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ABSTRACT

This study examined behavioral development during the first year of life of 41 infants diagnosed with cerebral palsy, hypotonia, or hypertonia. The KID Scale, an empirically normed, caregiver-report inventory which covers behavior in five domains (cognitive, motor, language, self help, and social) was administered at about 5, 9, and 12 months corrected gestational age. Results indicated that motor domain scores were significantly lower than language, self help, and social domain scores whereas cognitive scores were similar to motor scores. It also found that neuromotor diagnostic classification was a significant predictor of longitudinal growth trajectory during the first year. Overall, the infants in the study developed at a significantly slower rate than comparison premature infants (N=14) with no medical complications. However, the growth rate of infants with hypotonia did not differ significantly from the premature control infants. (DB)

Longitudinal Behavioral Change in Infants with Neuromotor Disabilities

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The purpose of this study was to describe behavioral development during the first year of life for those infants diagnosed with cerebral palsy and other neuromotor disabilities. To date, little information has been published on the development of these infants. A review of the literature suggests that previous studies of children with neuromotor diagnoses tend to focus on motor decrements, or offer global examinations of intellectual functioning to the exclusion of more broad-based cognitive and adaptive skills (Fletcher, Levin , & Butler, 1995). The current study attempts to fill a gap in the literature by providing a more differentiated examination of the behavioral development of this clinical group. The neuromotor diagnoses represented within this sample include cerebral palsy, hypertonia, and hypotonia. This study: 1) compares behavioral development of neuromotor diagnosed infants and premature control infants in the cognitive, motor, language, self help, and social domains; and 2) examines developmental growth trajectories for each of the three diagnostic groups.

Method

Subjects

The sample consists of 55 infants drawn from a larger population of 657 infants participating in an NICU follow-up program at the Dayton Children's Medical Center (DCMC) in Dayton, Ohio, conducted between 1987 and 1992. Infants diagnosed with early neuromotor disabilities qualified for inclusion in the current study. All medical diagnoses were retrieved from charts retrospectively, and were originally conferred by attending neonatologists. The 55 infants selected were divided into four groups based upon medical diagnoses: hypotonic (n=17), hypertonic (n=10), cerebral palsy (n=14), and a control group drawn randomly from the NICU premature infants without medical complications (n=14). In the neuromotor group, twelve of the infants with hypotonia were premature; 9 of the infants with hypertonia were premature; and 10 of the infants with cerebral palsy were premature.

Instrument

The KID Scale is an empirically normed, caregiver-report inventory containing 252 items that are descriptions of functional behaviors expected to be acquired during the first 15 months of life (Reuter & Wozniak, 1996). This instrument demonstrates good reliability and validity in determining the developmental status of infants. The KID Scale is divided into five domains: Cognitive, Motor, Language, Self Help, and Social. Standard scores for the five domains were used in the current study for the initial MANOVA analyses that examined profile differences between diagnostic groups. Full-scale raw scores were used for Hierarchical Linear Modeling (HLM) (Bryk & Raudenbush, 1992) analyses because standard scores do not reflect linear change over time.

Procedure

The protocol for the NICU follow-up at DCMC called for two or three successive KID Scales administered at about 5, 9, and 12 months corrected gestational age (CGA). Due to attrition, 256 of the 657 infants participating in the original study had 2 or more KID Scales, and of these 96 had 3 KID Scales. The infants chosen for the current analyses were selected from the 256 participants who had 2 or more completed KID Scales. Infants' mothers or fathers completed the Kid Scales. The MANOVA analyses examined profiles from the first two KID Scales collected for those children who met diagnostic criteria. A second set of analyses utilizing HLM included all available data points (as many as four) to construct developmental trajectories for each individual infant and an across-infant developmental trajectory for each group. This method of analysis makes it possible to describe behavioral change using the parameters of these trajectories rather than looking at means that are based upon specific time points.

Results

MANOVA

A 4 (Diagnosis) X 2 (Time) X 5 (Domain) doubly multivariate, repeated measures MANOVA, using standard scores for each domain based on CGA, yielded a significant main effect for Diagnosis [F (3, 51) = 5.02, p = .004] and Domain [F (4, 204) = 26.28, p < .001], and a trend for Diagnosis X Time interaction [F (3, 51) = 2.46, p = .074].

