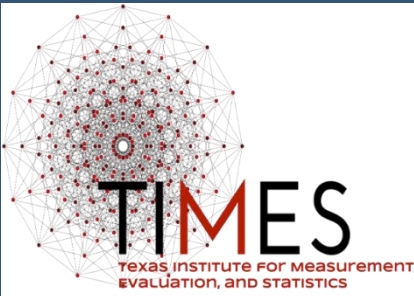**Texas Center for Learning Disabilities**

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The Role of Executive Functions in the Assessment, Identification, and Intervention for Students with Significant Reading Difficulties

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There are no conflicts of interest

Outline

- What is (are) Executive Function(s) (EF)?

- A Framework for EF in the Context of Reading

- EF Utilization: Research and Practice

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Conceptualizations

- EF: a many splendored thing

- Schools of thought (Conceptual)

  - Linkage to Brain (EF "proper"; Neuropsychology)

  - Broader than Cognition (Self-Regulation; Developmental, Clinical, Educational)

  - Limited Capacity (WM; Cognitive)

- Subdomains (Measurement)

  - WM, Inhibition, Shifting/Switching, Planning, Fluency

Definitions

- *Listing:*

- Strategic planning, impulse control, organized search, flexible thought and action

- Planning/sequencing, simultaneous attention, resisting interference, inhibiting inappropriate responses, and sustaining behavior

- The collection of working memory, inhibition, planning, self-regulation, problem solving, processing speed, and flexibility

Definitions (cont.)

- ***Integration/Control:***

- Optimizing performance when several simultaneous cognitive processes are required

- Discovery or following new rules of behavior regulation instead of established ones that don't work for the task at hand

- Domain general control processes involving inhibition and delayed responding

- Task analysis, strategy control (selection and revision), strategy monitoring

- The difference between "knowing" and "doing"

- Processes that guide/direct/manage, cognition/ emotion/behavior, during active novel problem solving

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Definitions (cont.)

- ***Goal Direction:***

- Capacities that enable a person to engage successfully in independent, purposive, self serving behavior

- Metacognitive capacity to perceive and respond adaptively, to flexibly change, to anticipate and consider consequences, and respond appropriately to serve a goal

- Organizing and managing goal directed behavior

- Integration of basic cognitive process to anticipate, form goals, plan, monitor results, and use feedback

- Maintenance of a set to achieve a goal

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EF Measurement: Dimensions

- Age appropriateness/specificity
- Complexity – the elemental v. molar continuum
- The "domain knowledge" it presumes
- Input and output response requirements
- Level of abstractness
- Psychometric properties (reliability/validity)
- Overlap with other EF measures
- The *type* of EF it assess

Measures by Type (Instructions)

- Type I. "Figure this out…"
- Type II. Analogy/Matrix/Abstraction
- Type III. "Plan how to do this. Here are some elements and rules. Don't make a mistake…"
- Type IV. "You want to do *that*. Do *this* instead…"
- Type V. "Do this.. and that…btw, keep track of this"
- Type VI. "Do what I know you can, but do it fast!"
- Type VII. "Do this simple/alternating task you are not all that familiar with…Fast!"
- Type VIII. "Do it this way…that way…that way… this way…"
- Type IX. "Let me ask your mom/spouse about this…"

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Models of EF

- Miyake et al. (2000, 2011)

- Stuss et al. (1986; 2011)

- Roberts & Pennington (1996)

- Shallice (1982)

- Baddeley and Central Executive (1976; 2014)

- Cowan/Engle and controlled attention (2001)

- Barkley (1990; 2014)

- Anderson (2004)

EF: Putting it all together

- *EFs: domain general control processes important for managing goal-directed behavior*

- EF is a process, not a thing (an it or a they)

- We have EF to (a) solve problems; (b) do things requiring effort; (c) act appropriately

- The goal is critical – attaining a goal is the "result" of EF

- EF is domain general, but tasks/goals will pull differentially for/from various modalities.

