The Domain-Generality of Working Memory and Fluid Intelligence
A Psychometric Network Re-Analysis of Kane et al. (2004)

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Introduction

The Relationship between WM and Gf

- The multiple-component model describes working memory (WM) as a system with a central executive and subsystems for storage. Later theories focus on how attention-related individual differences reflect the cognitive mechanism of the central executive.
- Correlations among WM tasks support a domain-general interpretation of WM, where WMC is primarily linked to executive attention processes (EF) and related to higher-order cognitive abilities like fluid intelligence (Gf).
- Domain-specific patterns also exist, with WMC measures reflecting specific abilities like language comprehension or visuo-spatial abilities suggesting a hierarchical understanding of WM with multiple underlying factors.

Domain-General vs Domain-Specific

- **Kane et al. (2004)** used SEM to analyze verbal and spatial complex and simple span tasks, confirming that complex span tasks largely reflect a domain-general ability factor.
- The domain-general factor in WM tasks, likely reflecting EF, drives the predictive utility of WM measures to Gf, reflected by the common factor of reasoning tasks. Domain-specific variances, likely reflecting specific storage processes, relate strongly to domain-specific aspects of reasoning.
- Traditional reflective models assume common variance among tasks is caused by a general ability. Recently, we (Kovacs & Conway, 2019; Hao et al., 2024) interpret a portion of this shared variance among cognitive tasks as a formative factor, resulting from overlapping cognitive processes across tasks.
- Hence, psychometric network models are more appropriate than latent factor models for estimating these associations and mechanisms.

Methods & Results

We apply psychometric network models to Kane et al. (2004) data, aiming to provide new insights into the cognitive abilities underlying WM and Gf, proposing that traditional latent factor models may overemphasize domain-general components.

Data & Statistical Procedures

Kane et al. memory & Reasoning Tasks (N = 236)

- Complex Span tasks: Verbal (3) & Spatial (3)
- Simple Span tasks: Verbal (3) & Spatial (3)
- Reasoning tasks: Verbal (5), Spatial (5), & Fluid/Matrix (3)

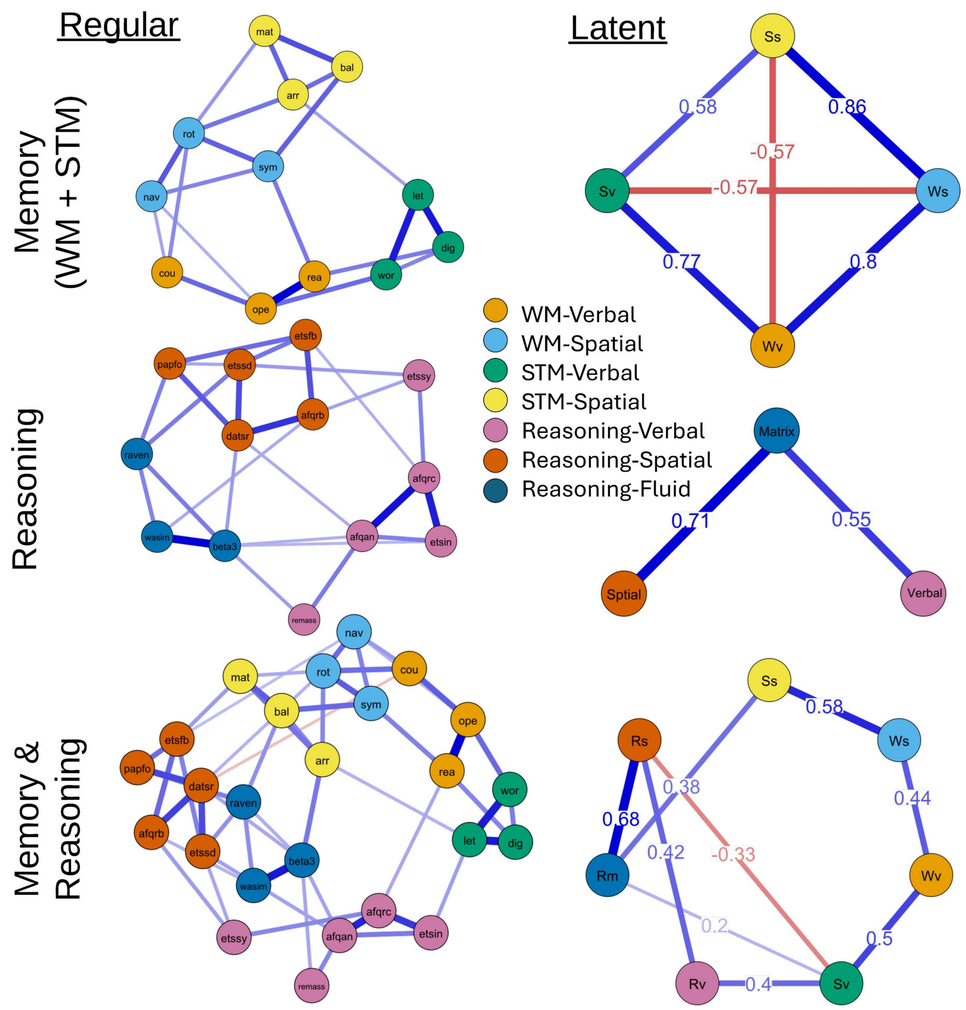
Network models of WM & Gf

- Regular Gaussian graphical network models and latent networks for memory only, Gf only, and together
- Regular network model: Non-directional, Weighted edges
- Latent network model: network model of latent factors

Summary of Results

- WM is a more domain-general construct than STM while there is still a strong influence of domain specificity, consistent with latent variable models in Kane et al.
- STM measures were strong predictors of domain-specific reasoning and less strong predictors of Gf.
- The conceptualization of Gf based on matrix reasoning tasks may be biased towards spatial abilities.
- Current network models did not clearly support WM as a stronger predictor of Gf and a weaker predictor of domain-specific reasoning.

Key Results



Conclusion

- **The results from the exploratory and data-driven network models were partially consistent with the original findings in the SEM models of Kane et al. (2014).**
- **Working memory and reasoning may have more domain-specific overlap than latent factor models suggest.**
- **Cognitive models of WM and reasoning emphasized domain-general mechanisms because conventional psychometric models estimated domain-general covariance through common factors.**

Other Findings from the Networks

- The “mediating” roles of STM nodes
- Paths between Ws & Wv and Rs & Rv
- Non-sig. path between Ss & Sv
- Interpretation of the negative paths