Figure 1 depicts the Domain profile for each Diagnosis at Time 1 (M age = 5.4 months, SD = 2.4) and Time 2 (M age = 9.2 months, SD = 2.5). Parameter estimates indicated the Diagnosis main effect was due to healthy premature infants obtaining significantly higher standard scores than all of the neuromotor diagnostic groups across domains and time (p's ≤ .05).

Multiple comparisons using the Bonferroni correction to investigate the Domain main effect indicated that Motor Domain scores were significantly lower than Language, Self Help, and Social Domain scores (p's < .05) for all groups collapsing across Time 1 and Time 2. The Cognitive Domain standard scores were not significantly different from Motor domain scores.

HLM

The fact that the Diagnosis X Time interaction was only a trend may be attributed to the lack of power due to the small sample size. Within the second phase of this study, HLM was conducted to clarify the effect of diagnostic classification on overall behavioral change across time as it takes into account individual growth trajectories. In addition, HLM does not require consistent numbers of data points per subject and thus available third-test and fourth-test time data was included. A two level HLM analysis was conducted. At the first level, in this case the individual infant level, 55 individual growth curves based upon full-scale raw scores using CGA at each test time were created. At the second level, in this case across individuals, presence or absence of cerebral palsy, hypertonia, and hypotonia were used as predictors creating the across-infant growth trajectories for the four groups depicted in Figure 2. This combination of level 2 predictors yielded coefficients for each of the non-control groups in comparison to the control group (see Table 1). The parameter estimate for the premature controls is an estimate of the number of KID Scale behaviors acquired by the premature infants controlling for the other groups. Thus, the premature infants acquire approximately 19 KID Scale behaviors per month. The parameter estimates for the other groups indicate that infants with cerebral palsy are

expected to acquire approximately 5 fewer KID Scale behaviors per month ($p \leq .001$) than do the healthy premature control infants. Infants diagnosed with hypotonia acquire approximately 3.5 fewer KID Scale behaviors per month ($p = .003$) than the control group, while those with hypertonia acquire 2.5 fewer behaviors per month ($p = .07$). The diagnostic classifications of cerebral palsy and hypertonia were associated with significantly slower rates of behavioral acquisition when compared to premature infants without medical complications. The growth rate of infants with hypotonia, however, did not differ significantly from the premature control infants. These results are tempered by the low reliability of the parameter estimates (.20 for the intercept, .06 for the slope). In part, the low reliability estimates reflect the heterogeneity of the diagnostic groups, the small sample size, and the limited number of data points per subject (2-4 points). However, it should be noted that our HLM model, which included intercept, CGA at each test time (slope), and diagnostic classification accounted for 92% of the across and within individual variance.

Discussion

Motor development during infancy is an area that receives early attention from parents and physicians, perhaps because the delayed attainment of motor milestones is more apparent than are delays in other behavioral domains (Stein, Bennett, & Abbott, 1996). Although infantile neuromotor diagnoses of cerebral palsy, hypertonia, and hypotonia are made largely on the presence of motor delays and disabilities, behavioral deficits in other domains accompany these diagnoses (see Figure 1). We believe that research attempts to better characterize the developmental profiles of infants diagnosed with neuromotor disorders are important for the implementation and evaluation of early intervention services targeting this population, and may also serve to clarify diagnostic issues.

Neuromotor diagnoses applied during infancy are thought to be relatively unstable, with a significant proportion of children "outgrowing" their motor deficits (Harris, 1997; Nelson & Ellenberg, 1982). However, little research is available documenting the longitudinal behavioral development of infants receiving such diagnoses. The second phase of our analyses incorporating HLM were conducted to examine the longitudinal growth trajectory of the infants in our study. We found that neuromotor diagnostic classification is a significant predictor of longitudinal growth trajectory within the first year of life for those infants participating in an NICU follow-up. Infants with cerebral palsy and hypertonia develop at a significantly slower rate than healthy NICU graduates.

