Acta Genet Med Gemellol 41: 123-135 (1992)

Seventh International Congress
on Twin Studies.

Temperament Prediction for Neonate Twins: Relation to Size for Gestational Age in Same-Sex Pairs

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Abstract. Infants from 22 pairs of appropriate-for-gestational-age/small-for-gestational-age (AGA/SGA) same-sex twins were assessed for temperament stability between the neonatal period and 30 months of age. The evaluation of neonatal temperament included observers' ratings of irritability, resistance to soothing, activity level while awake, activity level during sleep, reactivity, and reinforcement value. At 6, 9, 12, 18, 24, and 30 months mothers rated their infants' temperament on standardized questionnaires which yielded nine temperament categories: activity level, rhythmicity, approach or withdrawal, adaptability, intensity of reaction, quality of mood, attention span, distractibility, and threshold of responsiveness. The Bayley Scales of Infant Development were administered at 6, 9, 12, 18, 24, and 30 months to assess mental development. The results of longitudinal correlational analyses indicated that, for the AGA infants, there was a pattern of significant predictive relations between the neonatal ratings of temperament and maternal ratings of temperament at 6, 9, 12, 18, 24, and 30 months. The SGA infants did not demonstrate similar behavioral stability from the lying-in period up to 30 months of age. Furthermore, for AGA infants there was a consistent trend for both reactivity and neonatal activity during sleep to predict mental development scores between 6 and 30 months. A similar pattern was not observed for the SGA cotwins. The results indicated that temperament stability is an additional area of risk for SGA twins, and that the developmental function of the underlying processes in the neonatal measures is different for AGA and SGA infants.

Key words: Temperament, Development, Size-for-gestational-age, Twins

INTRODUCTION

The twin who is the smaller of the pair at birth has been found to be at risk in the area of cognitive development when compared with his or her heavier cotwin. For example,

in a sample of 9 MZ pairs tested between 4.5 and 17 years of age, the lighter twin had lower scores than the heavier twin on the Stanford-Binet Intelligence Scale, the Verbal Scale of the Wechsler Intelligence Scale for Children, and the Peabody Picture Vocabulary Test [3,4]. Lower global and performance IQ scores were found for the lighter twin in a study of fourteen 9-to-17-year-olds [14]. No significant differences were observed between lighter and heavier cotwins in a study of 125 MZ pairs on performance on the Bayley Scales of Infant Development at 8 months or on the Stanford-Binet Intelligence Scale at 4 years [12]. In a study using a sample of a hundred 7-to-15-year-old twins [22], significant differences were not observed between lighter and heavier cotwins when the entire sample was evaluated on several tests of verbal and nonverbal skills, although lighter male twins performed more poorly than their heavier male cotwins on the Block Design Level test.

Other research has found that children who are small-for-gestational-age (SGA) at birth are at risk for neurological, psychomotor, and behavioral abnormalities, poor scores on developmental tests, and learning difficulties in school when compared with infants who are appropriate-for-gestational-age (AGA) at birth [1,25,31]. In infancy, differences between AGA and SGA groups have been observed in motor and reflex behavior in the first 10 days of life [2,20], in habituation rates at 4 months [11], in neurological integrity at 40 weeks [26], and in psychomotor development at 18 months [23].

The above studies have demonstrated that SGA infants are at higher risk than AGA infants in several areas of developmental integrity. It also is of interest to determine if temperament is an additional area to be considered in the evaluation of risk for the SGA twin. Previous research has described an association between temperament variables and poor behavioral adjustment [5,8,9,10,15] and intellectual achievement [17,24].

Furthermore, it has been demonstrated that some aspects of temperament apparent in the neonatal period are related to behavior assessed later in infancy [7,18,21,30]. A comparison of temperament stability in AGA and SGA cotwins from the neonatal period through 30 months of age could help determine if the SGA twin is at developmental risk in this behavioral area in relation to his or her AGA cotwin. For this purpose, neonate twins from AGA/SGA pairs received a standardized, objective behavioral assessment before hospital discharge and were rated by their mothers on standardized questionnaires at 6,9,12,18,24, and 30 months of age. Correlational analyses were computed between the neonatal ratings and the questionnaire ratings at each age between 6 and 30 months. In addition, it was of interest to determine if the neonatal assessment could provide information about the mental development of the AGA and SGA twins. For this purpose, mental development was assessed at each of the longitudinal ages, and correlational analyses were computed between the neonatal ratings and the mental development scores.