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Relation to Reading

- ***What does EF have to do with reading?***

- Comprehension > Fluency > Decoding

- Reading requires working memory, inhibition, shifting, planning, and fluency

- Reading requires ongoing monitoring of performance and integration of new information with background information

- Reading is a goal-directed behavior

EF and Reading

- You may have heard of "Brain Training" or "Working Memory Training"

- The arguments for these make logical sense and are scientifically interesting:

  - EF relates to A, B, and C. Therefore, if we increase EF, we also increase A, B, and C. That would be efficient.

- The evidence for these programs generalizing to academic skills is weak

- Integration with known intervention:

  - Directly

  - Indirectly
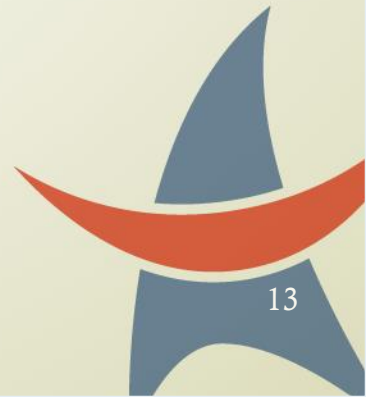
EF & Reading: Where are gaps?

- We know lots about:

  - Structure of EF at preschool and in adults

  - How individual EFs relate to reading (WM, then Inhibition, then…), and to pre-reading

- We know less about:

  - EF structure at school-age

  - How EFs overlap with one another and with strong covariates in predicting reading

- We focus on comprehension, comprehensive EF, large sample, predominantly at-risk

Outline

- What is (are) Executive Function(s) (EF)

- *A Framework for EF in the Reading Context*

- EF Utilization: Research and Practice

A Framework For EF

- A project of the Texas Center for Learning Disabilities

- Elucidate Structure

- Evaluate Developmental Complexity

- Contextualize With More Basic Processes

- Evaluate Predictive Power and Utility (for Reading Comprehension)