Currently, there is little evidence that early intervention targeting neuromotor disabilities is effective (Pakula & Palmer, 1997). It is hoped that increased understanding of the range of deficits that accompany infantile neuromotor disorders may shed light on the individual differences that effect an infant's ability to benefit from early intervention services. It is important to have studies describing the behavioral development of infants with specific disabilities to provide the baseline for early intervention evaluation studies, and as an aid in customizing future early intervention programs to diagnoses.

A systems theory of infant development, based on an "interactional synergy" (Thelen, 1995), may be helpful in conceptualizing the behavioral deficits found in infants diagnosed with neuromotor disabilities. Thus, delays in motor development impact development in other

behavioral domains as well. Such interactions among behavioral domains during infancy may provide an explanation for why outcome studies indicate that the more "successful" early intervention programs for children with cerebral palsy provide a broad based infant stimulation program rather than solely targeting motor deficits (Harris, 1997; Palmer, 1988)

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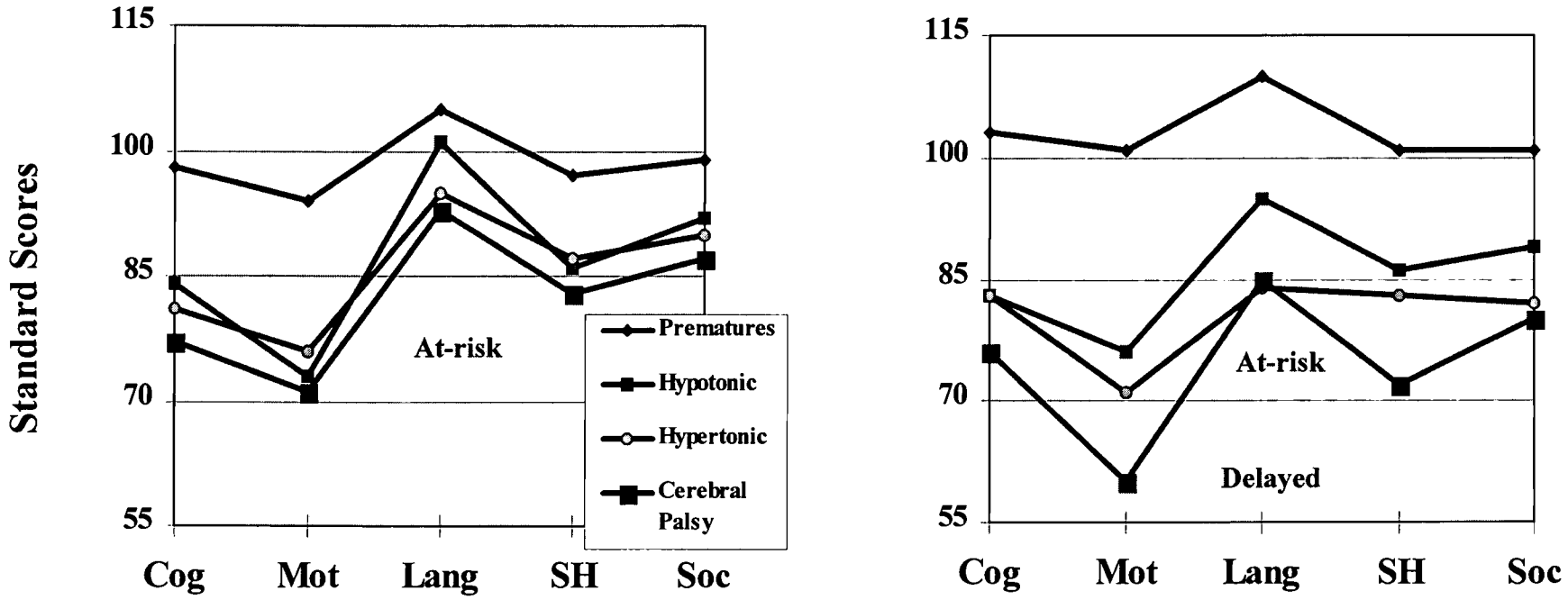
Developmental Status



