

Summary Statistics of Neonatal Intensive Care Unit Network Neurobehavioral Scale Scores From the Maternal Lifestyle Study: A Quasinormative Sample

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ABSTRACT. Descriptive statistics for the Neonatal Intensive Care Unit Network Neurobehavioral Scale summary scores are provided based on data from 1388 1-month-old infants in the Maternal Lifestyle Study (MLS) of prenatal drug exposure and child outcome. The multisite MLS is described, followed by tables with descriptive statistics and percentile for the Neonatal Intensive Care Unit Network Neurobehavioral Scale summary scores. The tables include data for the entire MLS sample as well as tables by drug exposure status, gestational age, poverty status, sex, race and ethnicity, and MLS study site. These tables can be used as quasinorms for comparison with other infants of this age. *Pediatrics* 2004;113:668–675; MLS, multisite, NNNS, neurobehavioral, norms, prenatal drug exposure, summary scores.

ABBREVIATIONS. NNNS, Neonatal Intensive Care Unit Network Neurobehavioral Scale; MLS, Maternal Lifestyle Study; NICHD, National Institute of Child Health and Human Development; MISU, Maternal Interview of Substance Use.

The purpose of this article is to provide descriptive statistics for the Neonatal Intensive Care Unit Network Neurobehavioral Scale (NNNS) scores from a large, prospective, longitudinal study of prenatal drug exposure and child outcome: the Maternal Lifestyle Study (MLS). The MLS started as an interagency collaborative effort involving the National Institute of Child Health and Human Development (NICHD); the National Institute on Drug Abuse; the Administration on Children, Youth and Families; and the Center for Substance Abuse Treatment. The MLS is the largest clinical, prospective, longitudinal study to date of acute neonatal events

and long-term health and developmental outcomes associated with cocaine use during pregnancy. The MLS was developed with the recognition that cocaine use by pregnant women is a marker variable for 2 critical factors that can affect child outcome in addition to prenatal cocaine exposure: use of drugs other than cocaine and an inadequate caregiving environment.^{1–3} The MLS was designed to address many of the methodologic issues in the field. They include, in addition to polydrug use and the role of the caregiving environment, sample size, methods of drug detection, prematurity, other confounding variables (eg, medical factors, interventions, protective services), and neurodevelopmental assessments such as the NNNS that are sensitive to putative drug effects.

The NNNS was developed for MLS as part of a separate contract (N01-HD-2-3159) from the NICHD and National Institute on Drug Abuse because of concern that existing instruments were not sensitive to the neurobehavioral effects of prenatal drug exposure and infants at risk. The contract supported the development of a neurodevelopmental assessment battery specifically designed to tap hypothesized mechanisms of action of the effects of cocaine on the “four A’s of infant behavior”: arousal, attention, affect (including social interaction), and action (motor patterning).^{3,4}

SAMPLE

The sample included 1211 infants who were enrolled in the longitudinal phase of the MLS. The MLS is conducted at 4 NICHD Neonatal Research Network sites (Brown University, Providence, RI; University of Miami, Miami, FL; Wayne State University, Detroit, MI; and the University of Tennessee at Memphis, Memphis, TN). The study was conducted in 2 phases: acute outcome and longitudinal outcome. Subjects in the longitudinal phase were drawn from the 11 811 mothers who consented to participate in the acute phase.⁵ Maternal exclusion criteria for the acute phase were age <18 years, identified psychosis or history of institutionalization for mental retardation or emotional problems, and language barriers that prevented her from giving informed consent or understanding the study. Infant exclusion criteria were outborn birth; multiple gestation; birth weight <501 g; gestational age >42 weeks; and if, in the

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TABLE 1. α Coefficients for NNNS Summary Scores

Summary Score	No. of Items	No. of Cases	α
Habituation	3	1331	0.85
Attention	7	1085	0.84
Handling	8	1256	0.77
Quality of movement	6	1062	0.56
Regulation	15	672	0.57
Nonoptimal reflexes	15	1189	0.78
Asymmetric reflexes	16	1332	0.41
Stress/abstinence	48	1296	0.70
Arousal	7	1178	0.64
Hypertonicity	10	1036	0.44
Hypotonicity	10	1036	0.37
Excitability	13	815	0.55
Lethargy	15	966	0.57

TABLE 2. Medical Characteristics of Cocaine/Opiate-Exposed and Comparison Groups

	Cocaine/Opiate Exposed (<i>N</i> = 658; Mean [SD], Median, or <i>n</i> [%])	Comparison (<i>N</i> = 30; Mean [SD], Median, or <i>n</i> [%])
Best OB gestational age, wk	36.2 (4.0)	36.3 (4.1)
Birth weight, g	2571 (760)	2682 (865)
Length, cm	46.4 (4.8)	47.0 (5.2)
Head circumference	32.0 (2.9)	32.2 (3.1)
Apgar 1 (median)	8	8
Apgar 5 (median)	9	9
Male, %	340 (51.8)	384 (52.7)

SD indicates standard deviation; OB, best obstetric estimate.

judgment of the attending physician, the infant was unlikely to survive. Meconium samples were collected in the nursery and shipped to a central laboratory for analysis of metabolites of illicit drugs.^{6,7} The assay consisted of an enzyme multiplied immunoassay technique screen for cocaine, opiates, THC, amphetamines, and PCP followed by gas chromatography/mass spectroscopy confirmation for pre-

sumptive positive screens. A history of maternal alcohol, marijuana, and nicotine use during the pregnancy was recorded during a hospital interview with the mother.