METHOD AND PROCEDURES

Subjects

The sample consisted of 22 pairs of same-sex twins (8 male, 14 female) in which one twin of the pair was appropriate-for-gestational-age (AGA) and the other twin was small-for-gestational-age (SGA). Size for gestational age was determined by using the norms from

Lubchenco et al [16] that define SGA infants as those in the lower 10th percentile of weight for gestational age. The National Institute of Child Health and Human Development has recommended the use of these criteria for both clinical and research purposes [27]. These criteria have been recommended for use in the evaluation of intrauterine growth in twins [19]. These twins were participating in a larger study of development in twins, and size for gestational age was not determined until after the behavioral assessment was completed.

Mean birthweight was 2723 g for AGA twins and 2171 g for SGA twins, and was significantly different between the groups ($F\ [1,48] = 28.2$, $p < 0.0001$). Mean birth length was 48.2 cm for AGA twins and 45.9 cm for SGA twins, and was significantly different between the groups ($F\ [1,47] = 7.35$, $p < 0.009$). There were no significant differences in one-minute and five-minute Apgar scores between the AGA and SGA infants (AGA = 7.6 and 8.8 respectively; SGA = 7.4 and 8.7 respectively).

Neonatal Assessment

The neonates were assessed just prior to discharge from the hospital. The AGA neonates were assessed at a mean age of 5.1 days; the SGA neonates were assessed at a mean age of 7.2 days. Test chronological age was significantly higher for the SGA twins than for the AGA twins ($t = -2.08$, $p < 0.05$). This finding was due primarily to five pairs of twins in which the SGA twin was tested later than the AGA twin (1 each by 3, 5, 6, 15 and 17 days). For 12 pairs the cotwins were tested on the same day, and for 5 pairs the cotwins were tested on consecutive days (in three pairs the SGA twin was tested second). Thus, the twins from 77% of the pairs were tested on the same day or within one day of their cotwins.

Assessment items were selected so that five categories of behavior could be described: irritability, resistance to soothing, reactivity, reinforcement value, and activity. The assessment was organized to elicit a variety of behaviors relative to each category. The procedures have been presented in detail elsewhere [28,29]. In brief, neonates were examined during a period that extended from one feeding to the next (3-4 hours) according to the following protocol:

1. Each neonate was fed at his or her regularly scheduled feeding time. Behavioral state and irritability were rated by the examiner before, during and immediately after the feeding. Ratings also were made of the neonate's feeding adequacy (ie, rooting, sucking, spitting, etc).

2. For a 10-minute period during the first active sleep state, 15-second time-sampling recordings were made of spontaneous activity, consisting of the number and vigor of limb movements, to obtain an index of activity during sleep. For each neonate, a mean score was determined for activity during this observation period, then transformed to a normalized 5-point scale.

3. Midway between feedings the neonate was awakened so that maturational level, sensorimotor status, and orienting behaviors could be assessed. Measures included visual or auditory orienting responses toward a bulls-eye, rattle, bell, voice, and face plus voice combined; reflexive responses such as foot withdrawal, Moro, and sucking;

summary measures of alertness, cuddliness, activity level, and reinforcement value of the neonate's behavior; and, patterns of irritability and soothability in response to specific items such as the orienting items and reflex testing.

4. Ratings were then made of the neonate's response to a potentially stressful stimulus. For this procedure, a metal disc was chilled in ice water for 3 minutes, then placed against the neonate's left thigh and held there for 5 seconds. The procedure was repeated five times, and after each presentation the neonate's behavioral responsivity, irritability, and soothability were rated.

5. Finally, ratings were made of episodic irritability and resistance to soothing throughout the course of the assessment sequence, but especially before a feeding. A standard series of soothing procedures was applied, including responsivity to a pacifier, vocal stimulation, manual stimulation, placement in the prone position, lifting to shoulder, cradling in arm, and swaddling in blanket. Individual responsivity to the various types of soothing and degree of intervention necessary for soothing were assessed.

