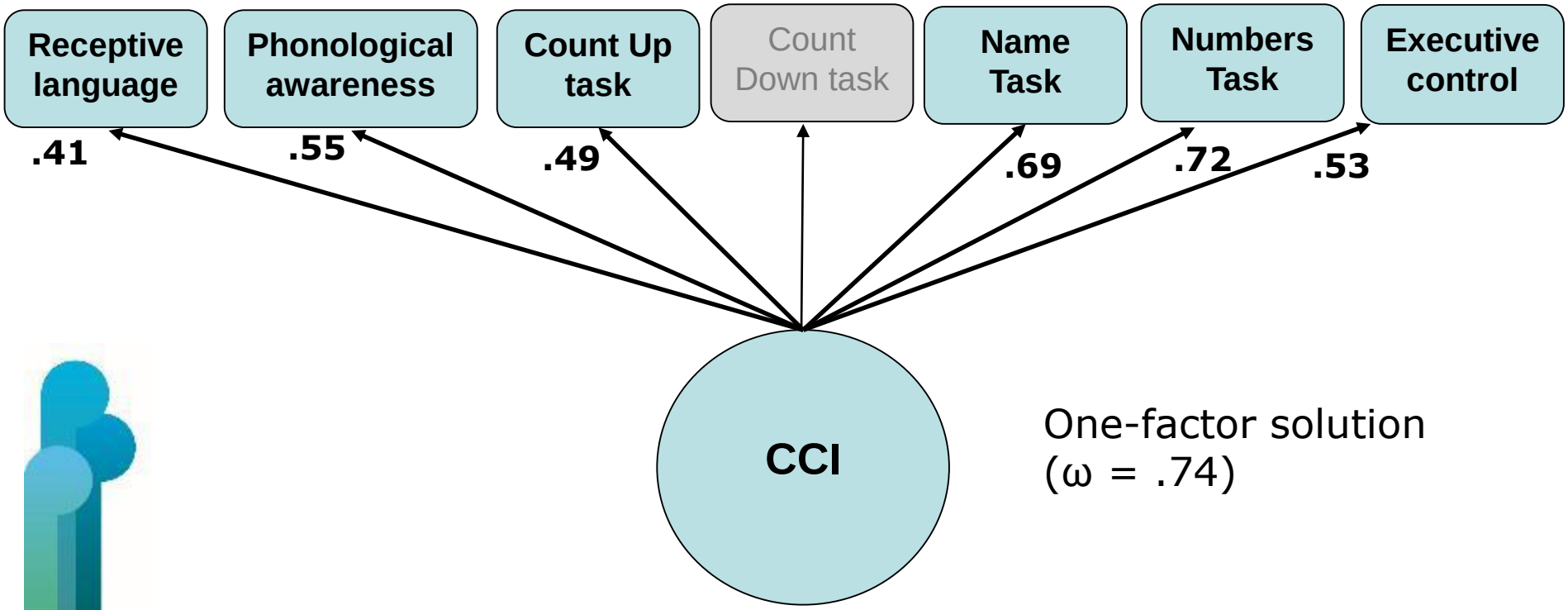
Creating a cognitive composite index at 4.5 years