Infants were selected for the longitudinal phase to be in the exposed group or the comparison group. Exposed infants were defined by maternal admission of cocaine or opiate use during the pregnancy based on the hospital interview or positive gas chromatography/mass spectroscopy confirmation of cocaine or opiate metabolites. Comparison infants were defined by maternal denial of cocaine or opiate use during the pregnancy and a negative enzyme multiplied immunoassay technique screen for cocaine and opiate metabolites. Uses of alcohol, marijuana, or tobacco were allowed in the comparison group.

Infants were excluded from the longitudinal phase when they had a chromosomal abnormality or toxoplasmosis, rubella cytomegalovirus, herpes, and syphilis infection or when the mother planned to move out of the catchment area. A list of possible comparison infants from the "unexposed" group within each center that matched an infant in the

TABLE 3. Maternal Characteristics of Cocaine/Opiate-Exposed and Comparison Groups

	Cocaine/Opiate Exposed (<i>N</i> = 658; %)	Comparison (<i>N</i> = 730; %)
Race		
Black	75.0	78.2
White	17.2	14.4
Hispanic	6.4	6.3
Other (non-Hispanic)	1.4	1.1
Age		
18–25	21.3	52.4
26–35	64.5	40.2
36–49	14.2	7.4
Marital status		
Married	11.9	25.7
Never married	83.6	72.3
Divorced/widowed	4.4	2.1
Insurance		
Medicaid	88.1	77.4
Self-pay	5.3	4.1
Private/HMO	5.9	18.1
Unknown	.60	.40
Education		
<12 y	48.5	31.2
12 y	34.6	44.4
≥13 y	17.0	24.5
Prenatal care (any)	78.5	96.3

HMO indicates health maintenance organization.

TABLE 4. Patterns of Cocaine Use for Admitted Users

Cocaine Use	Trimester					
	First		Second		Third	
	<i>N</i>	(%)	<i>N</i>	(%)	<i>N</i>	(%)
Daily	61	(17.3)	40	(11.3)	25	(7.2)
3–6 d/wk	56	(15.9)	45	(12.7)	32	(9.2)
1–2 d/wk	93	(26.3)	77	(21.8)	62	(17.8)
1–3 d/mo	57	(16.1)	68	(19.3)	55	(15.8)
1–2 d/3 mo	28	(7.9)	30	(8.5)	58	(16.6)
Not at all	58	(16.4)	93	(26.3)	117	(33.5)

TABLE 5. Summary of 1-Month NNNS for the Whole Sample in the MLS ($N = 1388$)

NNNS Scale	Descriptives					Percentiles						
	<i>N</i>	Mean	SD	Minimum	Maximum	5	10	25	50	75	90	95
Habituation	298	7.23	1.89	1.00	9.00	3.98	4.00	6.33	8.00	9.00	9.00	9.00
Attention	1213	5.36	1.39	1.29	8.43	3.00	3.43	4.38	5.43	6.43	7.14	7.43
Handling	1213	0.54	0.29	0	1.00	0	0.13	0.25	0.63	0.75	0.88	1.00
Quality of movement	1213	4.41	0.77	1.20	6.20	3.00	3.33	4.00	4.50	5.00	5.33	5.50
Regulation	1213	5.05	0.87	2.20	7.50	3.61	3.93	4.46	5.07	5.67	6.14	6.48
Nonoptimal reflexes	1213	4.62	2.14	0	12.00	1.00	2.00	3.00	5.00	6.00	7.00	8.00
Asymmetric reflexes	1213	0.88	1.15	0	7.00	-	-	0	1.00	1.00	2.00	3.00
Stress/abstinence	1213	0.18	0.09	0	0.57	0.06	0.08	0.12	0.16	0.24	0.29	0.33
Arousal	1213	4.39	0.69	2.43	6.67	3.29	3.46	3.86	4.33	4.86	5.29	5.57
Hypertonicity	1213	0.57	0.95	0	8.00	-	-	-	0	1.00	2.00	2.00
Hypotonicity	1213	0.24	0.57	0	5.00	-	-	-	-	0	1.00	1.00
Excitability	1213	3.87	2.30	0	11.00	0	1.00	2.00	4.00	6.00	7.00	8.00
Lethargy	1213	3.24	1.97	0	11.00	0	1.00	2.00	3.00	4.00	6.00	7.00

exposed group on race, sex, and gestational age was sent by the data center to each study site. Mothers on the list were called in sequence to confirm consent for phase II and to schedule the 1-month visit. When an infant in the comparison group did not attend the 1-month visit, another match was generated for each exposed infant until a comparison infant was successfully enrolled or the recruitment period ended. This procedure resulted in 2 groups that were matched on race, sex, and gestational age. The 1388 mother-infant dyads (658 in the exposed group and 730 in the comparison group) that came to the 1-month visit were enrolled in the longitudinal study.

The longitudinal phase began at the infant's first follow-up visit at 1 month (age corrected for prematurity). Information about the frequency and the quantity of substance use for each trimester during this pregnancy was collected from the Maternal Interview of Substance Use (MISU) administered to the biological mothers only. The MISU was completed by 1255 biological mothers who brought their infants to the 1-month visit within the 2-week time frame.

The NNNS was completed on 1211 of these infants. All infants were examined between 42 and 44 weeks' postconceptional age by psychometrists certified on the examination and masked as to infant exposure status.

NNNS SUMMARY SCORES

Summary scores for the NNNS were developed using an approach that combined conceptual and statistical (coefficient α) aggregation of items and scores. The summary scores were first developed on a random selection of one half of the sample and then "replicated" on the second half of the sample. The 13 summary scores (see Appendix 2 later in this issue) described previously in the volume include habituation, attention, handling, quality of movement, regulation, nonoptimal reflexes, asymmetric reflexes, stress/abstinence, arousal, hypertonia, hypotonia, excitability, and lethargy. A higher score on each scale means a higher level of the construct. For example, a high score on hypertonia means that the infant was more hypertonic; a high score on hypotonia means that the infant was more hypotonic. The α

coefficients for the summary scores based on the 1211 scores from the MLS data are shown in Table 1.