The behaviors were rated on 5-point scales, with a higher score indicating a higher level of the measured attribute. The assessment items then were combined, and the scaled scores were averaged to form four composite scales: irritability, resistance to soothing, reactivity, and reinforcement value. The specific items drawn from these assessments to form the composite scales were defined as follows:

1. *Irritability*: Refers to irritability during the various situations in the assessment (ie, irritability before feeding, irritability in response to visual stimuli, auditory stimuli, manipulation, and aversive stimuli).

2. *Resistance to soothing*: Refers to the neonate's response to soothing procedures during various parts of the assessment (ie, console latency after withdrawal reflex to prick on sole of foot, soothability after reflex testing and after application of the cold disc, soothability by pacifier and by the various handling procedures described previously).

3. *Reactivity*: Refers to the neonate's responsivity and degree of orienting to visual and auditory stimuli (ie, visual following of bulls-eye; auditory orienting to a rattle, bell, voice, and face plus voice; alertness during presentation of orienting items).

4. *Reinforcement value*: Refers to the effect of the neonate's behavior on the attitude of the examiner toward the neonate (ie, cuddliness; reinforcement value of neonate's behavior during all assessments, but especially for maturational level, sensorimotor status and orienting behaviors; response to handling).

In addition, two measures of activity were included: one during sleep, and one while awake. These six scores defined the neonatal behavioral profile for each neonate.

Interrater reliabilities, determined by intraclass correlations for exact agreement on raw scores, were as follows: irritability, $r = 0.94$; resistance to soothing, $r = 0.99$; reactivity, $r = 0.94$; reinforcement value, $r = 0.90$; activity awake, $r = 0.79$; and activity asleep, $r = 0.92$.

Temperament Questionnaire

Mothers completed the Infant Temperament Questionnaire [9] when the twins were 6 and 9 months of age, and the Toddler Temperament Scale [13] when the twins were 12, 18, 24 and 30 months of age. The questionnaires included 95 and 97 items, respectively, rated on 6-point scales. The ratings were combined to yield nine scores representing the categories of temperament postulated by Thomas and Chess [32], as follows: activity, rhythmicity, approach/withdrawal, adaptability, intensity of reaction, mood, attention/persistence, distractibility, and threshold of responsiveness. The temperament categories were rated as follows:

Activity: High score = high activity, low score = low activity

Rhythmicity: High score = nonrhythmic in vegetative functions, low score = very rhythmic

Approach/withdrawal: High score = withdrawn and avoidant in new situations, low score = approachful to new situations

Adaptability: High score = slow to adapt to changes, low score = very adaptable to changes

Intensity of reaction: High score = intense, low score = mild intensity

Mood: High score = negative in mood (unhappy), low score = positive in mood

Attention/persistence: High score = low attention/persistence, low score = high attention/persistence

Distractibility: High score = high distractibility, low score = low distractibility

Threshold of responsiveness: High score = low threshold (sensitive), low score = high threshold

Mental Development

The Bayley Scales of Infant Development [6] were administered to the twins when they were 6, 9, 12, 18, 24, and 30 months of age to assess mental development.

RESULTS

Neonatal Ratings and Questionnaire Ratings

To determine if there were consistent individual differences from the neonatal period through 30 months of age, correlations were computed between the neonatal variables and the 6-, 9-, 12-, 18-, 24-, and 30-month questionnaire ratings. Separate correlations were computed for the AGA and SGA twins. The results are presented in Tables 1 through 6. To evaluate the predictive patterns, only those variables that demonstrated predictive relations are presented. In general, it is clear that there are patterns of significant predictive relations between the neonatal ratings and the questionnaire ratings for the AGA twins. Individual differences detected in AGA twins during the neonatal peri-

Table 1 - Predictive relations between neonatal assessment and *6-month* temperament questionnaire

NEONATAL VARIABLE[a]	6-Month Questionnaire[a]				
	RHYTH	APPR	MOOD	DIST	THRSH
AGA Correlations					
IRR				0.50*	0.48*
SOO				0.53*	
REAC			−0.53*	−0.56*	
REIN		−0.46*	−0.62**	−0.62**	
SGA Correlations					
IRR					
SOO			0.52*	0.65**	
REAC					
REIN	0.47*				

