Development of Means-End Problem-Solving in Infants Born Preterm vs. Full-Term
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Introduction
Infants born preterm are at risk for delays in cognitive, perceptual-motor, and problem-solving abilities (Jongbloed-Pereboom et al., 2012); this can negatively impact school readiness and academic achievement (Pritchard et al., 2009; Taylor et al., 2011).

Infants born preterm may demonstrate learning impairments as early as at the first months of life. Means-end learning assessments may be more effective than standardized assessment tools for identifying very early learning delays in this population (Lobo & Galloway, 2013). The purpose of this study was to longitudinally evaluate problem-solving behaviors in two means-end tasks in infants born preterm or full-term. We hypothesized that preterm infants would display delays in problem-solving behaviors, and we aimed to determine the motor behaviors associated with successful problem solving to be targeted by future interventions to facilitate early learning for at-risk infants.

Methods
Participants:
- Infants born full-term (FT): n = 23, 13 males, 39.4 ± 1.1 weeks gestational age.
- Infants born preterm (PT): n = 30, 10 males, 26.7 ± 0.3 weeks gestational age.

Procedure:
- The infants were assessed longitudinally in their homes at 6, 9, 12, 18, and 24 months (corrected age for infants born preterm) in a towel (Figure 3A) and turntable (Figure 3B) means-end tasks.
- Each task had three 30-second trials: the toy (end-object) was placed on the far end of the towel/turntable (means-end tasks).
- Behaviors were coded using OpenSHAPA software and classified as Goal-Directed (GDB; those likely to result in toy attainment) or Non-Goal-Directed (NGDB; those not likely to result in toy attainment).
- A successful trial occurred when the infant contacted the toy while looking at it before the end of the trial.

Statistical Analyses:
- Statistical analyses were conducted using Hierarchical Linear and Nonlinear Modeling Software (HLM; Raudenbush et al., 2004) and binomial logistic regression.

Results
- Infants born PT performed less GDB and more NGDB than those born FT (Figure 2; GDB Towel: t(51)=1.89, p=.065; GDB Turntable: t(51)=2.29, p=.026; NGDB Towel: t(51)=1.89, p=.064; NGDB Turntable: t(244)=2.28, p=.023).
- Infants born PT were less successful in both tasks than those born FT throughout the first 24 months (Figure 1; Towel: R²=0.32, χ²(2)=198.8, p<.0001; Turntable: R²=0.39, χ²(2)=251.3, p<.0001).
- Performance of more GDB was related to increased trial success (Towel: R²=0.53, χ²(2)=367.2, p<.0001; Turntable: R²=0.65, χ²(2)=480.3, p<.0001), while more NGDB was related to decreased success (Towel: R²=0.33, χ²(2)=201.7, p<.0001; Turntable: R²=0.48, χ²(2)=521.7, p<.0001).

Discussion
- Goal-directed behaviors (GDB) were strongly associated with more successful means-end problem solving, whereas non-goal-directed behaviors (NGDB) were related to less success.
- As infants born PT performed less GDB and more NGDB than their FT peers, they showed less success in problem solving throughout the first two years of life.
- Since the development of means-end problem solving is foundational for future social, cognitive, and linguistic development, means-end assessments might serve as a convenient diagnostic tool for identifying early delays in at-risk infants.
- Interventions should focus on:
  - Encouraging a high amount and variability of behavioral exploration in the early stages of learning
  - Encouraging looking at the end object even when acting on the means object to observe the consequences of one’s behaviors
  - Encourage the performance of more goal-directed behavior in the later stages of learning

References
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