Medical and Maternal Characteristics

Medical characteristics of the infants are presented in Table 2. Preterm infants (<38 weeks) accounted for 41% ($N = 270$) of the cocaine/opiate-exposed group and 43% ($N = 314$) of the comparison group. The percentages of preterm infants born at <33 weeks were 10.8% ($N = 71$) in the cocaine/opiate-exposed group and 12.5% ($N = 91$) in the comparison group. Demographic information on the mothers is presented in Table 3. Mothers in the cocaine/opiate-exposed group were more likely to be older, not married, on Medicaid and not private insurance, less educated, and less likely to receive prenatal care than mothers in the comparison group.

Maternal Drug Use

On the basis of the hospital interview, more mothers in the exposed group used alcohol during pregnancy ($N = 461$; 70.3%) than in the comparison group ($N = 361$; 49.5%). Similarly, more mothers in the exposed group used tobacco ($N = 535$; 81.6%) than in the comparison group ($N = 211$; 28.9%), and more mothers in the exposed group used marijuana ($N = 253$; 38.6%) than in the comparison group ($N = 71$; 9.7%). On the basis of the MISU interview, Table 4 describes patterns of cocaine use for admitted users. As expected, cocaine use declined over the 3 trimesters. For example, the percentage of women who reported daily use decreased from 17% in the first trimester to 7% in the third trimester with a corresponding increase in the percentage of women who were not using from 16% in the first trimester to 33% in the third trimester.

Tables 5 to 18 show the means, standard deviations, minimum and maximum scores, and percentiles for the 13 NNNS summary scale scores. The tables are as follows: Table 5 shows the NNNS scores for the entire MLS sample.

Table 6 shows the NNNS scores for the exposed and comparison groups.

Tables 7 to 9 show the scores by gestational age using best obstetrical estimate divided in 3 categories (24–32 weeks, 33–37 weeks, and ≥ 38 weeks).

TABLE 6. Summary of 1-Month NNNS by Exposure Status in the MLS

NNNS Scale	Comparison										Exposed													
	Descriptives					Percentiles					Descriptives					Percentiles								
	N	Mean	SD	Minimum	Maximum	5	10	25	50	75	90	95	N	Mean	SD	Minimum	Maximum	5	10	25	50	75	90	95
Habituation	157	7.13	1.92	1.00	9.00	3.00	4.00	6.00	7.67	9.00	9.00	141	7.34	1.85	1.00	9.00	4.00	4.00	6.33	8.00	9.00	9.00	9.00	9.00
Attention	637	5.35	1.37	1.29	8.43	3.00	3.43	4.43	5.43	6.43	7.43	576	5.38	1.40	1.71	8.43	3.00	3.43	4.29	5.43	6.43	7.14	7.14	7.43
Handling	637	0.54	0.29	0	1.00	0	0.13	0.25	0.63	0.75	0.88	576	0.54	0.30	0	1.00	0	0.13	0.25	0.56	0.75	0.88	1.00	1.00
Quality of movement	637	4.45	0.77	1.20	6.20	3.00	3.50	4.00	4.50	5.00	5.33	576	4.37	0.77	2.00	5.83	3.00	3.33	3.88	4.50	4.83	5.33	5.50	5.50
Regulation	637	5.08	0.85	2.20	7.50	3.66	4.00	4.47	5.08	5.69	6.14	576	5.01	0.89	2.33	7.38	3.53	3.87	4.40	5.07	5.60	6.15	6.50	6.50
Nonoptimal reflexes	637	4.59	2.07	0	11.00	1.00	2.00	3.00	5.00	6.00	7.00	576	4.65	2.20	0	12.00	1.00	2.00	3.00	5.00	6.00	8.00	8.00	8.00
Asymmetric reflexes	637	0.87	1.14	0	7.00	-	-	-	0	1.00	2.00	576	0.90	1.16	0	6.00	-	-	0	1.00	1.00	3.00	3.00	3.00
Stress/abstinence	637	0.17	0.09	0	0.57	0.06	0.08	0.12	0.16	0.22	0.29	576	0.18	0.09	0	0.53	0.06	0.08	0.12	0.18	0.24	0.29	0.33	0.33
Arousal	637	4.40	0.70	2.57	6.50	3.29	3.43	3.86	4.43	4.86	5.29	576	4.38	0.69	2.43	6.67	3.14	3.57	3.86	4.33	4.86	5.29	5.51	5.51
Hypertonicity	637	0.52	0.90	0	5.00	-	-	-	0	1.00	2.00	576	0.62	1.00	0	8.00	-	-	-	0	1.00	2.00	2.00	2.00
Hypotonicity	637	0.23	0.56	0	5.00	-	-	-	-	0	1.00	576	0.24	0.57	0	4.00	-	-	-	-	0	1.00	1.00	1.00
Excitability	637	3.82	2.27	0	10.00	0	1.00	2.00	4.00	5.00	7.00	576	3.93	2.33	0	11.00	0	1.00	2.00	4.00	6.00	7.00	8.00	8.00
Lethargy	637	3.24	1.97	0	9.00	0	1.00	2.00	3.00	4.00	6.00	576	3.25	1.98	0	11.00	0	1.00	2.00	3.00	4.00	6.00	7.00	7.00

Table 10 shows the NNNS scores by poverty status (above and below the federal poverty line).

Table 11 shows the NNNS scores by sex.

Tables 12 to 14 show the NNNS scores by race and ethnicity (black, white, and Hispanic).

Tables 15 to 18 show the NNNS scores by site (Detroit, Memphis, Miami, and Providence).