[a]IRR = irritability, SOO = resistance to soothing, REAC = reactivity, REIN = reinforcement value, RHYTH = rhythmicity, APPR = approach/withdrawal, MOOD = Intensity of mood, DIST = distractibility, THRSH = threshold of responsiveness

* $p < 0.05$; ** $p < 0.01$

od were related to mothers' ratings of their twins' temperament between 6 and 30 months of age. Similar predictive patterns were not observed for the SGA twins. The results presented in Table 1 indicate that the irritable AGA neonate twin was likely to be rated as more distractible and having a low threshold of responsiveness at 6 months. Also, AGA neonate twins rated as difficult to soothe were likely to be more distractible at 6 months; those rated as reactive as neonates were more positive in mood and less distractible at 6 months; and those rated as more reinforcing as neonates were more approachful to new situations, more positive in mood, and less distractible at 6 months. SGA twins exhibited only one predictive relation from the neonatal period to 6 months similar to that of the AGA twins — SGA neonate twins rated as more difficult to soothe were likely to be more distractible at 6 months. In the main, however, longitudinal relations similar to those observed for the AGA twins were not demonstrated for their SGA cotwins.

As indicated in Table 2, there were a few significant relations between the neonatal assessment and 9-month ratings. AGA twins who were rated as more irritable as neonates were likely to be rated as highly active and more rhythmic at 9 months; and those rated as more reinforcing to the examiner as neonates were rated as mild in intensity at 9 months. None of these predictive relations were observed for the SGA twins. However, several predictive relations were observed for the SGA twins. SGA neonate twins who were highly active while awake were more withdrawn and avoidant at 9 months; those highly active during sleep were more distractible; those who were more

Table 2 - Predictive relations between neonatal assessment and *9-month* temperament questionnaire

NEONATAL VARIABLE[a]	9-Month Questionnaire[a]					
	ACT	RHYTH	APPR	INT	DIST	THRSH
AGA Correlations						
IRR	0.50*	−0.48*				
AWK						
ASL						
REAC						
REIN				−0.57*		
SGA Correlations						
IRR						
AWK			0.53*			
ASL					0.65**	
REAC				−0.60**		
REIN						−0.56*

[a]IRR = irritability, AWK = activity-awake, ASL = activity-asleep, REAC = reactivity, REIN = reinforcement value, ACT = activity, RHYTH = rhythmicity, APPR = approach/withdrawal, INT = intensity of reaction, DIST = distractibility, THRSH = threshold of responsiveness

* $p < 0.05$; ** $p < 0.01$

reactive as neonates were rated as mild in intensity at 9 months; and those who were more reinforcing to the examiner as neonates were rated as having a higher threshold of responsiveness at 9 months.

Tables 3,4,5 and 6 illustrate that similar differences in predictive relations from the neonatal period to temperament ratings at 12,18,24, and 30 months of age were observed between AGA and SGA twins. Although there were one or two predictors from the neonatal assessment to later questionnaire ratings at each age for the SGA twins, with the exception of the relation between neonatal resistance to soothing and 30-month adaptability, the predictors were not the same as those observed for the AGA twins. Furthermore, it is noteworthy that a pattern of predictive relations was observed between an objective assessment of neonatal behaviors and maternal ratings of 30-month temperament for twins who were appropriate for gestational age at birth, as presented in Table 6. Specifically, the AGA neonate twin who was more irritable, more difficult to soothe, less reactive to orienting stimuli, and less reinforcing to the examiner was likely to be rated as slow to adapt to changes at 30 months. The irritable, less reactive AGA neonate twin was also likely to be rated as highly active at 30 months, and the AGA neonate who was highly active during sleep was likely to be rated as highly intense and less attentive/persistent at 30 months. Finding these strong patterns of predictive relations from the neonatal period to 30 months of age for the AGA twins provides additional

Table 3 - Predictive relations between neonatal assessment and *12-month* temperament questionnaire