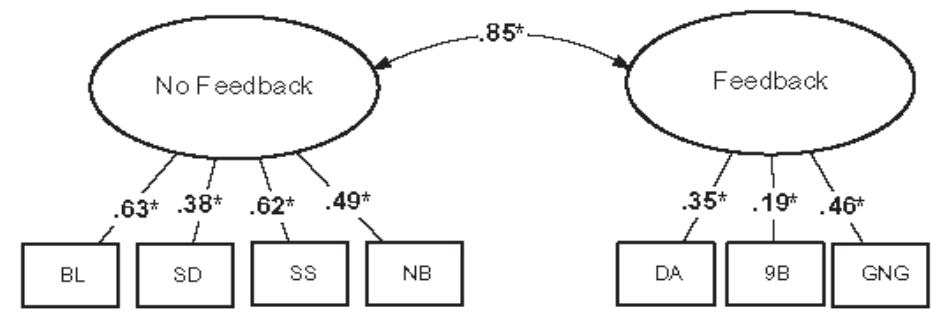- Experimentally Manipulate
  - Small Scale
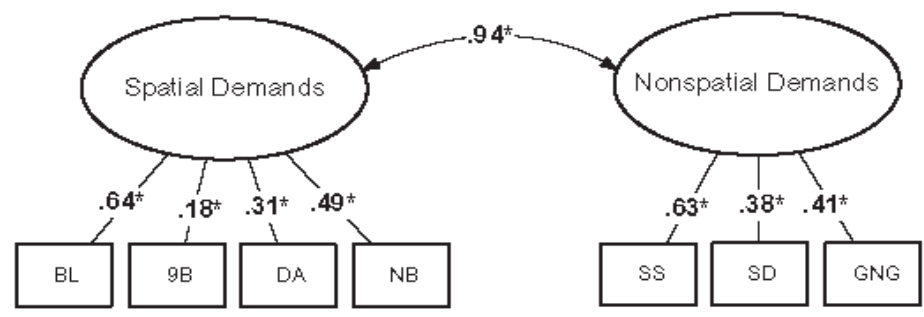