KID Scale Domains

Time 1 **Time 2**

Fig. 1

Fig. 2. Full Scale Growth Trajectories by Diagnostic Group

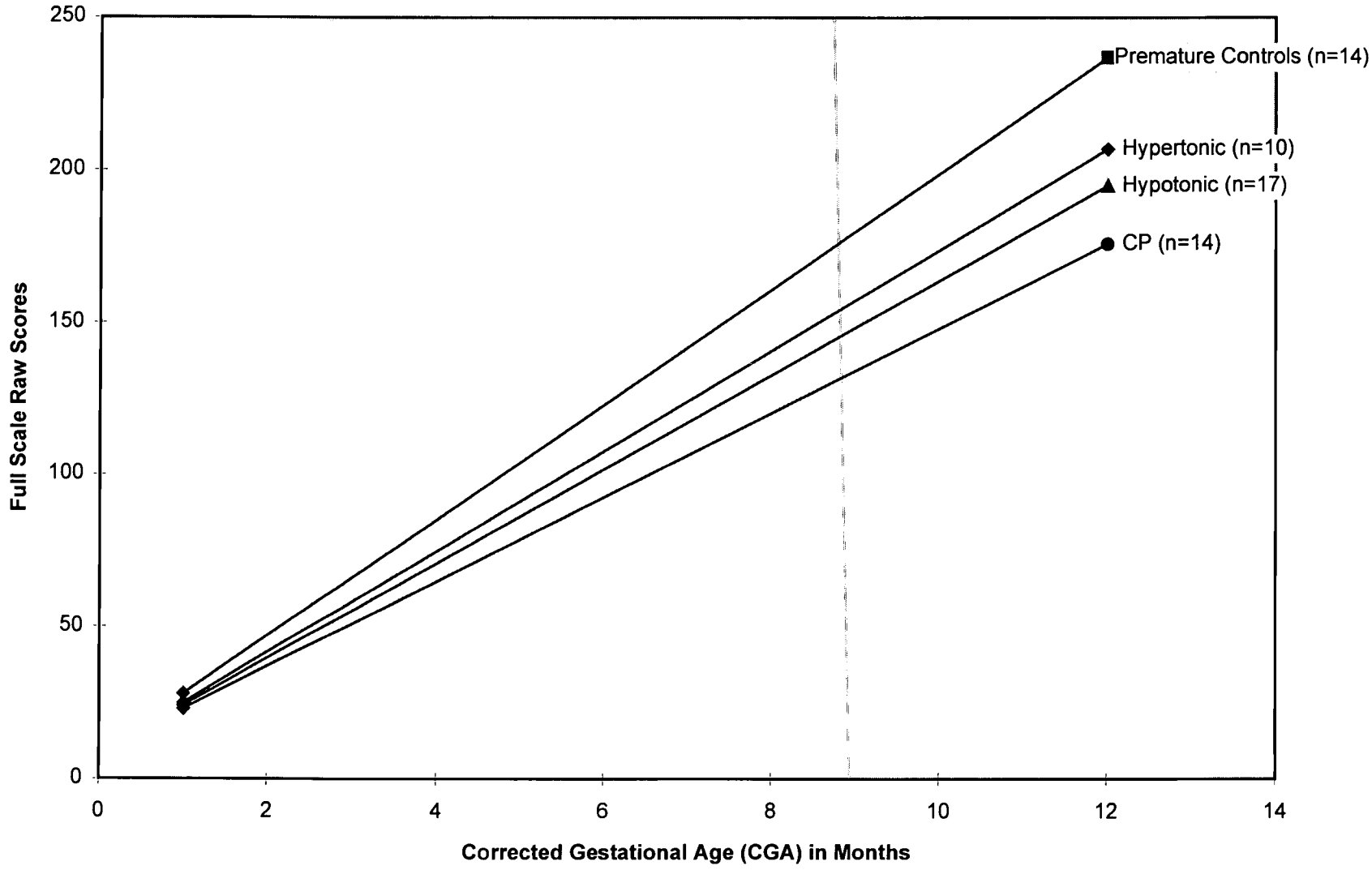


Table 1. KID Scale Behavioral Acquisition as Summarized by HLM for Neuromotor Diagnoses Compared to Healthy Premature Controls

Diagnostic Group	Slope	t ratio	p
Healthy premature control infants	19.044	20.274	0.001
Infants with hypertonia	-2.484	-1.846	0.070
Infants with cerebral palsy	-5.096	-4.397	0.001
Infants with hypotonia	-3.534	-3.171	0.003

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