Multidimensional IRT Analysis to Support Formative, Longitudinal Assessment of Early Childhood Development

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Symposium: Supporting Children's Early Learning and Kindergarten Goals with A Standards-Aligned Assessment: Effective Practices in Statewide Aggregate Reporting

AERA Annual Conference, 2019

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Overview

- DRDP's multidimensional models align with consensus views about K readiness

- Scores support statewide aggregate use (Talk 4) and formative assessment (Talk 5)

- Criticism about high correlations between dimensions overlooks atypical learners

Measurement considerations for KEAs[1]

- Multidimensionality
- Use(s)
- Underlying conceptions/theories of development
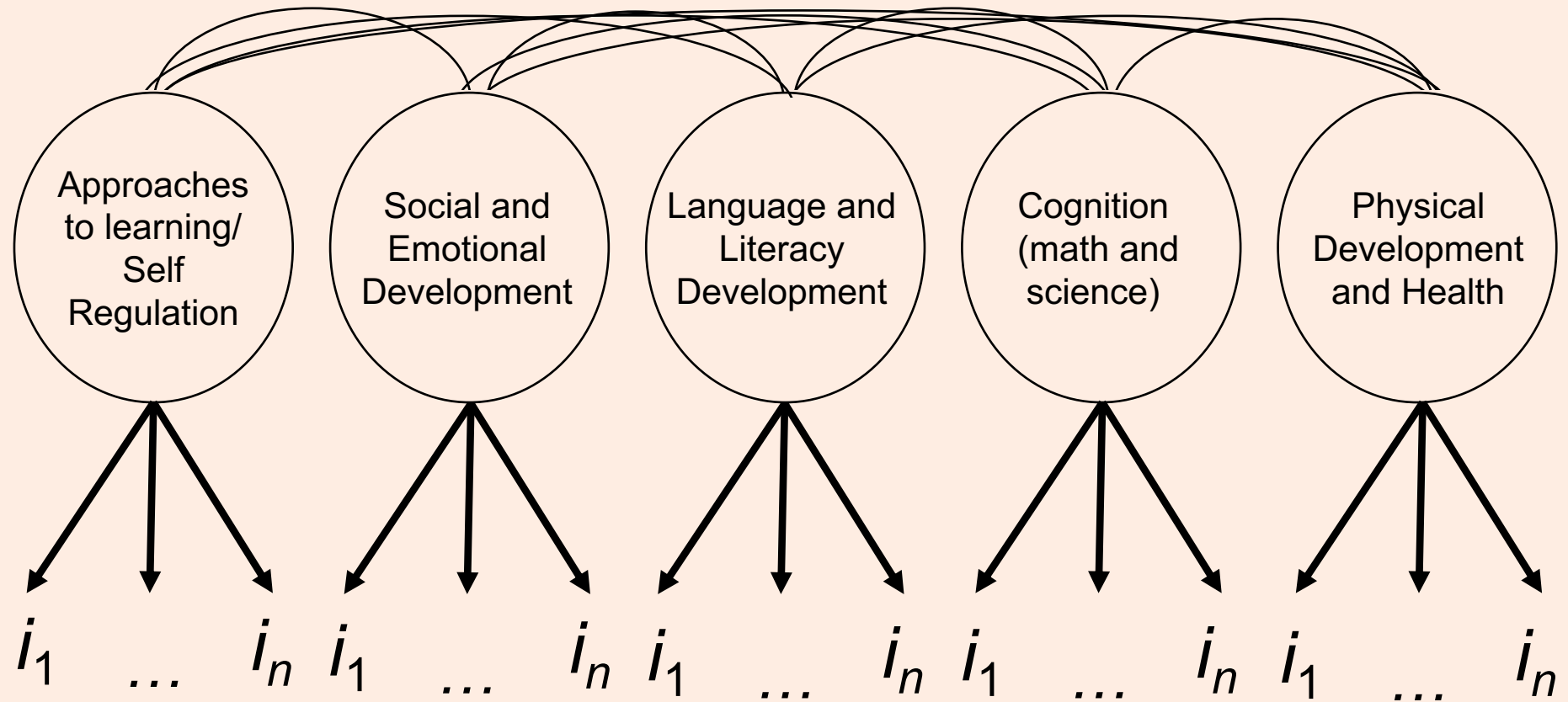
1. Ackerman, 2018; Snow, 2006.