DISCUSSION

MLS is the largest prospective study reported to date on the effects of prenatal cocaine/opiate exposure on neurobehavioral outcome in early infancy. Results from the MLS on the NNNS showed that prenatal cocaine exposure was related to lower arousal, poorer quality of movement and regulation, higher excitability, more hypertonia, and more non-optimal reflexes with most effects remaining after adjustment for covariates.⁸ There were also effects of heavy cocaine exposure and separate effects for opiates, alcohol, marijuana, tobacco, and birth weight. The NNNS has also been used in 4 other studies. In 1 study,⁹ infants with cocaine and alcohol exposure were compared with infants with alcohol exposure alone and those without prenatal drug exposure. Differences were found between the cocaine/alcohol and alcohol group as well as between these groups and the unexposed group. In another study, infants who were treated with diluted tincture of opium and phenobarbital were more alert and interactive with their environment, had smoother movements, were physically easier to handle, and were less stressed during the first 3 weeks than infants who were treated with diluted tincture of opium alone (M. Coyle, MD, A. Ferguson, OTR/L, L. LaGasse, PhD, E. Liu, PhD, and B. Lester, PhD, unpublished data, 2000). Johnson et al¹⁰ used the NNNS to show that buprenorphine may be more beneficial than methadone for pregnant, heroin-addicted women by reducing withdrawal in the infant. Finally, in a study of the effects of cigarette smoking during pregnancy, tobacco-exposed infants were more excitable and hypertonic, required more handling, and showed more stress/abstinence signs.¹¹ There were also dose-response relationships: higher levels of maternal salivary cotinine (metabolite of nicotine) and the number of cigarettes per day that the mother smoked during pregnancy were related to the number of stress/abstinence signs on the NNNS.

The advantages of the MLS data set include the large sample size, the use of the meconium assay to detect prenatal drug exposure along with maternal report, the multisite design that allows for geographic diversity, and the inclusion of preterm infants. The values in Tables 5 to 18 can be used to compare with other samples and can serve as quasi-norms for the 1-month-old infant.

The limitations of this sample are that the values are not truly norms because the sampling plan was not designed to collect normative data. The data are also limited to 1-month-old infants, and there is no true unexposed group as the comparison group included exposure to alcohol, marijuana, and tobacco. This is best thought of as a sample of infants at varying degrees of biological and/or social risk. The

Table 7. Summary of 1-Month NNNS by Gestational Age (24–32 Weeks)

NNNS Scale	Descriptives					Percentiles						
	N	Mean	SD	Minimum	Maximum	5	10	25	50	75	90	95
Habituation	61	7.06	1.96	1.00	9.00	3.55	4.00	6.00	7.67	8.83	9.00	9.00
Attention	204	5.30	1.39	2.25	8.29	3.00	3.43	4.14	5.33	6.43	7.00	7.43
Handling	204	0.50	0.28	0	1.00	0	0.13	0.25	0.50	0.75	0.88	1.00
Quality of movement	204	4.27	0.78	2.00	5.83	3.00	3.17	3.80	4.33	4.83	5.17	5.33
Regulation	204	5.01	0.86	2.91	7.46	3.62	3.82	4.40	5.07	5.61	6.14	6.42
Nonoptimal reflexes	204	5.05	2.21	0	10.00	1.25	2.00	3.00	5.00	7.00	8.00	9.00
Asymmetric reflexes	204	0.90	1.16	0	6.00	-	-	0	1.00	1.00	2.50	3.00
Stress/abstinence	204	0.20	0.09	0.02	0.53	0.06	0.08	0.12	0.18	0.27	0.33	0.35
Arousal	204	4.34	0.71	2.86	6.14	3.29	3.43	3.86	4.29	4.82	5.43	5.64
Hypertonicity	204	0.77	1.13	0	5.00	-	-	-	0	1.00	2.00	3.00
Hypotonicity	204	0.26	0.59	0	3.00	-	-	-	-	0	1.00	1.00
Excitability	204	3.98	2.34	0	9.00	0	1.00	2.00	4.00	6.00	7.00	8.00
Lethargy	204	3.50	2.00	0	10.00	1.00	1.00	2.00	3.00	5.00	7.00	7.00

Table 8. Summary of 1-Month NNNS by Gestational Age (33–37 Weeks)

NNNS Scale	Descriptives					Percentiles						
	N	Mean	SD	Minimum	Maximum	5	10	25	50	75	90	95
Habituation	109	7.07	1.99	1.00	9.00	3.00	4.00	6.00	7.67	9.00	9.00	9.00
Attention	433	5.38	1.36	1.29	8.29	3.00	3.57	4.43	5.50	6.38	7.14	7.43
Handling	433	0.54	0.28	0	1.00	0	0.13	0.38	0.63	0.75	0.88	1.00
Quality of movement	433	4.34	0.80	1.20	5.83	2.67	3.33	3.83	4.50	4.92	5.33	5.50
Regulation	433	5.00	0.89	2.73	7.38	3.49	3.87	4.40	5.00	5.65	6.19	6.51
Nonoptimal reflexes	433	4.64	2.28	0	12.00	0	2.00	3.00	5.00	6.00	7.60	8.00
Asymmetric reflexes	433	0.91	1.12	0	6.00	-	-	0	1.00	1.00	3.00	3.00
Stress/abstinence	433	0.18	0.09	0	0.57	0.06	0.08	0.12	0.18	0.24	0.3	0.33
Arousal	433	4.40	0.67	2.71	6.50	3.29	3.57	4.00	4.43	4.86	5.29	5.43
Hypertonicity	433	0.58	0.89	0	5.00	-	-	-	0	1.00	2.00	2.00
Hypotonicity	433	0.28	0.64	0	5.00	-	-	-	-	0	1.00	2.00
Excitability	433	3.96	2.23	0	10.00	0	1.00	2.00	4.00	6.00	7.00	8.00
Lethargy	433	3.17	1.93	0	11.00	0	1.00	2.00	3.00	4.00	6.00	7.00

