A Novel Means-End Problem Solving Assessment Tool (MEPSAT): Evaluation of Validity and Reliability

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Introduction

Means-end problem-solving (MEPS) tasks can serve as early indicators of infants' cognitive development (Lobo & Galloway, 2013). Previous studies have highlighted delays in performance and learning of MEPS in at-risk infants compared to typically developing infants (Clearfield et al., 2015; Cunha et al., 2018).

However, real-time identification of delays in MEPS can be challenging since MEPS behaviors have traditionally been analyzed using time-intensive behavioral coding methods (Babik et al., 2018; Cunha et al., 2018).

To provide an affordable and feasible assessment of MEPS for research and clinical settings, we developed a novel Means-End Problem-Solving Assessment Tool (MEPSAT).

The goal of this study was to evaluate construct validity and reliability of the MEPSAT.

Methods

- 22 typically developing infants (Mean=5.9 months at the first visit; SD=0.2) and 30 infants with motor delays [Mean=10.4 months (prematurity-corrected) at the first visit; SD=2.4].
- Infants were assessed longitudinally at 5 visits across 1-1.5-years in their homes.
- At each visit, infants engaged in a MEPS task: pulling a towel to retrieve a distant, supported toy (Figure 1).

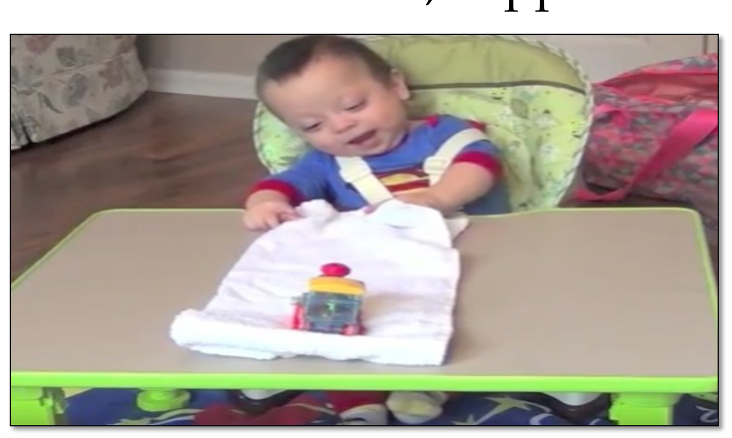

Figure 1. Experimental setup for the means-end problem solving assessment.

- The MEPSAT was used to score from videos: 1) Means-end learning; and 2) level of performance (Figures 2 A-B).
- Infants were also assessed using the Bayley Scales of Infant and Toddler Development (Bayley-III).

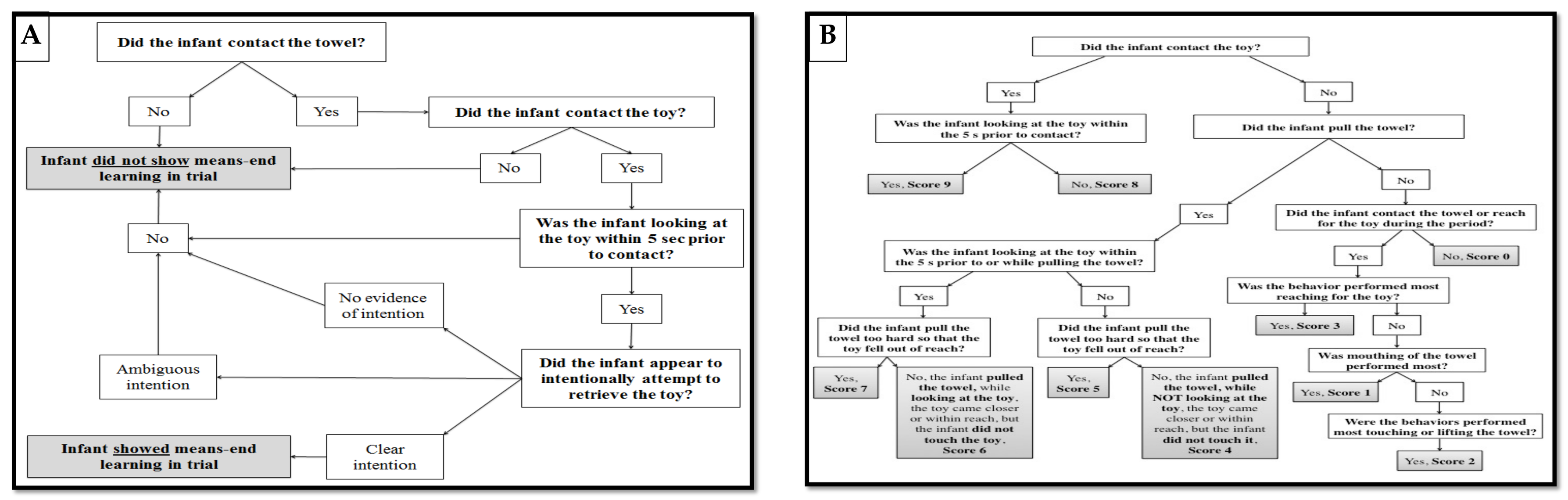

Figure 2. Means-end Problem Solving Assessment Tool (MEPSAT): A) Determination of learning; B) Rating the level of means-end performance on a scale from 0 through 9.