KEA measurement models

- Relaxed measurement
- Unidimensional/partial multidimensional models
- Multidimensional models

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Multidimensional model for the DRDP

DRDP model affordances

- Multiple domains supply reliable and valid diagnostic information about devleopment[2]
  - Aggregate data for statewide reporting
  - Individual-level data for formative assessment
- Standard setting for K readiness in multiple dimensions

2. DRDP Collaborative Research Group, 2018

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Criticism

- Correlations between dimensions tend to be 0.8 or greater.

- These correlations are too high.
  - Do the subscales provide meaningful information?
  - Don't they measure identical constructs?
  - Isn't a unidimensional model a more parsimonious solution?

Comparative case analysis
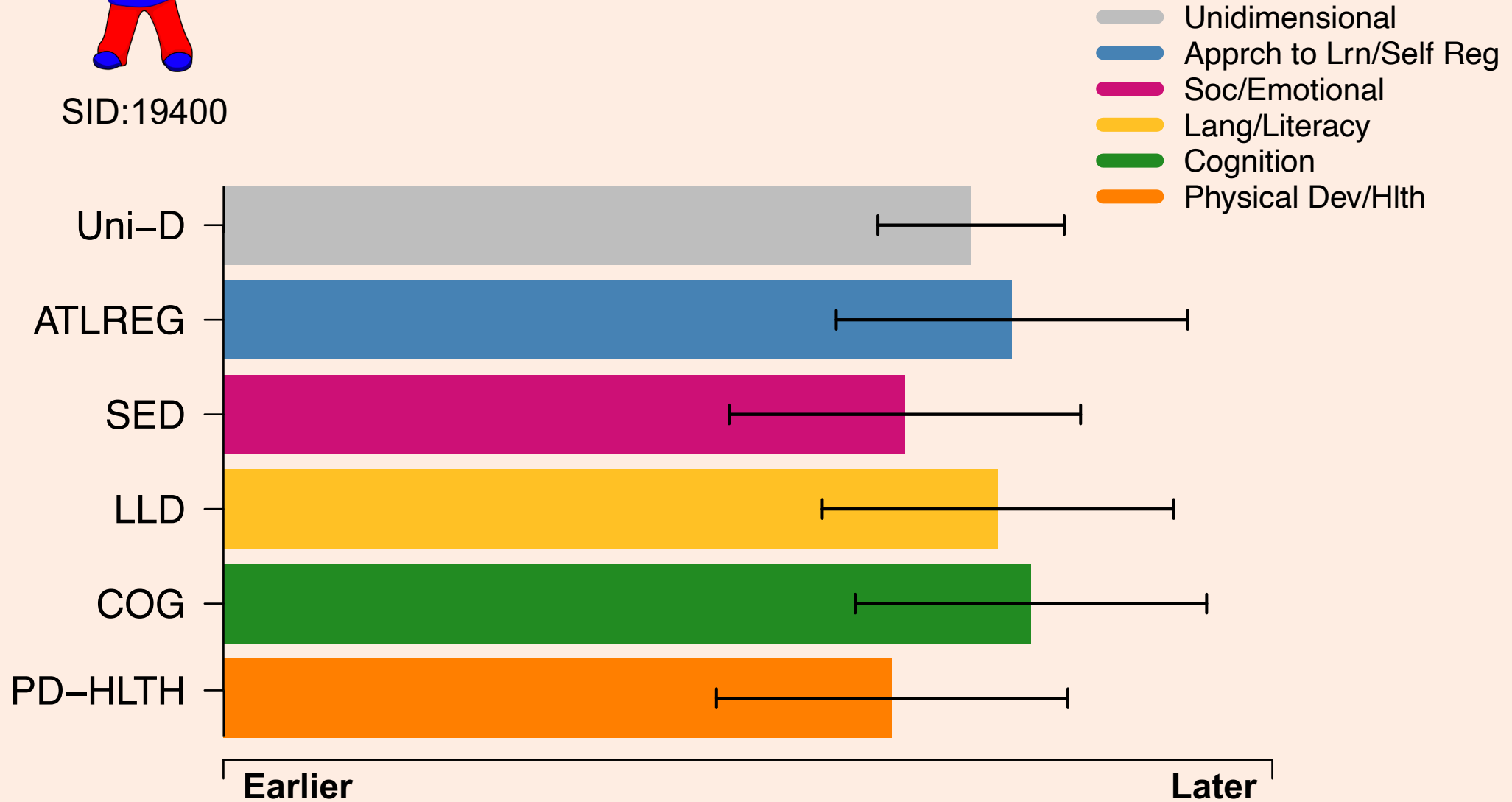
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Earlier Development **Later**