Principal axis factoring with promax rotation

4. Results

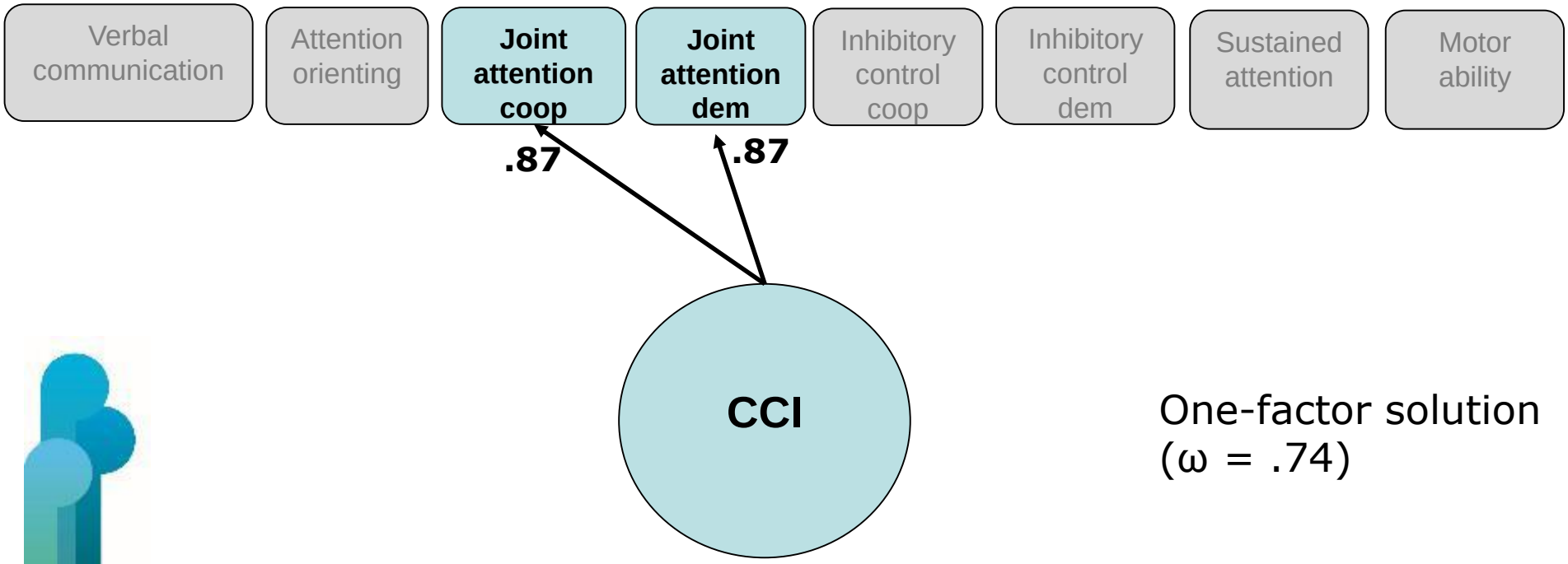
Creating a cognitive composite index at 4.5 years



One-factor solution
(ω = .74)

4. Results: Complete Cases

Creating a cognitive composite index at 2 years



One-factor solution
(ω = .74)

Validity of CCIs

Correlation with:

- **Pragmatic language/early literacy:** mother-report at 4.5 years
- **School readiness:** mother-report at 6 years

Table 3. Correlation of CCIs with literacy and school readiness

CCI	Literacy (4.5 years)	School readiness (6 years)
CCI 9 months	.13** (.12**)	.02** (.05)
CCI 2 years F1	.04* (.02)	.01** (-.02)
CCI 2 years F2	.11** (-)	.03** (-)
Verbal communication 2 years	.35** (.34**)	.11** (.10**)
CCI 4.5 years	.27** (.24**)	.12** (.15**)

Note. Correlation for complete cases in brackets.

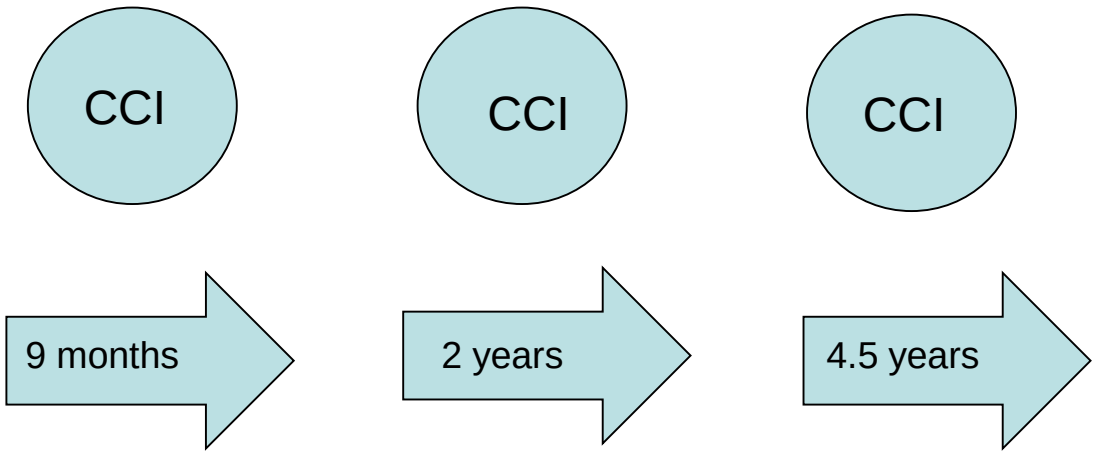
5. Conclusion

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
- Results of complete cases analysis vary at 2 years → largest amount of missing data
- CCIs provides the opportunity to potentially examine early cognitive trajectories along with factors that promote or hinder cognitive functioning in early childhood
- Results of imputed data with high rates of missingness have to be interpreted with caution