NEONATAL VARIABLE[a]	12-Month Questionnaire[a]				
	ACT	RHYTH	APPR	DIST	THRSH
AGA Correlations					
IRR				−0.57**	
SOO				−0.54*	0.44*
AWK	0.54*				
ASL					
REAC			0.44*		
REIN	−0.67**	0.59**			
SGA Correlations					
IRR					
SOO					
AWK					
ASL				0.65**	
REAC					
REIN					

[a]IRR = irritability, SOO = resistance to soothing, AWK = activity-awake, ASL = activity-asleep, REAC = reactivity, REIN = reinforcement value, ACT = activity, RHYTH = rhythmicity, APPR = approach/withdrawal, DIST = distractibility, THRSH = threshold of responsiveness

* $p<0.05$; ** $p<0.01$

Table 4 - Predictive relations between neonatal assessment and *18-month* temperament questionnaire

NEONATAL VARIABLE[a]	18-Month Questionnaire[a]					
	ACT	APPR	ADPT	INT	MOOD	ATT
AGA Correlations						
IRR	0.46*		0.45*		0.46*	
ASL						0.44*
REAC						
SGA Correlations						
IRR				−0.48*		
ASL						
REAC		0.45*				

[a]IRR = irritability, ASL = activity-asleep, REAC = reactivity, ACT = activity, APPR = approach/withdrawal, ADPT = adaptability, INT = intensity of reaction, MOOD = intensity of mood, ATT = attention/persistence

* $p<0.05$

https://doi.org/10.1017/S0001566000002324 Published online by Cambridge University Press

Table 5 - Predictive relations between neonatal assessment and *24-month* temperament questionnaire

NEONATAL VARIABLE[a]	24-Month Questionnaire[a]		
	APPR	MOOD	ATT
AGA Correlations			
IRR		0.55*	
SOO		0.46*	
ASL			0.49*
REIN			
SGA Correlations			
IRR	−0.45*		
SOO			
ASL			
REIN			−0.45*

[a]IRR = irritability, SOO = resistance to soothing, ASL = activity-asleep, REIN = reinforcement value, APPR = approach/withdrawal, MOOD = intensity of mood, ATT = attention/persistence

* $p<0.05$

Table 6 - Predictive relations between neonatal assessment and *30-month* temperament questionnaire

NEONATAL VARIABLE[a]	30-Month Questionnaire[a]			
	ACT	ADPT	INT	ATT
AGA Correlations				
IRR	0.50*	0.71**		
SOO		0.71**		
ASL			0.52*	0.48*
REAC	−0.59*	−0.58*		
REIN		−0.53*		
SGA Correlations				
IRR				
SOO		0.49*		
ASL				
REAC				
REIN				−0.54*

[a]IRR = irritability, SOO = resistance to soothing, ASL = activity-asleep, REAC = reactivity, REIN = reinforcement value, ACT = activity, ADPT = adaptability, INT = intensity of reaction, ATT = attention/persistence

* $p<0.05$; ** $p<0.01$

https://doi.org/10.1017/S0001566000002324 Published online by Cambridge University Press

support for the contention that there is a constitutional contribution to temperament development.

As indicated in Tables 1 through 6, there are both similarities and differences in the predictive patterns from the neonatal period to each age from 6 to 30 months for the AGA twins. The predictive relations can be summarized as follows. The irritable AGA neonate twin was likely to be rated later as highly active through the first 30 months; more rhythmic and low in threshold in the first year; more distractible at 6 months but less distractible at 12 months; slow to adapt to changes and negative in mood after the first year. The AGA neonate twin who was more active during sleep was likely to be rated later as low in attentiveness after the first year; more highly intense at 30 months. The more reactive AGA neonate twin was likely to be rated later as more positive in mood and less distractible in early infancy; more withdrawn and avoidant at 12 months; less active and more adaptable at 30 months. The AGA neonate twin rated as more reinforcing to the examiner was likely to be rated later as more approachful in new situations, mild in intensity, more positive in mood, and less distractible in the first year; low in activity level and nonrhythmic in vegetative functions at 12 months; more adaptable to change at 30 months.

Similar consistency in predictive relations was not observed for the SGA twins.