Unidimensional Score

Discrepant case analysis

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Earlier   Development   **Later**
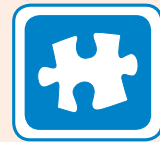
Unidimensional Score

Discrepant case analysis
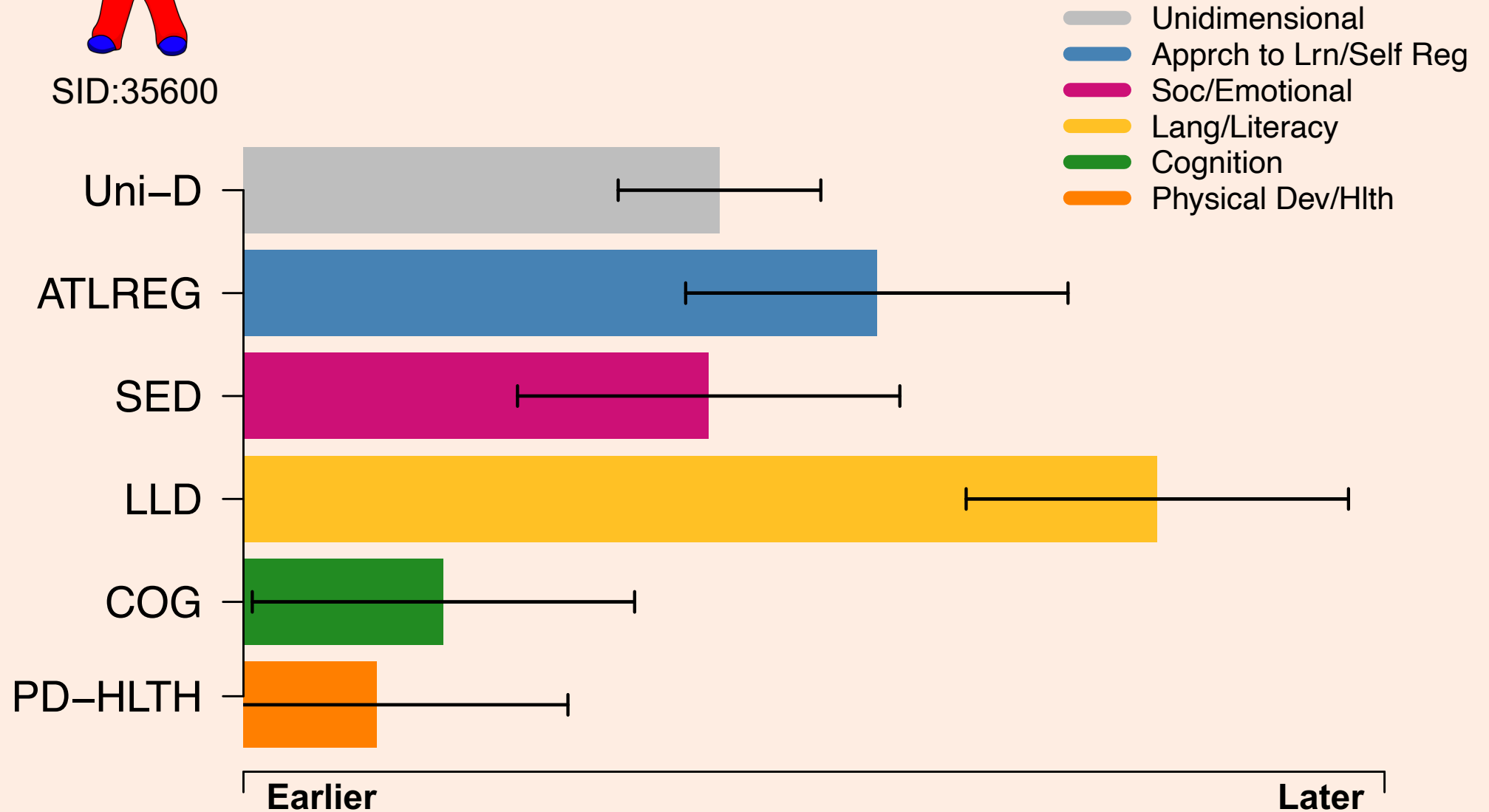
How many children are "discrepant?"