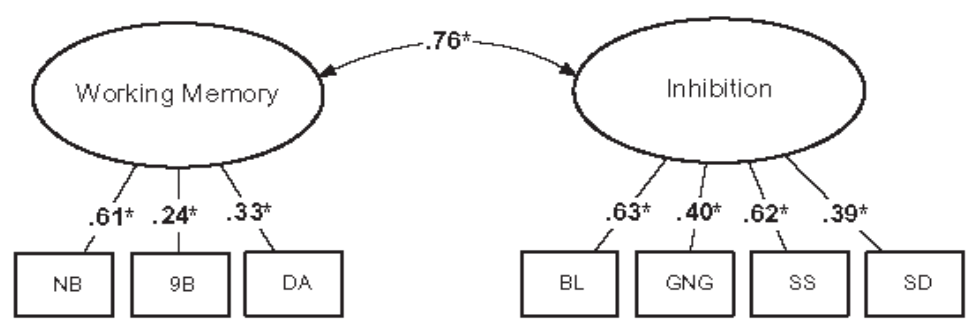 - Large Scale
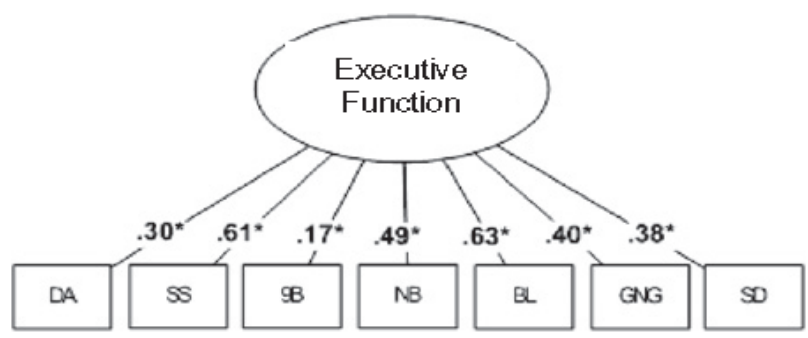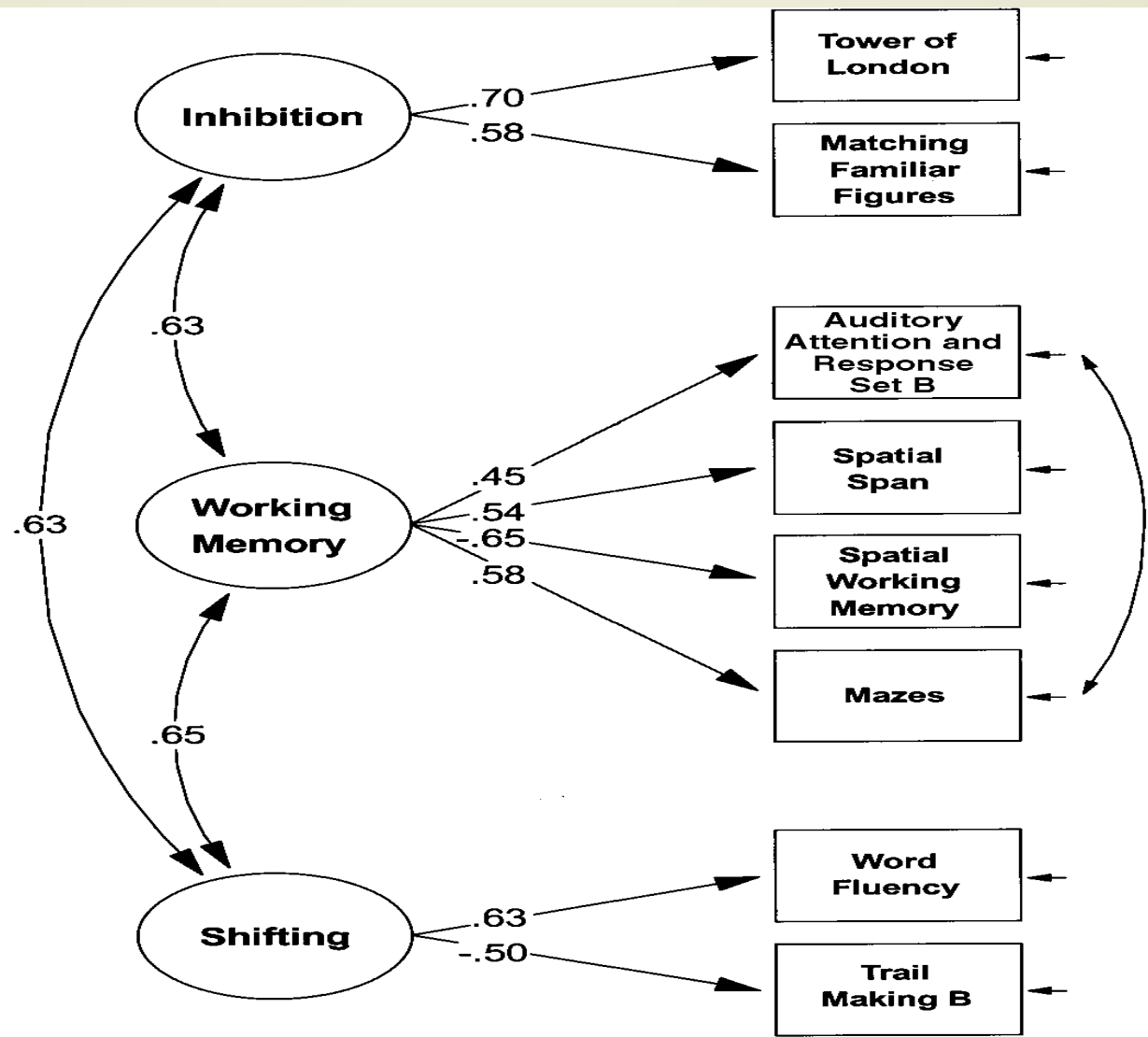