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

COMPASS Seminars 2019

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The Development of Cognitive Functioning Indices in Early Childhood

Outline

1. Background

2. The Growing up in New Zealand study (GUaNZ)

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
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

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

Missing data pattern:

- Little’s MCAR test: $p < .001 \rightarrow$ 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
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)
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

- 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

- Non-verbal communication
- Motor abilities
- CSBS Emotion
- CSBS Communication
- CSBS Expression
- CSBS Comprehension

CCI

Principal axis factoring with promax rotation
Creating a cognitive composite index at 2 years

4. Results

Principal axis factoring with promax rotation
4. Results

Creating a cognitive composite index at 4.5 years

Receptive language
Phonological awareness
Count Up task
Count Down task
Name Task
Name Task
Executive control

CCI

Principal axis factoring with promax rotation
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
Use of CCIIs for further analysis

Outlook

9 months  
CCI

2 years  
CCI

4.5 years  
CCI
1. Categorical indices

Trajectories/Movement:

• Stable
• Increase
• Decline
2. CCIs as latent constructs in SEM/path modelling

Outlook
Thank you!

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