- *Validity of the MEPSAT scores:* Validated against cognitive and motor subscales of the Bayley-III. Within-infant associations and between-infant associations were evaluated by linear mixed modeling (LMM).
- *Reliability of the MEPSAT scores:* Intra- and inter-rater reliability were evaluated via re-scoring of videos. It was calculated by quadratic weighted dependent kappas and intraclass correlation coefficients (ICC).

Results

Validity

- Significant within-child associations (p<.05) were observed between MEPSAT scores and Bayley-III scores for both typically developing children and those with motor delays
- Significant between-child effects (p<.05) were observed only for children with motor delays.

Table 1. Associations between MEPSAT outcomes (means-end learning and level of means-end performance) and Bayley-III.

Means-End Learning vs. Bayley Scores									
		Within-Infant Effects				Between-Infant Effects			
Sample	Bayley	β	SE	p	f^2	β	SE	p	f^2
Typical	Cog	0.56	0.09	**<.001**	0.10	0.03	0.04	0.559	0.02
Motor delay	Cog	0.17	0.05	**0.001**	0.11	0.52	0.13	**<.001**	0.63
Typical	FM	0.59	0.09	**<.001**	0.22	0.02	0.05	0.739	0.03
Motor delay	FM	0.16	0.04	**<.001**	0.14	0.59	0.13	**<.001**	0.77
Typical	GM	0.58	0.09	**<.001**	0.35	0.00	0.06	0.977	0.05
Motor delay	GM	0.22	0.05	**<.001**	0.20	0.46	0.14	**0.002**	0.40
Level of Means-End Performance vs. Bayley Scores									
		Within-Infant Effects				Between-Infant Effects			
Sample	Bayley	β	SE	p	f^2	β	SE	p	f^2
Typical	Cog	0.45	0.10	**<.001**	0.03	0.01	0.04	0.831	0.01
Motor delay	Cog	0.10	0.05	0.059	0.03	0.60	0.12	**<.001**	1.15
Typical	FM	0.47	0.10	**<.001**	0.05	-0.02	0.05	0.606	0.00
Motor delay	FM	0.12	0.04	**0.008**	0.07	0.68	0.11	**<.001**	1.49
Typical	GM	0.49	0.09	**<.001**	0.18	0.01	0.07	0.926	0.03
Motor delay	GM	0.15	0.05	**0.006**	0.08	0.54	0.13	**<.001**	0.71

- For both groups, variations in MEPSAT scores across time were related to variations in the Bayley-III scores across time
- Children with motor delays who showed greater MEPSAT scores on average also had higher Bayley-III scores on average.

Results

Reliability

- Strong intra- and inter-reliability of means-end learning and level of means-end performance scores was found for both typically developing children and children with motor delays.

Table 2. Table 3. Intra- and inter-rater reliabilities (with 95% CI) for MEPSAT scores

Quadratic Weighted Dependent Kappas for Means-End Learning		
Sample	Inter-Rater Reliability	Intra-Rater Reliability
Typical	.869 (.785, .952)	.936 (.854, >.999)
Motor delay	.979 (.965, .993)	.857 (.730, .985)
Intraclass Correlation Coefficients for Level of Means-end performance		
Sample	Inter-Rater Reliability	Intra-Rater Reliability
Typical	.995 (.992, .999)	.998 (.995, >.999)
Motor delay	.997 (.995, .999)	.996 (.992, >.999)

Conclusions

- The MEPSAT is supported by validity and reliability evidence and is thus a promising tool for screening to identify early problem-solving delays in infants with a range of motor abilities.
- The MEPSAT can be performed in the home environment quickly and with minimal resources.
- The. MEPSAT has a simple scoring system that can distinguish differences in performance among infants with varying levels of motor delay and detect changes in performance for a child across time.
- The MEPSAT can be used in clinical and research settings to assess the efficacy of interventions aimed at advancing problem-solving skills, motor ability, and cognitive outcomes in at-risk infants.

References

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