Table 9. Summary of 1-Month NNNS by Gestational Age (≥38 Weeks)

NNNS Scale	Descriptives					Percentiles						
	N	Mean	SD	Minimum	Maximum	5	10	25	50	75	90	95
Habituation	127	7.43	1.75	1.00	9.00	4.00	4.00	6.67	8.00	9.00	9.00	9.00
Attention	574	5.38	1.40	1.50	8.43	3.00	3.33	4.43	5.43	6.43	7.14	7.43
Handling	574	0.55	0.31	0	1.00	0	0.13	0.25	0.63	0.75	1.00	1.00
Quality of movement	574	4.52	0.74	1.6	6.20	3.17	3.50	4.17	4.50	5.17	5.50	5.50
Regulation	574	5.09	0.86	2.20	7.50	3.72	4.00	4.47	5.13	5.67	6.17	6.50
Nonoptimal reflexes	574	4.46	1.98	0	10.00	1.00	2.00	3.00	4.00	6.00	7.00	8.00
Asymmetric reflexes	574	0.86	1.17	0	7.00	-	-	-	0	1.00	2.00	3.00
Stress/abstinence	574	0.17	0.09	0	0.53	0.04	0.06	0.10	0.16	0.22	0.29	0.32
Arousal	574	4.40	0.70	2.43	6.67	3.29	3.43	3.86	4.43	4.86	5.29	5.57
Hypertonicity	574	0.48	0.91	0	8.00	-	-	-	0	1.00	1.00	2.00
Hypotonicity	574	0.19	0.50	0	4.00	-	-	-	-	0	1.00	1.00
Excitability	574	3.77	2.32	0	11.00	0	1.00	2.00	4.00	5.00	7.00	7.00
Lethargy	574	3.20	1.99	0	10.00	0	1.00	2.00	3.00	4.00	6.00	7.00

data set provided by Tronick et al (see “Normative Neurobehavioral Performance of Healthy Infants on the Neonatal Intensive Care Unit Network Neurobehavioral Scale” later in this issue) do include healthy newborn infants, and the Tronick study is also collecting data on preterm infants that will provide additional information. Finally, the MLS data are limited to the population studied and may not represent all drug-exposed infants. Most of the pregnant women who use cocaine and most of the subjects in research studies, including ours, are referred to as “recreational users” rather than “hard-core addicts.” Even our “heavy users” were rarely daily users, and use at all levels decreased over the 3 trimesters.

Despite these limitations, this is the largest database available as a reference on the neurobehavioral organization of drug-exposed infants and should be useful for researchers and clinicians as we learn more about these infants and develop appropriate treatment programs.

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Table 10. Summary of 1-Month NNINS by Poverty Status

NNINS Scale	< Below Federal Poverty Line										Above Federal Poverty Line													
	Descriptives					Percentiles					Descriptives					Percentiles								
	N	Mean	SD	Minimum	Maximum	5	10	25	50	75	90	95	N	Mean	SD	Minimum	Maximum	5	10	25	50	75	90	95
Habituation	206	7.19	1.92	1.00	9.00	4.00	4.00	6.00	8.00	9.00	9.00	73	7.29	1.95	1.00	9.00	2.70	4.00	4.00	6.42	8.00	9.00	9.00	9.00
Attention	698	5.34	1.37	1.50	8.43	3.00	3.49	4.29	5.43	6.36	7.01	422	5.41	1.39	1.29	8.29	3.00	3.43	4.43	5.57	6.57	7.14	7.14	7.43
Handling	698	0.53	0.29	0.00	1.00	0.00	0.13	0.25	0.63	0.75	0.88	422	0.57	0.29	0.00	1.00	0.00	0.13	0.38	0.63	0.75	1.00	1.00	1.00
Quality of movement	698	4.44	0.76	2.00	6.20	3.00	3.33	4.00	4.50	5.00	5.33	422	4.37	0.79	1.20	5.83	3.00	3.33	4.00	4.50	5.00	5.33	5.50	5.50
Regulation	698	5.05	0.88	2.69	7.38	3.53	3.92	4.46	5.08	5.70	6.14	422	5.00	0.87	2.20	7.50	3.61	3.88	4.40	5.00	5.60	6.14	6.41	6.41
Nonoptimal reflexes	698	4.55	2.17	0.00	11.00	1.00	2.00	3.00	5.00	6.00	7.00	422	4.71	2.11	0.00	11.00	1.00	2.00	3.00	5.00	6.00	7.00	8.00	8.00
Asymmetric reflexes	698	0.89	1.14	0.00	7.00	-	-	0.00	1.00	1.00	2.00	422	0.85	1.16	0.00	6.00	-	-	0.00	1.00	2.00	3.00	3.00	3.00
Stress/abstinence	698	0.17	0.09	0.00	0.53	0.04	0.06	0.10	0.16	0.22	0.29	422	0.19	0.09	0.00	0.53	0.06	0.10	0.12	0.18	0.24	0.31	0.31	0.35
Arousal	698	4.38	0.69	2.71	6.67	3.29	3.43	4.00	4.33	4.86	5.29	422	4.43	0.69	2.43	6.50	3.43	3.57	3.86	4.43	5.00	5.29	5.65	5.65
Hypertonicity	698	0.56	0.98	0.00	8.00	-	-	-	0.00	1.00	2.00	422	0.56	0.69	0.00	5.00	-	-	-	0.00	1.00	2.00	2.00	2.00
Hypotonicity	698	0.23	0.56	0.00	5.00	-	-	-	-	0.00	1.00	422	0.23	0.58	0.00	4.00	-	-	-	-	-	0.00	1.00	1.00
Excitability	698	3.88	2.28	0.00	11.00	0.00	1.00	2.00	4.00	5.00	7.00	422	3.94	2.31	0.00	10.00	0.00	1.00	2.00	4.00	6.00	7.00	8.00	8.00
Lethargy	698	3.26	1.97	0.00	11.00	0.00	1.00	2.00	3.00	4.00	6.00	422	3.17	1.97	0.00	10.00	0.00	1.00	2.00	3.00	4.00	6.00	7.00	7.00

