Reproducibility Of Neonatal Behavioral Assessments

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Background

- The Neonatal Behavioral Assessment Scale (NBAS) has been used in studies of effects of environmental toxicants on neonatal behavioral development.
- However, little is known about its reproducibility or predictive value.
- The NBAS consists of 18 neonatal reflexes, and 28 behavioral items.
- Scoring: 1 to 9 (higher score *typically* indicates better performance)
- Previous studies have used factor analysis to reduce 24 of the NBAS behavioral items into 6 groups:
  1. *Orientation* (average of 7 items)
  2. *Range of State* (average of 4 items)
  3. *Regulation* (average of 2 items)
  4. *Response Decrement* (average of 4 items)
  5. *Autonomic maturity* (average of 3 items)
  6. *Tone* (average of 4 items)

Objectives

- To assess the reproducibility of the previously defined NBAS behavioral clusters in the first three weeks of life.
- To assess potential socio-demographic sources of variability in NBAS performance.

Study Area

Study Location: New Bedford Harbor, MA, USA

The New Bedford Harbor in southeastern Massachusetts, USA is contaminated with PCBs as a result of disposal from local electronics manufacturers from 1940 until 1977. In 1982, the harbor was placed on the National Priorities List for clean-up. As part of the Superfund remediation plan, sediments were dredged between April 1994 and September 1995.

Methods

- 788 mother-infant pairs were recruited at birth at a local hospital between March 1993 and December 1998 for a study of PCBs and fetal/infant development.
- The mothers had resided in the four towns bordering the New Bedford PCB-contaminated site for the duration of pregnancy.
- The infants were primarily full term, healthy singletons.
- Participating infants had up to two neonatal examinations (N=440 had both):
  - Birth exam at ages 1-3 days (N=571)
  - 2-week exam at ages 7-21 days (N=578)
- Trained nursing staff performed the assessments. Inter-observer reliability was ≥ 90%.
- Factor analysis was used to reduce the 24 NBAS behavioral items into 6 clusters. Each factor (latent variable) included items with large absolute value of factor loadings (correlations).
- Missing items are common due to the state-dependent nature of this exam.
- Generalized estimating equations (GEE) were employed to utilize all available data in the factor analysis.
- NBAS reproducibility was assessed using:
  - consistency of the clusters at the two exams times
  - correlations among individual NBAS items at the two exam times
- Linear regression models were used to assess socio-demographic (SES) correlates of cluster scores (child's gender, maternal and paternal education, marital status, smoking during pregnancy, and OB risk), with adjustment for age at testing and gestational age in weeks.

Results

Table 1. NBAS cluster consistency (at birth and at 2 weeks); Highlight loadings ≥0.40

	Birth exam			2-week exam		
	Factor 1	Factor 2	Factor 3	Factor 1	Factor 2	Factor 3
Orientation						
Ball	0.75	-0.09	0.02	0.72	0.10	0.04
Rattle	0.73	-0.01	-0.06	0.72	0.05	-0.09
Face	0.77	-0.09	0.19	0.84	0.00	0.05
Voice	0.67	-0.03	-0.01	0.68	-0.05	-0.08
Face/voice	0.85	-0.08	0.06	0.84	0.00	0.12
Rattle/voice	0.84	0.00	0.10	0.80	0.06	0.05
Alertness	0.77	-0.21	-0.06	0.55	-0.14	0.22
Range-of-State						
Peak of excitement	-0.03	0.85	-0.08	0.06	0.84	-0.20
Build-up	-0.09	0.80	-0.02	0.03	0.84	-0.16
Irritability	-0.23	0.72	0.04	-0.03	0.78	-0.16
Lability of states	0.11	0.32	-0.65	0.18	0.40	-0.04
Regulation						
Self-quiet	0.05	-0.51	0.53	0.03	-0.77	0.22
Hand to mouth	0.04	0.02	0.45	-0.14	-0.04	-0.10
Response decrement						
Light	-0.04	-0.02	-0.18	0.00	-0.02	-0.01
Rattle	0.04	0.10	0.04	-0.03	-0.10	-0.02
Bell	0.10	-0.08	-0.08	-0.08	-0.02	0.01
Foot	-0.10	-0.19	0.36	0.05	0.09	-0.06
Motor						
General tone	-0.08	0.36	0.11	-0.15	0.23	-0.45
Pull to sit	0.07	0.25	0.35	0.01	0.36	0.12
Defensive movements	0.05	0.26	0.52	0.01	0.24	-0.14
Activity	-0.04	0.50	-0.03	-0.08	0.27	-0.36
Autonomic maturity						
Tremulousness	-0.03	-0.13	-0.15	-0.07	-0.03	0.40
Startle	-0.05	-0.05	-0.06	0.17	0.37	0.09
Motor maturity	0.11	-0.13	0.39	0.09	-0.15	0.59

Table 2. Spearman correlation between NBAS items (at birth and at 2 weeks)

