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Exploratory network analysis of the French Wechsler Intelligence Scale for children-Fourth Edition (WISC-IV)

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INTRODUCTION

- Exploratory and Confirmatory Factor Analysis are frequently used to uncover underlying **latent variables** that explain the structural covariation in the data.
 - WISC-IV: 4 latent variables are considered to be responsible of the structural covariation between subtest scores: Verbal Comprehension [VC], Perceptual Reasoning [PR], Processing Speed [PS], and Working Memory [WM].
- The **psychometric network modeling** suggests to move away from the latent variable perspective, and considers that dimensions arise from the interactions between *entities* in a network.
 - Network includes nodes (psychological variables) connected by edges (statistical relationships).
 - Models focused on the estimation of direct relationships between observed variables.

OBJECTIVE

- Analysis of the structure of the French WISC-IV by applying a network approach.
 - Estimation of the number of dimensions underlying the WISC-IV using network psychometrics.
 - Estimation of the network; edges represent the relations between the subtests of the WISC-IV.
 - Estimation of the centrality of each variable, to determine the overall connectivity of a subtest, and the importance of each score.

METHOD

- Sample:**
 - 483 French-speaking Swiss children aged from 7 to 12 years. The sample included 230 males (mean age = 9.50, SD=1.30) and 253 females (mean age = 9.54, SD=1.29).
- Material:**
 - The 10 core subtests of the WISC-IV and the optional subtest Picture Completion were administered to children (PC was not administered to 19 children).

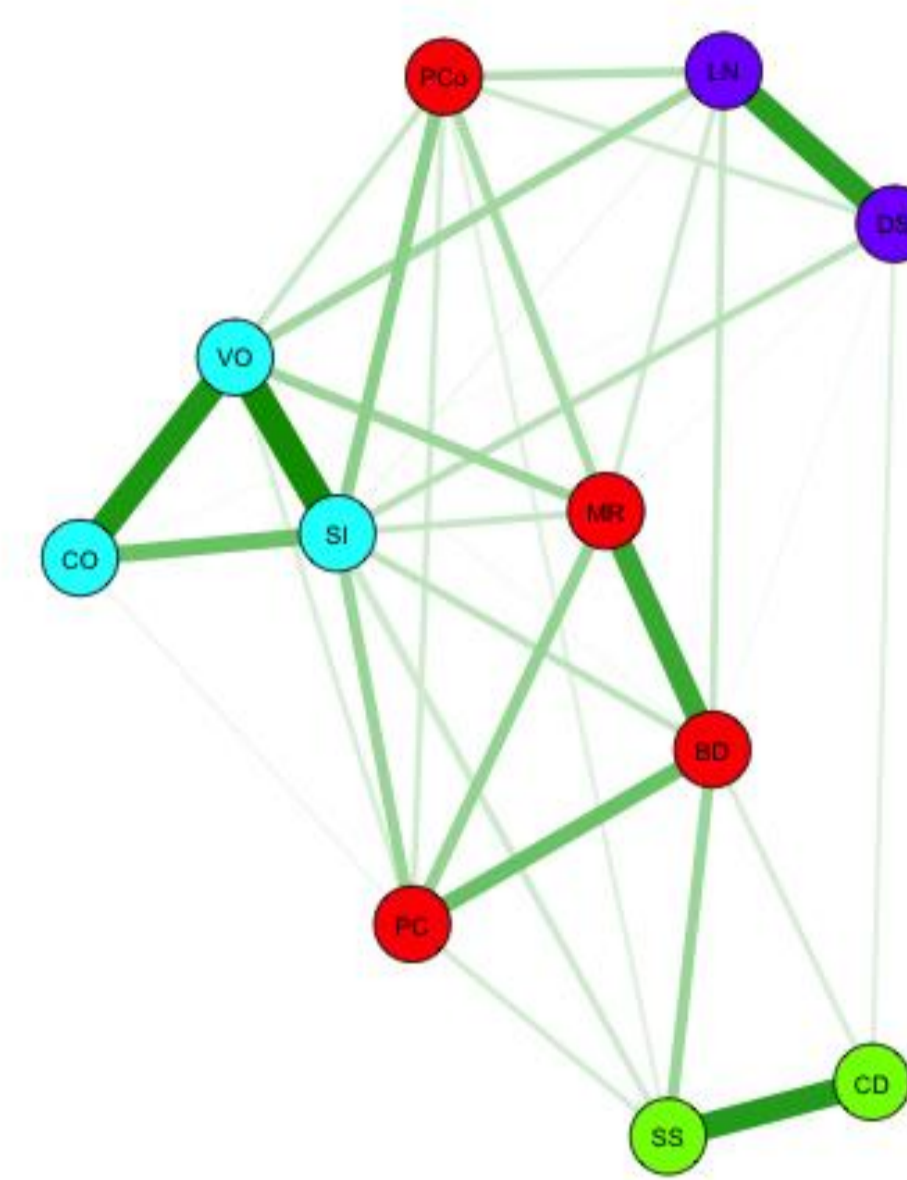
VC: Verbal Comprehension	PR: Perceptual Reasoning	WM: Working Memory	PS: Processing Speed
SI: Similarities	BD: Block Design	DS: Digit Span	CD: Coding
VO: Vocabulary	MR: Matrix Reasoning	LN: Letter-number	SS: Symbol Search
CO: Comprehension	PCo: Picture Concepts (PC: Picture Completion)		