Outlook

Use of CCIs for further analysis

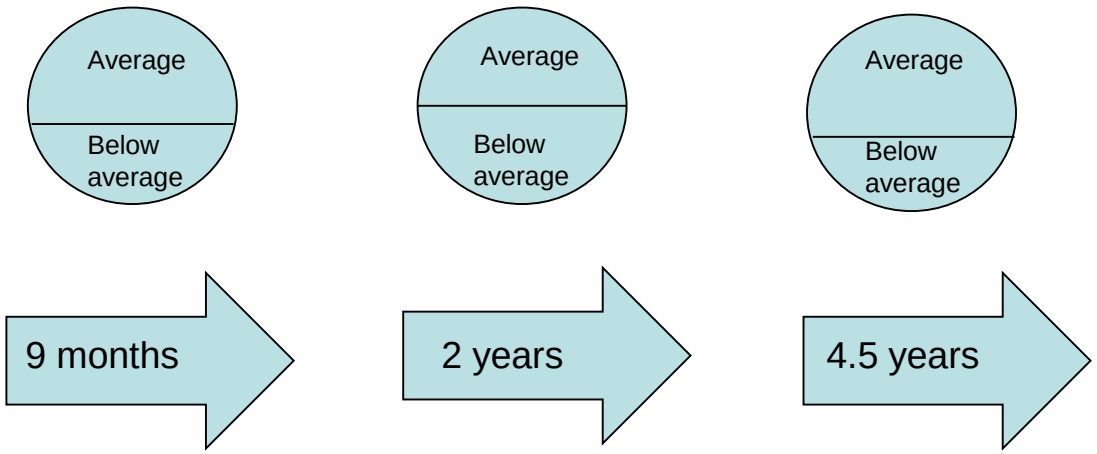


Outlook

1. Categorical indices

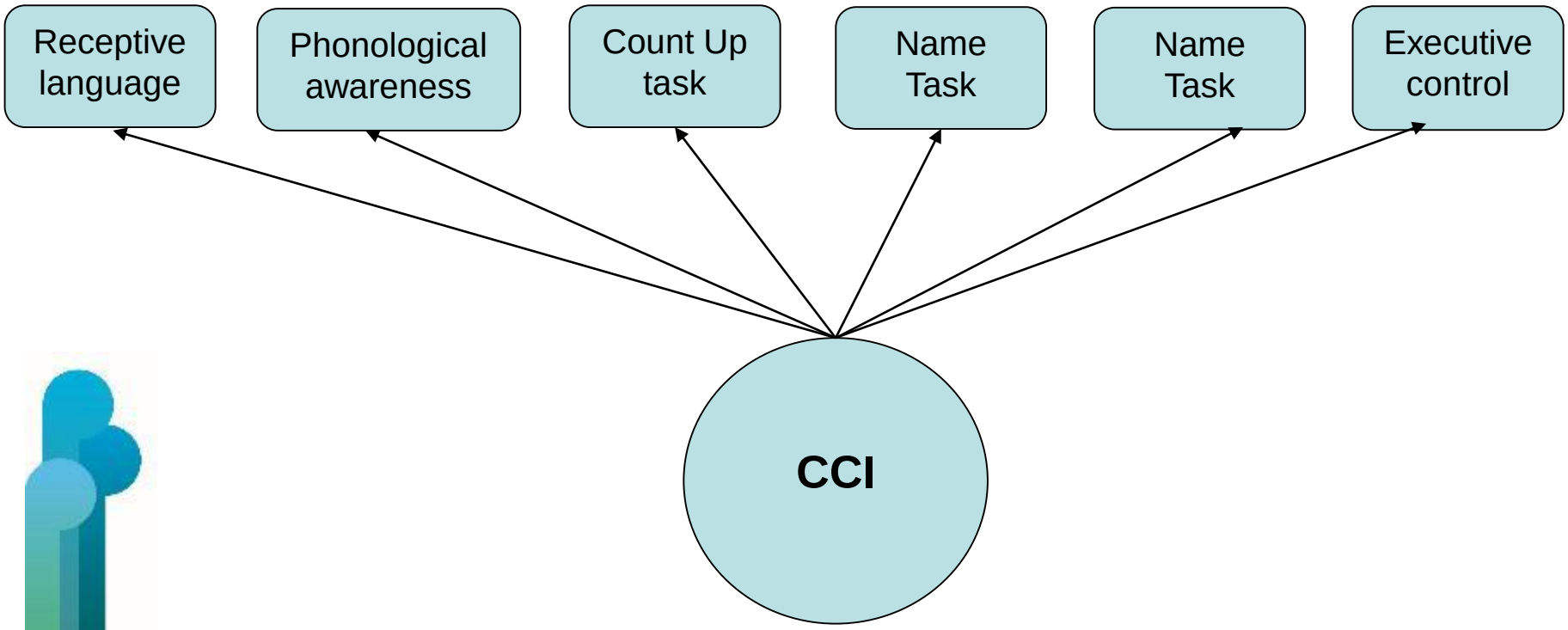
Trajectories/Movement:

- Stable
- Increase
- Decline

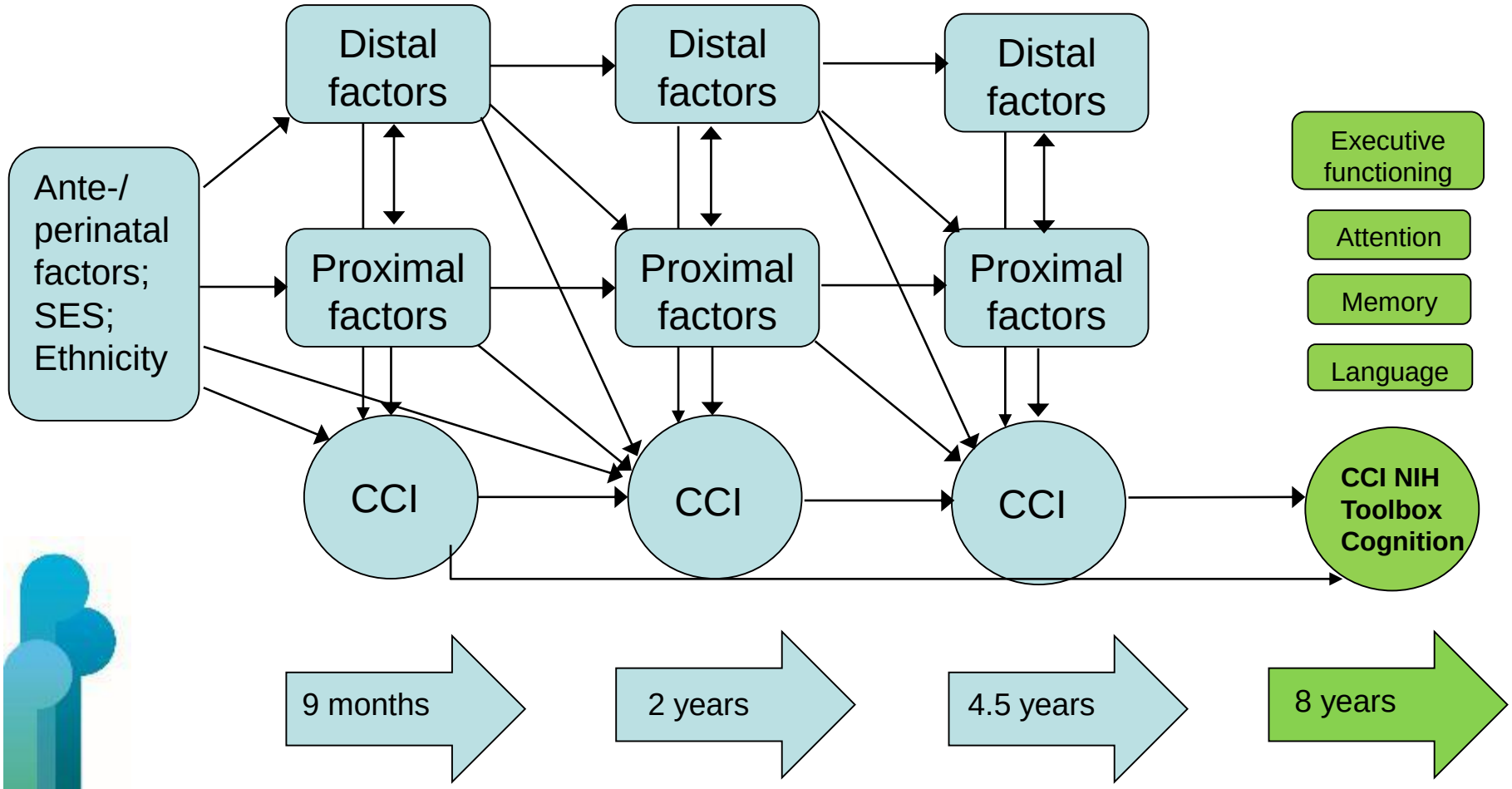


Outlook

2. CCIs as latent constructs in SEM/path modelling



Outlook


Distal factors
Distal factors
Distal factors
Ante-/ perinatal factors; SES; Ethnicity
Proximal factors
Proximal factors
Proximal factors
Executive functioning
Attention
Memory
Language
CCI
CCI
CCI
CCI NIH Toolbox Cognition
9 months
2 years
4.5 years
8 years

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Thank you!

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