Table 11. Summary of 1-Month NNINS by Gender in the MLS

NNINS Scale	Male										Female													
	Descriptives					Percentiles					Descriptives					Percentiles								
	N	Mean	SD	Minimum	Maximum	5	10	25	50	75	90	95	N	Mean	SD	Minimum	Maximum	5	10	25	50	75	90	95
Habituation	163	7.42	1.75	1.00	9.00	4.00	4.47	6.67	8.00	9.00	9.00	135	7.00	2.02	1.00	9.00	3.40	4.00	6.00	7.67	9.00	9.00	9.00	9.00
Attention	641	5.32	1.44	1.29	8.43	2.76	3.29	4.29	5.43	6.43	7.14	572	5.41	1.32	1.50	8.43	3.09	3.71	4.43	5.54	6.43	7.14	7.14	7.43
Handling	641	0.54	0.30	0.00	1.00	0.00	0.13	0.25	0.63	0.75	0.88	572	0.54	0.29	0.00	1.00	0.00	0.13	0.25	0.63	0.75	0.88	1.00	1.00
Quality of movement	641	4.38	0.80	1.20	6.20	2.85	3.33	3.83	4.50	5.00	5.33	572	4.45	0.74	2.00	5.83	3.00	3.40	4.00	4.50	5.00	5.33	5.50	5.50
Regulation	641	4.99	0.87	2.20	7.50	3.60	3.87	4.40	5.00	5.60	6.08	572	5.11	0.87	2.33	7.38	3.61	4.00	4.50	5.13	5.73	6.21	6.51	6.51
Nonoptimal reflexes	641	4.61	2.09	0.00	11.00	1.00	2.00	3.00	5.00	6.00	7.00	572	4.63	2.19	0.00	12.00	1.00	2.00	3.00	5.00	6.00	7.00	8.00	8.00
Asymmetric reflexes	641	0.89	1.19	0.00	6.00	-	-	-	0.00	1.00	2.00	572	0.87	1.10	0.00	7.00	-	-	0.00	1.00	1.00	2.00	3.00	3.00
Stress/abstinence	641	0.18	0.09	0.00	0.57	0.06	0.08	0.12	0.16	0.24	0.31	572	0.17	0.08	0.00	0.53	0.06	0.08	0.10	0.16	0.22	0.29	0.33	0.33
Arousal	641	4.39	0.70	2.43	6.67	3.29	3.57	3.86	4.43	4.86	5.29	572	4.38	0.69	2.57	6.50	3.29	3.43	3.86	4.33	4.86	5.29	5.57	5.57
Hypertonicity	641	0.58	1.01	0.00	8.00	-	-	-	0.00	1.00	2.00	572	0.55	0.87	0.00	5.00	-	-	-	0.00	1.00	2.00	2.00	2.00
Hypotonicity	641	0.24	0.61	0.00	5.00	-	-	-	-	0.00	1.00	572	0.23	0.52	0.00	3.00	-	-	-	-	-	0.00	1.00	1.00
Excitability	641	4.02	2.36	0.00	10.00	0.00	1.00	2.00	4.00	6.00	7.00	572	3.7	2.21	0.00	11.00	0.00	1.00	2.00	4.00	5.00	7.00	7.00	7.00
Lethargy	641	3.29	2.04	0.00	11.00	0.00	1.00	2.00	3.00	4.00	6.00	572	3.19	1.89	0.00	9.00	0.00	1.00	2.00	3.00	4.00	6.00	7.00	7.00

Table 12. Summary of 1-Month NNNS by Race and Ethnicity in the MLS (Race = Black)

NNNS Scale	Descriptives					Percentiles						
	N	Mean	SD	Minimum	Maximum	5	10	25	50	75	90	95
Habituation	261	7.24	1.88	1.00	9.00	3.70	4.07	6.33	8.00	9.00	9.00	9.00
Attention	921	5.33	1.43	1.29	8.43	3.00	3.43	4.29	5.43	6.43	7.14	7.56
Handling	921	0.53	0.30	0.00	1.00	0.00	0.13	0.25	0.50	0.75	0.88	1.00
Quality of movement	921	4.39	0.81	1.20	6.20	2.85	3.20	4.00	4.50	5.00	5.33	5.50
Regulation	921	5.08	0.91	2.20	7.50	3.53	3.87	4.46	5.13	5.73	6.23	6.54
Nonoptimal reflexes	921	4.62	2.19	0.00	11.00	1.00	2.00	3.00	5.00	6.00	7.00	8.00
Asymmetric reflexes	921	0.78	1.05	0.00	6.00	–	–	–	0.00	1.00	2.00	3.00
Stress/abstinence	921	0.17	0.09	0.00	0.57	0.04	0.06	0.10	0.16	0.22	0.29	0.33
Arousal	921	4.40	0.72	2.43	6.67	3.16	3.43	3.86	4.43	4.86	5.29	5.57
Hypertonicity	921	0.62	1.02	0.00	8.00	–	–	–	0.00	1.00	2.00	3.00
Hypotonicity	921	0.23	0.56	0.00	5.00	–	–	–	–	0.00	1.00	1.00
Excitability	921	3.91	2.33	0.00	11.00	0.00	1.00	2.00	4.00	6.00	7.00	8.00
Lethargy	921	3.33	1.96	0.00	10.00	0.00	1.00	2.00	3.00	5.00	6.00	7.00