- Different calculations are possible (c.f., Briggs & Wilson, 2003)

$$Discrepancy_{cd} = Multidimensional_{cd} - Unidimensional_c$$

for child *c* and dimension *d*

- **Outcome**: What % of children have a statistically significant discrepancy?

- **Effect size:** How large are the discrepancies?
  - Months of development

Percentage of discrepant children

Domain	Discrepancy	Months of Development	
	%	*Median*	*SD*
ATL-REG	14.6	10.5	12.6
SED	11.9	9.7	11.5
LLD	11.3	6.7	8.3
COG	13.7	7.8	9.5
PD-HLTH	27.0	7.6	8.8

ATL-REG: Approaches to Learning and Self Regulation

SED: Social and Emotional

LLD: Language and Literacy

COG: Cognition

PD-HLTH: Physical Development and Health

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Thank you

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1. Ackerman, D. J. (2018). *Real world compromises: Policy and practice impacts of kindergarten entry assessment-related validity and reliability challenges* (Research Report No. RR-18-13). Princeton, NJ: Educational Testing Service.

2. Briggs, D. C., & Wilson, M. (2003). An introduction to multidimensional measurement using Rasch models. *Journal of Applied Measurement, 4,* 87-100.

3. DRDP Collaborative Research Group. (2018). *Technical Report for the Desired Results Developmental Profile* (2015). Report prepared for the California Department of Education.

4. Snow, K. (2006). Measuring School Readiness: Conceptual and Practical Considerations. *Early Education and Development, 17*, 7–41.

Appendix
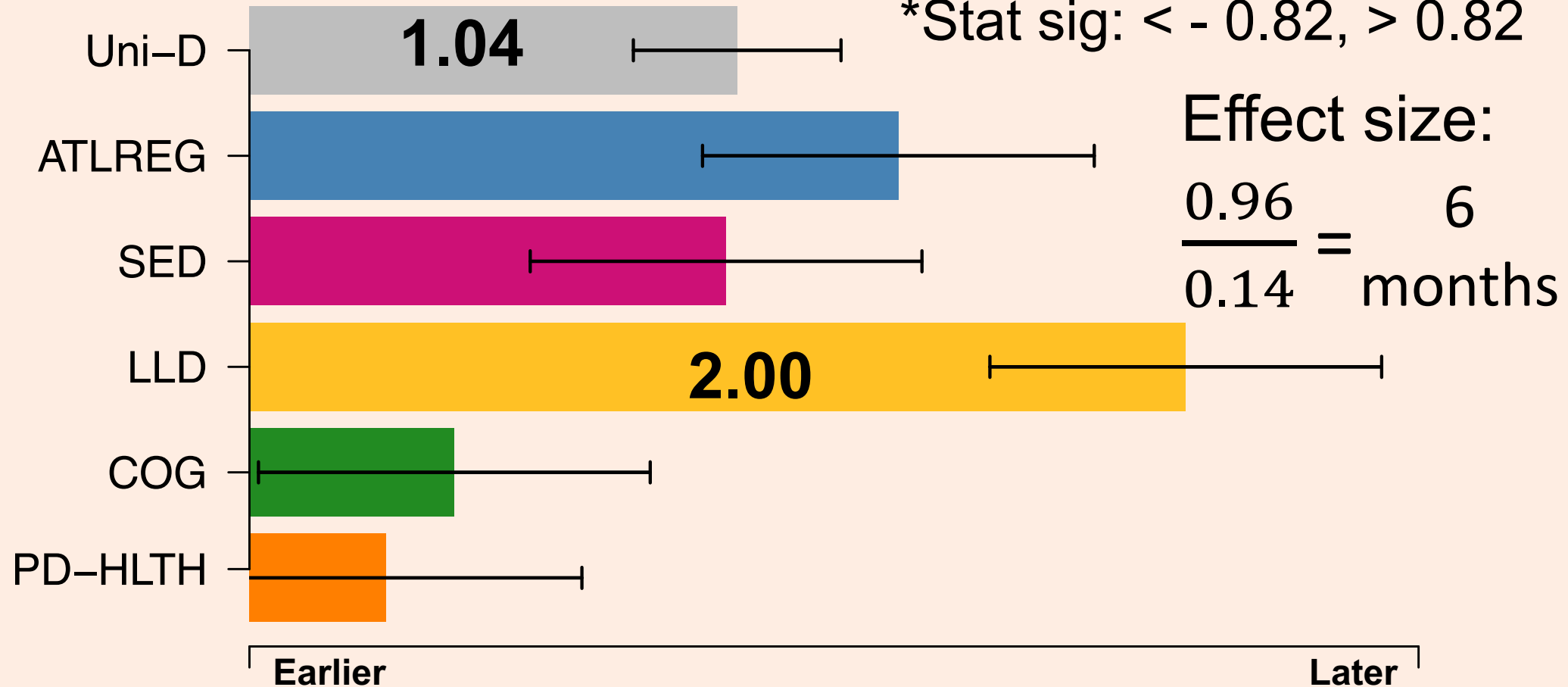
Each dimension represents a developmental scale