	Birth exam Mean (SD)	2-week exam Mean (SD)	Correlation
Orientation			
Ball	6.00 (1.51)	6.56 (1.50)	0.28
Rattle	7.08 (1.51)	7.31 (1.41)	0.20
Face	6.16 (1.18)	6.68 (1.19)	0.31
Voice	7.11 (1.54)	7.55 (1.45)	0.33
Face/voice	6.55 (1.14)	6.95 (1.15)	0.36
Rattle/voice	6.32 (1.31)	6.94 (1.26)	0.34
Alertness	5.38 (1.60)	6.02 (1.76)	0.42
Range-of-State			
Peak of excitement	5.23 (1.51)	4.90 (1.45)	0.19
Build-up	3.63 (2.33)	2.69 (2.13)	0.18
Irritability	4.72 (1.93)	3.81 (2.14)	0.24
Lability of states	4.08 (1.34)	3.42 (1.55)	0.62
Regulation			
Self-quiet	4.55 (2.46)	4.43 (2.48)	0.38
Hand to mouth	3.75 (2.13)	3.69 (2.13)	0.25
Response decrement			
Light	6.74 (1.99)	6.82 (2.00)	0.20
Rattle	7.53 (1.54)	7.34 (1.58)	0.09
Bell	7.78 (1.49)	8.04 (1.43)	0.06
Foot	5.06 (1.60)	5.64 (1.19)	0.34
Motor			
General tone	5.58 (0.68)	5.27 (0.54)	0.31
Pull to sit	4.97 (1.14)	5.27 (1.06)	0.27
Defensive movements	5.50 (2.32)	6.45 (2.05)	0.44
Activity	4.87 (0.62)	4.80 (0.66)	0.19
Autonomic maturity			
Tremulousness	6.70 (2.13)	8.02 (1.75)	0.23
Startle	8.90 (0.32)	8.91 (0.31)	0.01
Motor maturity	5.10 (0.70)	5.82 (0.80)	0.19

Table 3. NBAS cluster consistency by child's gender* : 2-week exam

	Boys			Girls		
	Factor 1	Factor 2	Factor 3	Factor 1	Factor 2	Factor 3
Orientation						
Ball	0.80	-0.13	0.07	0.75	-0.25	0.16
Rattle	0.69	-0.16	-0.15	0.61	-0.06	-0.19
Face	0.82	-0.09	0.11	0.87	-0.13	0.05
Voice	0.61	-0.17	-0.15	0.59	-0.15	-0.20
Face/voice	0.87	-0.07	0.09	0.87	-0.06	0.07
Rattle/voice	0.86	-0.10	-0.00	0.82	-0.15	0.13
Alertness	0.79	-0.22	0.11	0.80	-0.20	0.15
Range-of-State						
Peak of excitement	-0.25	0.83	-0.12	-0.20	0.77	-0.15
Build-up	-0.14	0.88	-0.12	-0.25	0.82	-0.04
Irritability	-0.30	0.73	-0.15	-0.36	0.69	0.03
Lability of states	0.13	0.47	-0.08	0.12	0.50	0.17
Regulation						
Self-quiet	0.11	-0.65	0.13	0.16	-0.52	0.05
Hand to mouth	0.01	-0.04	0.04	-0.03	0.02	0.01
Response decrement						
Light	0.01	-0.10	0.27	0.05	0.04	0.20
Rattle	0.03	-0.11	0.45	-0.03	0.02	0.02
Bell	-0.05	0.10	0.53	0.12	0.14	-0.11
Foot	-0.12	-0.05	0.07	-0.02	0.14	0.68
Motor						
General tone	-0.35	0.12	-0.31	-0.29	0.16	-0.23
Pull to sit	0.04	0.09	0.01	-0.02	0.11	0.01
Defensive movements	-0.22	0.01	-0.16	-0.08	-0.07	-0.02
Activity	-0.10	0.24	-0.16	0.01	0.22	-0.11
Autonomic maturity						
Tremulousness	-0.05	-0.12	0.55	0.02	0.02	0.67
Startle	0.01	-0.10	0.54	0.09	-0.14	0.33
Motor maturity	0.19	-0.20	0.61	0.25	-0.24	0.52

Similar results with maternal/paternal education, marital status, smoking, OB risk

Table 4. Sociodemographic predictors of performance on the two NBAS exams

	Orientation		Range of State	
	β (95% CI)	p-value	β (95% CI)	p-value
Child's gender (girl)	-0.04 (-0.24, 0.17)	0.72	-0.14 (-0.35,0.07)	0.19
Maternal education (college+)	-0.14 (-0.36, 0.07)	0.19	0.25 (0.03, 0.47)	0.02
Married	0.20 (-0.02, 0.43)	0.08	-0.0004 (0.23,0.23)	0.99
Smoking during pregnancy (yes)	-0.24 (-0.47, -0.01)	0.01	0.11 (-0.13, 0.34)	0.37
OB risk score	0.005 (-0.005, 0.02)	0.31	0.01 (0.003, 0.02)	0.01
Age at exam (days)	0.04 (0.03, 0.05)	<0.0001	-0.05 (-0.06, -0.03)	<0.0001

Conclusion

- Results demonstrate reproducibility of NBAS exam cluster, in particular – orientation and range-of-state – between populations, over time, and across SES variables, supporting the robustness of the clustering scheme.
- Predictors of the more reproducible NBAS clusters included factors associated with child development at older ages (e.g., maternal smoking during pregnancy), thereby supporting the sensitivity of certain NBAS cluster measures to environmental toxicants.