Table 13. Summary of 1-Month NNNS by Race and Ethnicity in the MLS (Race = White)

NNNS Scale	Descriptives					Percentiles						
	N	Mean	SD	Minimum	Maximum	5	10	25	50	75	90	95
Habituation	27	7.36	1.93	1.00	9.00	2.20	4.00	6.50	8.00	9.00	9.00	9.00
Attention	198	5.42	1.29	2.00	8.43	2.99	3.41	4.68	5.64	6.29	7.00	7.15
Handling	198	0.61	0.27	0.00	1.00	0.13	0.25	0.5	0.63	0.75	1.00	1.00
Quality of movement	198	4.45	0.65	2.17	5.67	3.40	3.66	4.00	4.50	4.83	5.33	5.50
Regulation	198	4.92	0.73	2.73	6.86	3.82	4.00	4.40	4.93	5.43	5.86	6.27
Nonoptimal reflexes	198	4.64	2.06	0.00	12.00	1.00	2.00	3.00	5.00	6.00	7.00	8.00
Asymmetric reflexes	198	1.09	1.29	0.00	5.00	–	–	0.00	1.00	2.00	3.00	3.05
Stress/abstinence	198	0.21	0.08	0.02	0.47	0.08	0.10	0.16	0.20	0.25	0.31	0.33
Arousal	198	4.38	0.60	3.14	6.50	3.57	3.66	3.86	4.38	4.71	5.14	5.43
Hypertonicity	198	0.43	0.66	0.00	3.00	–	–	–	0.00	1.00	1.00	2.00
Hypotonicity	198	0.27	0.66	0.00	4.00	–	–	–	–	0.00	1.00	2.00
Excitability	198	3.76	2.08	0.00	10.00	0.00	1.00	2.00	4.00	5.00	6.00	7.00
Lethargy	198	2.93	2.04	0.00	10.00	0.00	1.00	2.00	3.00	4.00	6.00	7.00

Table 14. Summary of 1-Month NNNS by Race and Ethnicity in the MLS (Ethnicity = Hispanic)

NNNS Scale	Descriptives					Percentiles						
	N	Mean	SD	Minimum	Maximum	5	10	25	50	75	90	95
Habituation	8	7.13	2.10	4.00	9.00	4.00	4.00	4.75	7.50	9.00	–	–
Attention	77	5.65	1.09	1.71	7.43	4.11	4.40	4.79	5.57	6.43	7.00	7.29
Handling	77	0.50	0.30	0.00	1.00	0.00	0.13	0.25	0.50	0.75	0.88	1.00
Quality of movement	77	4.52	0.65	3.00	5.67	3.33	3.67	4.00	4.50	5.08	5.37	5.50
Regulation	77	4.99	0.71	3.33	6.27	3.85	3.93	4.41	5.07	5.61	5.93	6.07
Nonoptimal reflexes	77	4.51	1.74	0.00	9.00	2.00	2.00	3.00	5.00	6.00	6.20	7.20
Asymmetric reflexes	77	1.53	1.56	0.00	7.00	–	–	0.00	1.00	2.00	4.00	5.00
Stress/abstinence	77	0.18	0.09	0.02	0.37	0.06	0.08	0.11	0.16	0.24	0.31	0.33
Arousal	77	4.34	0.60	3.00	5.57	3.29	3.57	3.86	4.29	4.79	5.14	5.30
Hypertonicity	77	0.35	0.58	0.00	2.00	–	–	–	0.00	1.00	1.00	2.00
Hypotonicity	77	0.17	0.41	0.00	2.00	–	–	–	–	0.00	1.00	1.00
Excitability	77	3.82	2.34	0.00	9.00	0.00	1.00	2.00	4.00	5.00	7.00	8.00
Lethargy	77	2.91	1.73	0.00	11.00	0.00	1.00	2.00	3.00	4.00	5.00	6.00

Table 15. Summary of 1-Month NNNS by Site in the MLS (Site = Detroit)

NNNS Scale	Descriptives					Percentiles						
	N	Mean	SD	Minimum	Maximum	5	10	25	50	75	90	95
Habituation	89	7.48	1.89	1.00	9.00	3.50	4.50	6.67	8.00	9.00	9.00	9.00
Attention	523	5.62	1.43	1.50	8.43	3.03	3.57	4.57	5.71	6.75	7.43	7.85
Handling	523	0.53	0.30	0.00	1.00	0.00	0.13	0.25	0.50	0.75	0.88	1.00
Quality of movement	523	4.29	0.86	1.60	6.20	2.67	3.00	3.80	4.33	5.00	5.33	5.50
Regulation	523	5.01	0.89	2.20	7.50	3.54	3.85	4.40	5.07	5.67	6.13	6.43
Nonoptimal reflexes	523	5.12	2.25	0.00	12.00	2.00	2.00	4.00	5.00	7.00	8.00	9.00
Asymmetric reflexes	523	0.65	0.99	0.00	6.00	–	–	–	0.00	1.00	2.00	3.00
Stress/abstinence	523	0.20	0.10	0.00	0.57	0.06	0.08	0.12	0.18	0.27	0.33	0.37
Arousal	523	4.47	0.75	2.43	6.67	3.29	3.57	4.00	4.43	5.00	5.43	5.81
Hypertonicity	523	0.71	1.07	0.00	8.00	–	–	–	0.00	1.00	2.00	3.00
Hypotonicity	523	0.33	0.68	0.00	5.00	–	–	–	–	0.00	1.00	2.00
Excitability	523	3.96	2.39	0.00	10.00	0.00	1.00	2.00	4.00	6.00	7.00	8.00
Lethargy	523	2.94	1.87	0.00	9.00	0.00	1.00	2.00	3.00	4.00	5.00	6.80