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Language and Literacy Development (LLD)

Responding Earlier	Responding Later	Exploring Earlier	Exploring Middle	Exploring Later	Building Earlier	Building Middle	Building Later	Integrating Earlier

Early Infancy ·· Kindergarten Entry

Developmental Domain: LLD — Language and Literacy Development

LLD 10: Emergent Writing
Child shows increasing ability to write using scribbles, marks, drawings, letters, characters, or words to represent meaning*

Mark the latest developmental level the child has mastered:

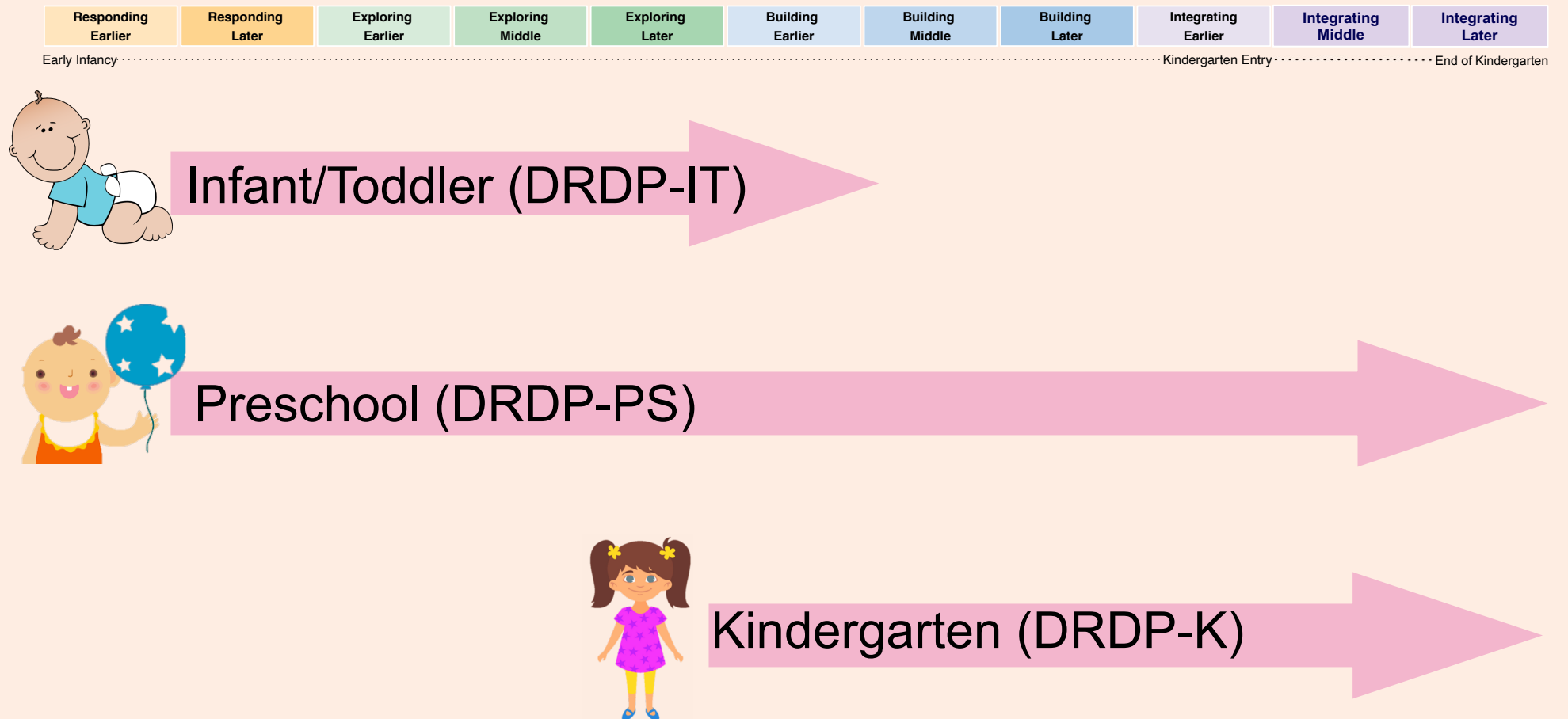| Responding		Exploring			Building			Integrating
Earlier	**Later**	**Earlier**	**Middle** ○	**Later** ○	**Earlier** ○	**Middle** ○	**Later** ○	**Earlier** ○
		There are no earlier levels for this measure	**Makes marks on paper**	**Makes scribble marks**	**Makes scribble marks or simple drawings that represent people, things, or events**	**Makes marks to represent own name or words**	**Uses letters or clearly recognizable approximations of letters to write own name**	**Writes several words or a few simple phrases, or clearly recognizable approximations**
Possible Examples			• Dips sponge in paint and dots onto paper. • Makes a dot on a paper and then makes more	• Uses crayons, pencils, or markers to make back-and-forth marks. • Paints using large or	• Draws circles and lines and comments, "Baby," and "Mommy." • Makes marks on paper	• Makes marks that are linear and spaced like letters or words while writing a pretend	• Writes own name on drawings made in class. • Signs a self-made card	• Writes, "bog" ["*dog*"], copying the word from a book, to label a drawing of a dog.