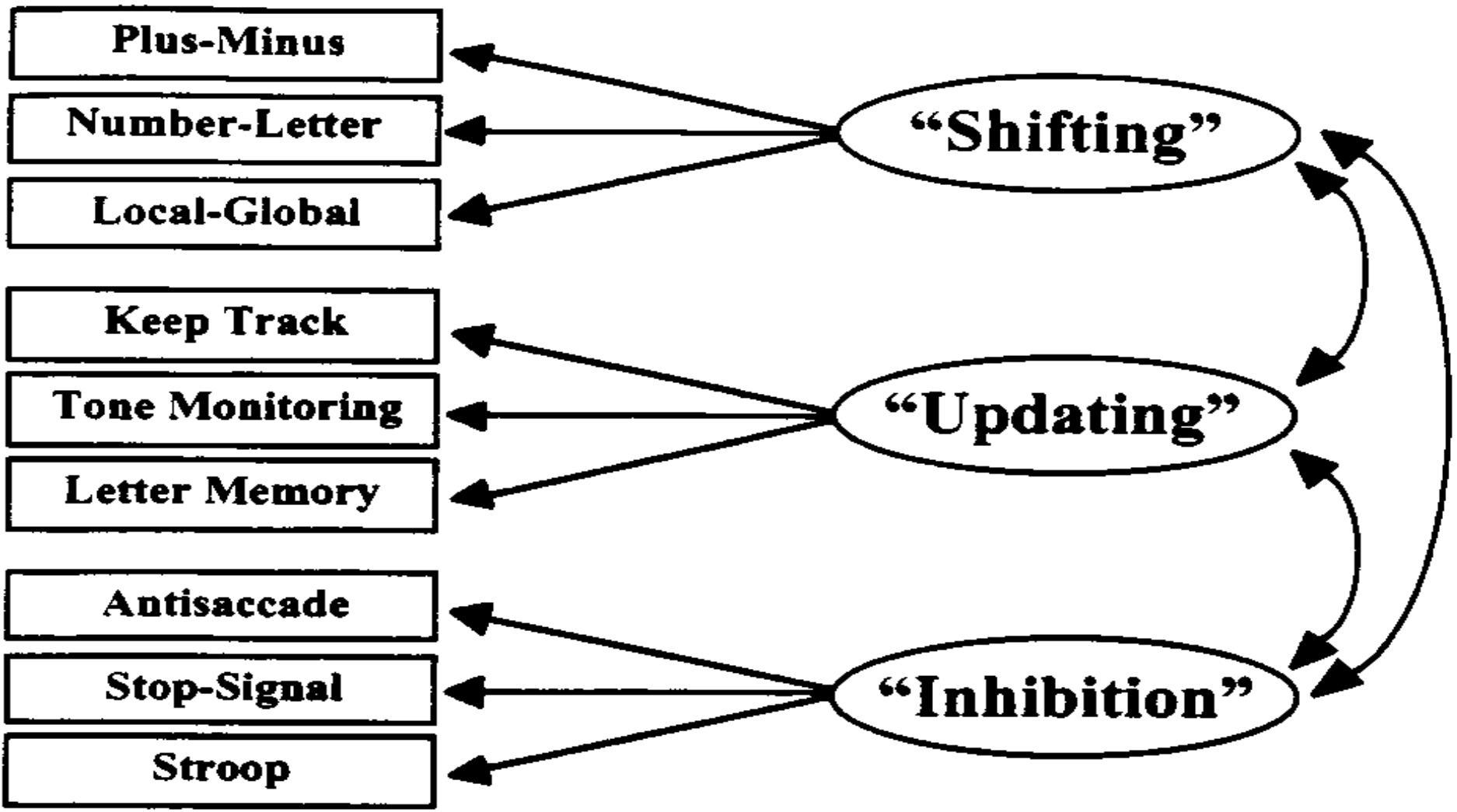
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Structure of EF: Preschool