Table 16. Summary of 1-Month NNNS by Site in the MLS (Site = Memphis)

NNNS Scale	Descriptives					Percentiles						
	N	Mean	SD	Minimum	Maximum	5	10	25	50	75	90	95
Habituation	148	6.98	1.95	1.00	9.00	2.45	4.00	6.00	7.50	8.50	9.00	9.00
Attention	300	4.82	1.37	1.29	7.71	2.57	3.00	3.86	4.76	5.86	6.71	7.14
Handling	300	0.54	0.30	0.00	1.00	0.00	0.13	0.25	0.63	0.75	0.88	1.00
Quality of movement	300	4.47	0.74	1.20	5.83	3.17	3.40	4.00	4.6	5.33	5.50	
Regulation	300	5.20	0.92	2.77	7.46	3.50	3.85	4.60	5.21	5.90	6.35	6.64
Nonoptimal reflexes	300	4.10	2.19	0.00	10.00	0.00	1.00	3.00	4.00	6.00	7.00	8.00
Asymmetric reflexes	300	0.84	1.00	0.00	5.00	–	–	0.00	1.00	1.00	2.00	3.00
Stress/abstinence	300	0.15	0.07	0.00	0.35	0.06	0.08	0.10	0.14	0.18	0.24	0.31
Arousal	300	4.32	0.62	2.71	6.14	3.29	3.43	4.00	4.29	4.71	5.14	5.42
Hypertonicity	300	0.50	0.88	0.00	5.00	–	–	–	0.00	1.00	2.00	2.00
Hypotonicity	300	0.19	0.53	0.00	4.00	–	–	–	–	0.00	1.00	1.00
Excitability	300	3.82	2.17	0.00	11.00	0.00	1.00	2.00	4.00	5.00	7.00	7.00
Lethargy	300	3.90	2.08	0.00	10.00	1.00	2.00	2.00	4.00	5.00	7.00	8.00

Table 17. Summary of 1-Month Scale by Site in the MLS (Site = Miami)

NNNS Scale	Descriptives					Percentiles						
	N	Mean	SD	Minimum	Maximum	5	10	25	50	75	90	95
Habituation	50	7.59	1.63	4.00	9.00	4.00	4.58	6.67	8.17	9.00	9.00	9.00
Attention	187	5.16	1.34	1.71	8.14	2.83	3.41	4.17	5.14	6.29	6.86	7.23
Handling	187	0.39	0.27	0.00	1.00	–	0.00	0.13	0.38	0.63	0.75	0.88
Quality of movement	187	4.73	0.66	2.20	5.83	3.50	3.83	4.33	4.83	5.33	5.50	5.50
Regulation	187	5.20	0.85	2.91	7.23	3.82	4.13	4.53	5.23	5.80	6.34	6.65
Nonoptimal reflexes	187	4.42	1.82	0.00	9.00	1.00	2.00	3.00	5.00	6.00	7.00	7.00
Asymmetric reflexes	187	0.99	1.17	0.00	6.00	–	–	0.00	1.00	2.00	3.00	3.00
Stress/abstinence	187	0.11	0.05	0.00	0.31	0.03	0.04	0.08	0.10	0.14	0.18	0.20
Arousal	187	4.30	0.78	2.57	5.86	3.06	3.14	3.71	4.29	5.00	5.29	5.57
Hypertonicity	187	0.28	0.75	0.00	5.00	–	–	–	–	0.00	1.00	1.00
Hypotonicity	187	0.20	0.45	0.00	2.00	–	–	–	–	0.00	1.00	1.00
Excitability	187	3.47	2.34	0.00	10.00	–	0.00	1.00	3.00	5.00	6.00	7.00
Lethargy	187	3.84	2.05	0.00	11.00	1.00	1.00	2.00	4.00	5.00	7.00	8.00

Table 18. Summary of 1-Month NNNS by Site in the MLS (Site = Providence)

NNNS Scale	Descriptives					Percentiles						
	N	Mean	SD	Minimum	Maximum	5	10	25	50	75	90	95
Habituation	11	6.95	1.75	4.00	9.00	4.00	4.00	6.00	7.50	8.00	9.00	–
Attention	203	5.70	1.02	2.43	7.57	3.65	4.49	5.00	5.86	6.43	7.00	7.14
Handling	203	0.69	0.21	0.13	1.00	0.25	0.38	0.50	0.75	0.88	1.00	1.00
Quality of movement	203	4.35	0.56	2.67	5.67	3.37	3.67	4.00	4.33	4.67	5.00	5.33
Regulation	203	4.76	0.65	2.70	6.36	3.78	4.00	4.33	4.73	5.20	5.64	5.86
Nonoptimal reflexes	203	4.29	1.73	0.00	9.00	1.00	2.00	3.00	4.00	5.00	6.00	7.00
Asymmetric reflexes	203	1.44	1.47	0.00	7.00	–	–	0.00	1.00	2.00	3.00	5.00
Stress/abstinence	203	0.23	0.06	0.12	0.43	0.14	0.16	0.18	0.22	0.29	0.31	0.33
Arousal	203	4.35	0.53	3.00	5.57	3.57	3.71	4.00	4.29	4.71	5.09	5.29
Hypertonicity	203	0.56	0.78	0.00	4.00	–	–	–	0.00	1.00	2.00	2.00
Hypotonicity	203	0.09	0.32	0.00	2.00	–	–	–	–	–	0.00	1.00
Excitability	203	4.09	2.16	0.00	10.00	1.00	1.00	2.00	4.00	6.00	7.00	8.00
Lethargy	203	2.50	1.52	0.00	8.00	0.00	1.00	2.00	2.00	3.00	4.00	6.00

ministration on Children, Youth, and Families, and the Center for Substance Abuse Treatment.

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