Analyses:

- Within the network approach, we used the R-package *exploratory graph analysis (EGA)* to estimate the number of dimensions.
- A Gaussian Graphical Model (GGM) was used to model the undirected network between subtests. Centrality indices were computed from the network.
 - In GGM, an edge is the partial correlations between 2 variables, controlling for all other associations in the network.
 - We used the R-package *qgraph* that includes the *LASSO* regularization to return a sparse network model.
 - We used the R-package *bootnet* to assess the stability of the network structure and centrality indices.

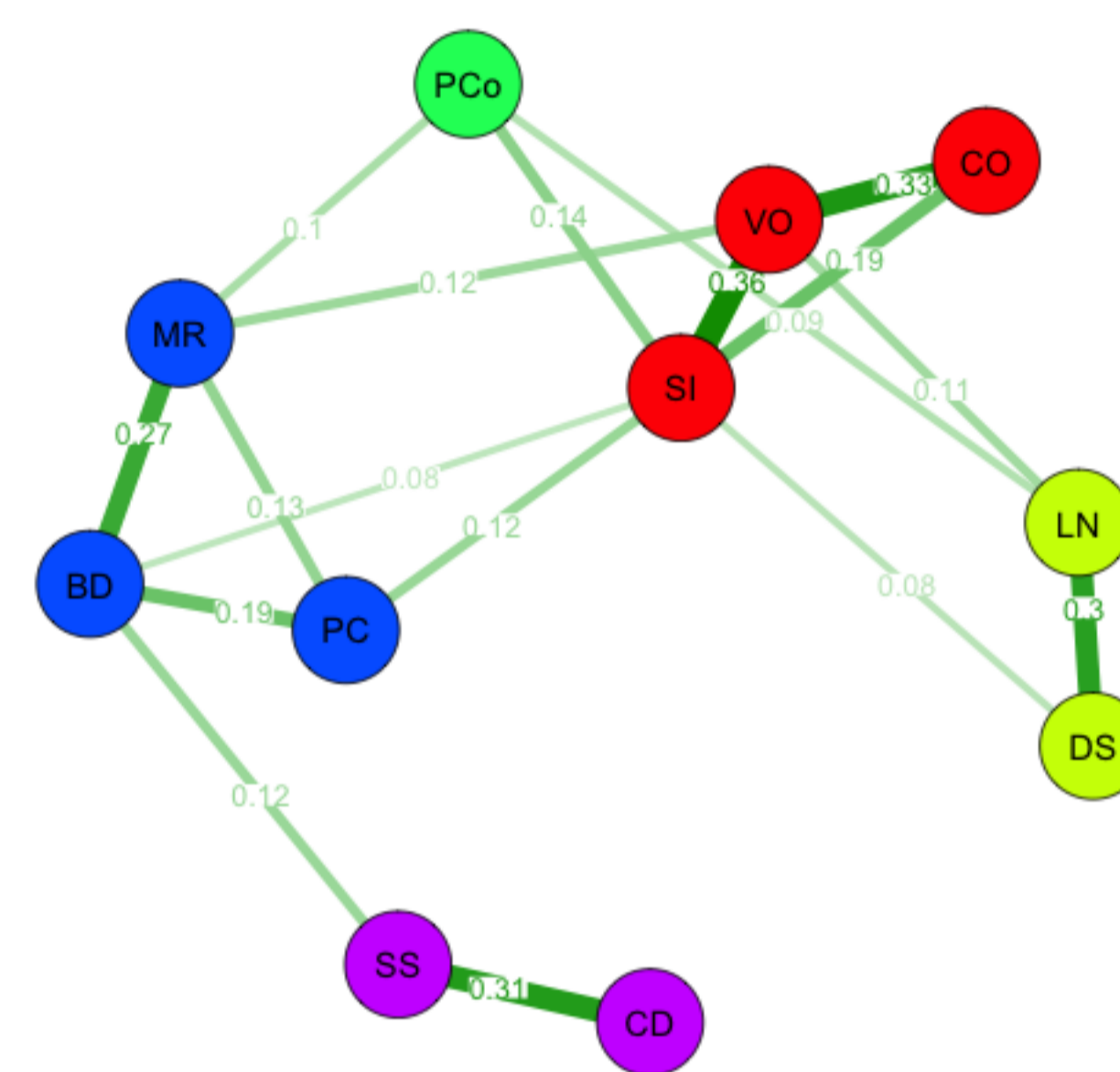
RESULTS

1. Estimation of the number of dimensions



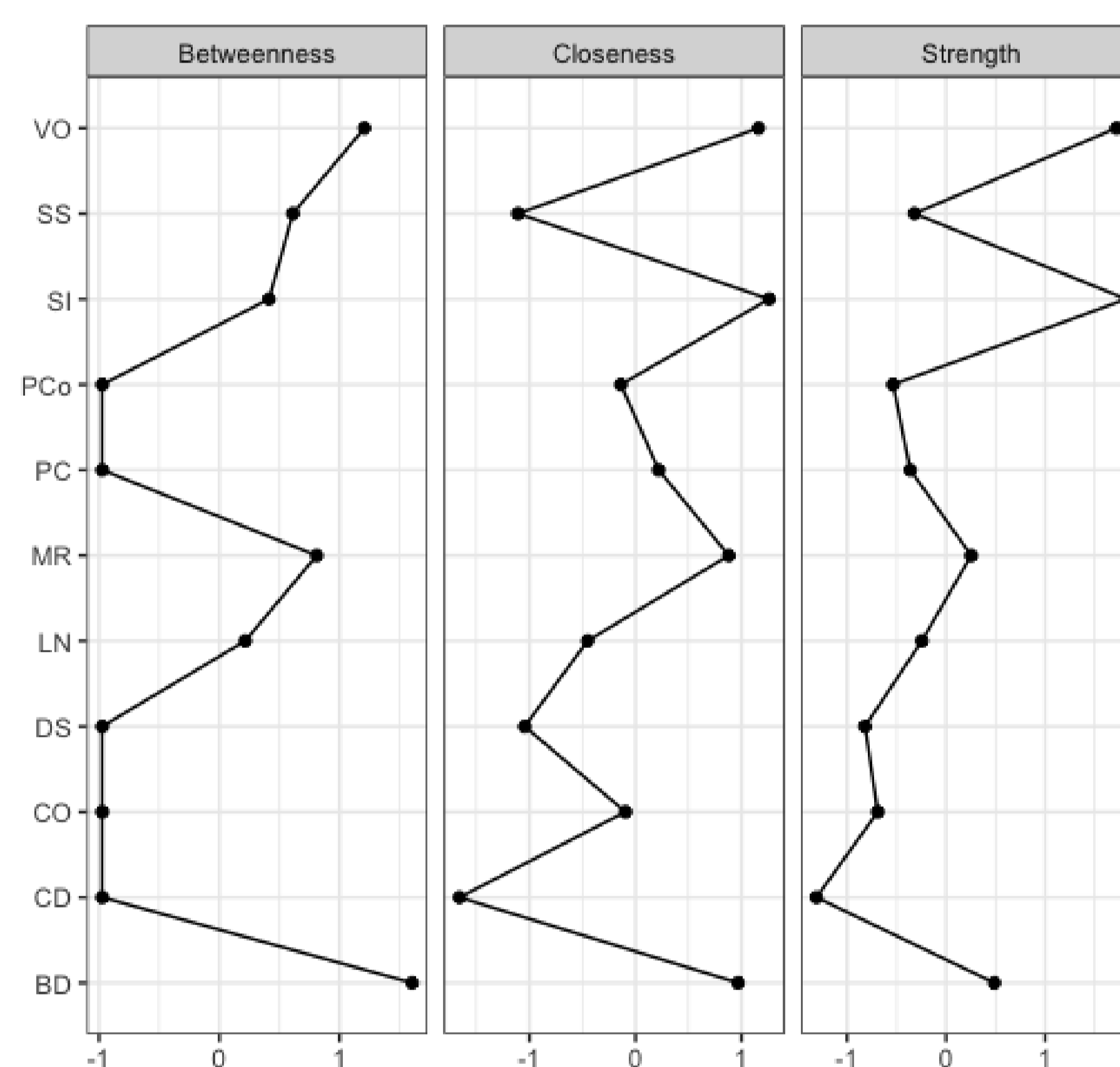
- EGA suggested to retain 4 dimensions.
- Green lines = positive correlations
- Thicker edge = larger correlation

2. Network structure (with significant edges only)



- Four clusters emerged: VC (SI, VO, CO); WM (LN, DS); PS (SS, CD); and VisuoSpatial (VS with BD, PC, MR)
 - Cluster : group of connected nodes
- PCo is related with VC, WM, and VS.

Centrality indices



- Betweenness:** how many shortest paths between 2 nodes go through the node in question. Includes direct and indirect connections of a subtests. A subtest with high betweenness is more important in connecting nodes.
- Closeness:** how strongly a node is indirectly connected to other nodes in the network.
- Node strength:** how strongly a node is directly connected to other nodes in the network.

CONCLUSIONS

- Network approach conceptualizes psychological dimensions as networks of psychological variables that directly interact with one another (without assuming a latent variable).
- Exploratory Graph Analysis (EGA) revealed 4 clusters.
- The clusters of nodes VC, WM, and PS in the network are equal with the 3 latent variables with factor analysis. Network analysis showed that the fourth dimension is more “VisuoSpatial” than “Perceptual Reasoning”.
- The three most central node in the network are Similarities, Vocabulary and Block Design. This finding is partially consistent with factor analysis that showed that g loadings of Similarities and Vocabulary tasks were the highest.
- In sum, broad abilities and general intelligence can be conceptualized as networks of basic components.