Fig. 1. Alternative CFA models of preschool EF. 9B, Nine Boxes task; BL, Big–Little Stroop; DA, Delayed Alternation task; GNG, Go/No-Go task; NB, Nebraska Barnyard task; SD, Snack Delay task; SS, Shape School task (Inhibit condition). Standardized factor loadings and coefficients are shown.

Structure of EF: Children

Structure of EF: Adults

Participants

- 846 students from above-average risk schools

- Overlap with G4 intervention study

| Variable	Percent	Test	Mean (SD)
Limited English	23.4%	*WJ Letter-Word*	96.0 (13.5)
Sex (F)	51.5%	*TOWRE Sight*	87.6 (15.0)
Ethnicity	Hispanic 51.9% White 16.5% AAmer 29.2%	*Gates*	89.0 (15.0)
Grade	3 22.0% 4 57.2% 5 20.8%	*TOSREC*	83.4 (19.4)
Free Lunch	79.9%	*WJ Calculations*	102.0 (12.4)

Measures

- Multiple measures of EF, several subdomains:
  - Working memory (store, manipulate, update)
  - Inhibition (prepotent)
  - Shifting (two processes, back and forth)
  - Planning (goal/problem)
  - Fluency (generative, under parameters, timed)
  - Self-Regulated Learning (reading strategies, skill/preference, self-efficacy/effort)
  - Metacognitive (inattention)
  - Behavioral Regulation (hyperactivity, impulsivity)
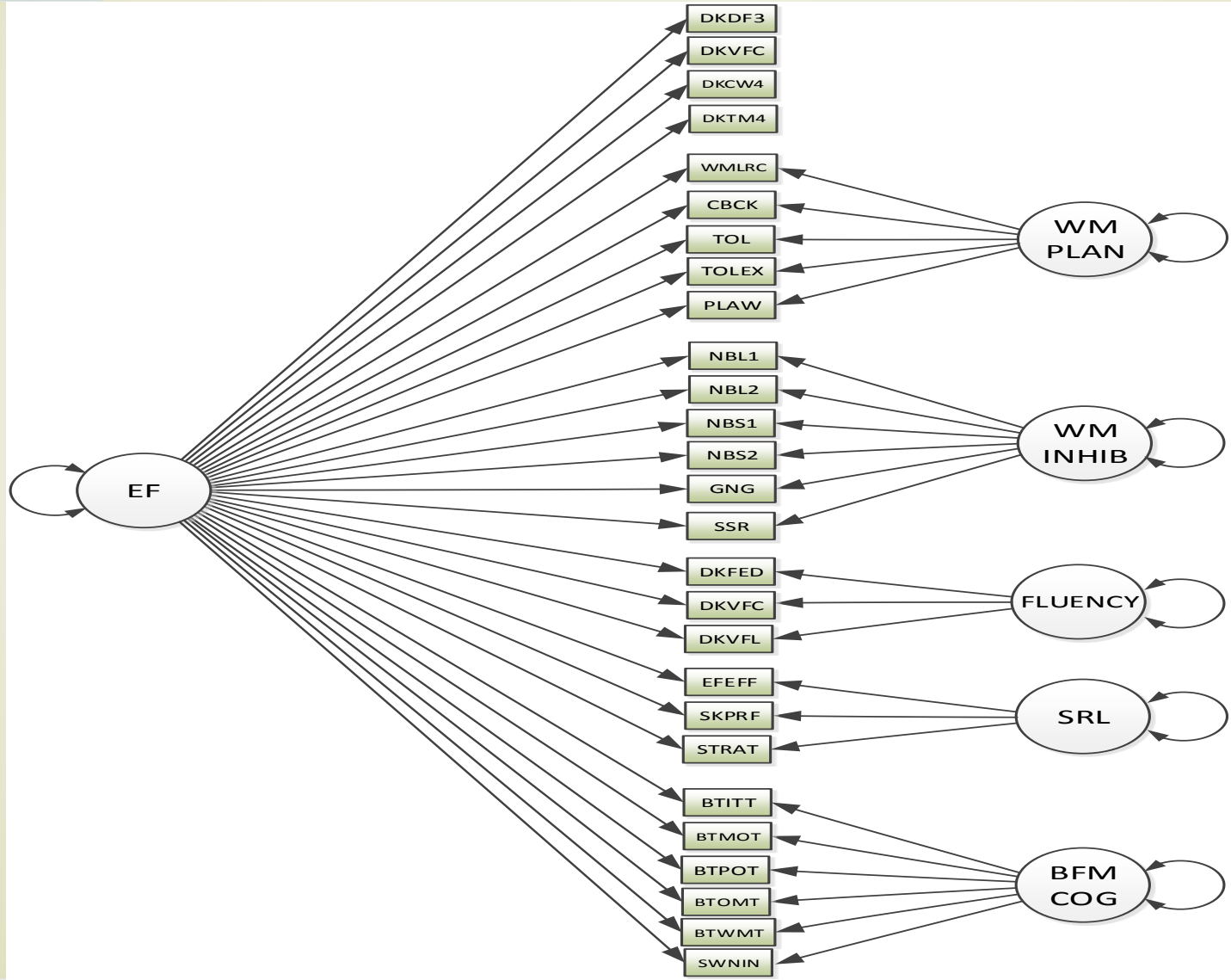
Issues Related to Assessing EF

- Psychometric
  - Which domains, across age, with strong reliability and validity

- Efficiency/Power
  - The minimum number and type for maximum impact

- Consistency
  - Among researchers, among clinicians, at the level of both measure and construct

- Covariance
  - Must consider related processes

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EF and Reading Via:

- Prediction

  - By correlating EF with reading

  - By evaluating how EF contributes to reading over known factors

- Identification

  - By evaluating what EF tells you about reading status on an individual basis

- Mechanism

  - By identifying ways in which intervention could be targeted at the group and individual level

EF Correlates with Reading

- Most distinctive factors from model are general EF, self-regulated learning, and behavioral inattention/metacognition

	General EF	SRL	Behavior
Decoding	.49	.08	.23
Fluency	.44-.52	.13-.19	.13-.18
Comprehension	.55-.61	.05-.07	.16-.20

Language Correlates with Reading

- Known relevant language components include vocabulary, phonological awareness, rapid naming, and oral comprehension

|	Vocab	PA	RAN	Oral Comp
Decoding	.50	.55	.38	.42
Fluency	.35-.60	.39-.42	.40-.63	.32-.57
Comprehension	.62-.65	.41-.46	.39, .39	.59-.64

Non-EF Predictors of Reading

- Age, Language Status, Ethnicity, Grade

- Collectively, these account for:
    - 27% decoding (all demo relevant)
    - 27% reading fluency (all demo relevant)
    - 30% reading comprehension (all demo relevant)

- Language Factors (Phonological Awareness, Rapid Naming, Vocabulary, Listening Comprehension)
    - 44% decoding (all but listening comprehension relevant)
    - 47% reading fluency (all but vocabulary relevant)
    - 46% reading comprehension (all relevant)

EF Predictors of Reading

- EF Alone:

  - 27% decoding (all EF relevant)

  - 24% reading fluency (all EF relevant)

  - 28% reading comprehension (general EF, WM/Plan, and Behavior)

- All Factors

  - 55% decoding (demographic, language, EF – general, WM/Plan, Fluency, SRL, Behavior)

  - 57% reading fluency (demographic, language, EF – general, WM/Plan, SRL, Behavior)

  - 57% reading comprehension (demographic, language, EF – general, WM/Inhibit, SRL, Behavior)
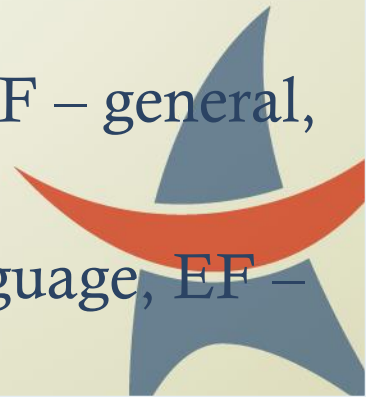
EF and Reading Identification

- If low on decoding (n = 157), 28% also low on EF

- If low on EF (n = 135), 33% also low on decoding

- If low on fluency (n = 387), 21% also low on EF

- If low on EF (n = 134), 60% also low on fluency

- If low on comprehension (n = 442), 25% also low on EF

- If low on EF (n = 132), 83% also low on comprehension

Language & Reading Identification

- If low on decoding (n = 158), 39% also low on LA

- If low on LA (n = 131), 47% also low on decoding

- If low on fluency (n = 388), 26% also low on LA

- If low on LA (n = 129), 78% also low on fluency

- If low on comprehension (n = 443), 28% also low on LA

- If low on LA (n = 129), 95% also low on comprehension

How to Include EF?

- Principled experimentation
  - An uphill climb for EF/WM per se
- Use as a supplement/adjuvant
  - Added on?
  - Incorporated into lesson planning
  - Integrated with extant validated intervention
- Approaches and concepts used in other areas:
  - Mahone & Slomine
  - Ylvisaker & Feeney
  - Graham & Harris

Conclusions

- EF and Reading are related
    - General EF and Metacognition/Behavior
    - Even in context of very strong "covariates"
    - Strong overlap in predictors (e.g., demographic, linguistic, EF).

- EF not sufficient, not demonstrably necessary, for identification of reading problems

- Intervening on EF to get to reading is inefficient, and therefore, the route must be indirect

- Need more data on best aspects of EF for which reading outcome, under which conditions.