Three DRDP instruments span development

Responding Earlier	Responding Later	Exploring Earlier	Exploring Middle	Exploring Later	Building Earlier	Building Middle	Building Later	Integrating Earlier	Integrating Middle	Integrating Later

Early Infancy .... Kindergarten Entry .... End of Kindergarten

Infant/Toddler (DRDP-IT)

Preschool (DRDP-PS)

Kindergarten (DRDP-K)

ATL-REG Domain: Labels Used in DRDPtech to Identify the Transitions Between Developmental Levels within Each Measure

DRDP (2015): Approaches to Learning – Self-Regulation (ATL-REG)		View	Responding		Exploring		Building			Integrating		
			Earlier	Later	Earlier	Later	Earlier	Middle	Later	Earlier	Middle	Later
			RE	RL	EE	EL	BE	BM	BL	IE	IM	IL
			RE	RL	EE	EL	BE					
ATL-REG1	Attention Maintenance	IT PS*	0	1	2	3	4					
			RE	RL	EE	EL	BE					
ATL-REG2	Self-Comforting	IT PS*	0	1	2	3	4					
			RE	RL	EE	EL	BE					
ATL-REG3	Imitation	IT PS*	0	1	2	3	4					
			RE	RL	EE	EL	BE	BM	BL	IE	IM	IL
ATL-REG4 for IT-PS (ATL-REG1 for K)	Curiosity and Initiative in Learning	IT PS K	0	1	2	3	4	5	6	7	8	9
			RE	RL	EE	EL	BE	BM	BL	IE	IM	IL
ATL-REG5 for IT-PS (ATL-REG2 for K)	Self-Control of Feelings and Behavior	IT PS K	0	1	2	3	4	5	6	7	8	9
					EE	EL	BE	BM	BL	IE	IM	IL
ATL-REG6: for PS (ATL-REG3: for K)	Engagement and Persistence	PS K			0	1	2	3	4	5	6	7
					EE	EL	BE	BM	BL	IE	IM	IL
ATL-REG7: for PS (ATL-REG4: for K)	Shared Use of Space and Materials	PS K			0	1	2	3	4	5	6	7

DRDP Linking

- Overlap between measures and categories
- One continuous measurement scale
- Reliability and validity evidence[2] supports the use of aggregate scores for…
  - State reporting
  - Assessing change

2. DRDP Collaborative Research Group, 2018