Neonatal Ratings and Mental Development

To determine if there were predictive relations between the neonatal assessment and mental development from 6 through 30 months of age for the AGA and SGA twins, correlations were computed between the neonatal variables and the MDI scores at 6,9,12,18,24 and 30 months. Separate correlations were computed for the AGA and SGA twins. The results are presented in Table 7. The results indicated that there were a few significant predictive relations between the neonatal assessment and mental development scores up to 30 months for the AGA twins: the neonate twin who was more difficult to soothe received higher MDI scores at 9 months; high activity during sleep was negatively correlated with MDI scores at 30 months; high neonatal reactivity was related to lower MDI scores at 18 months; and higher neonatal ratings on reinforcement value were negatively correlated with 12-month MDI scores. No significant predictive relations were observed for the SGA twins from the neonatal period through 30 months of age. Although there were only a few significant predictive relations between the neonatal assessment and MDI scores, there were some predictive trends for the AGA twins for activity during sleep and reactivity. These correlation coefficients, as shown in Table 7, did not all reach statistical significance because of the small sample sizes (range = 21 to 16 from 6 to 30 months). The two sets of trends are noteworthy, however, because of their consistency. These trends suggest that higher activity during sleep and higher reactivity in the neonatal period were related to lower mental development scores for the AGA twins.

For the SGA twins, a similar trend was not observed for prediction of mental development scores from neonatal activity during sleep. There were two modest correlations for the SGA twins between neonatal reactivity and later mental development scores, although the remaining correlations generally were zero-order correlations. Ad-

Table 7 - Predictive relations between neonatal assessment and mental development (MDI) scores

NEONATAL VARIABLE	Mental Development (MDI)					
	6 MO	9 MO	12 MO	18 MO	24 MO	30 MO
AGA Correlations						
IRRITABILITY	0.38					
SOOTHABILITY		0.42*				
ACTIVITY-AWAKE	0.39					
ACTIVITY-ASLEEP	−0.35		−0.38	−0.35	−0.37	−0.53*
REACTIVITY		−0.34	−0.42	−0.52*		−0.35
REINFORC. VALUE			−0.63**			
SGA Correlations						
IRRITABILITY			−0.44	−0.45		
SOOTHABILITY						
ACTIVITY-AWAKE						
ACTIVITY-ASLEEP						
REACTIVITY		−0.34				−0.44
REINFORC. VALUE	−0.33					

* $p < 0.05$; ** $p < 0.01$

ditionally, however, there were some modest, although not significant, correlations between neonatal irritability and mental development scores after the first year of life for this group. These findings demonstrated that there were differences in the patterns of predictive relations between neonatal behaviors and mental development scores up to 30 months of age for AGA and SGA twins.

CONCLUSION

These findings have demonstrated that an objective behavioral assessment in the neonatal period predicted mothers' ratings of temperament for their AGA twins at 6, 9, 12, 18, 24, and 30 months of age. The changing patterns from the neonatal period to the different ages probably reflect, as suggested by previous findings [30], maturational changes and effects of transactions with the environment. It is particularly noteworthy that consistent, although modest, predictive patterns were obtained from the neonatal period to 30 months of age. This study adds to the growing body of data indicating that there is a constitutional contribution to temperament development.

In contrast, similar patterns of predictive relations were not obtained for the SGA twins. Differences between the AGA and SGA twins were also observed in the pattern of relations between the neonatal ratings and the mental development scores at 6, 9, 12,

18, 24 and 30 months of age. Intrauterine factors associated with growth retardation may result in central nervous system insult and inhibit the expression of temperament and other behaviors in the neonatal period. If some predictive stability is to be expected in the healthy infant, then lack of stability could reflect either continued effects of the intrauterine insult, or recovery from the intrauterine insult during early development. In any event, the results suggest that temperament development is another area of risk to be considered in the evaluation of the SGA twin. Although the significance of the findings cannot be addressed by the data available from this study, it appears that the developmental function of the underlying processes in the neonatal measures is different for the AGA and SGA twins.

Acknowledgements: This research was supported in part by a grant from the John D. and Catherine T. MacArthur Foundation, and Grants HD-14352 and HD-22637 from the National Institute of Child Health and Human Development. The author is grateful to the parents and their infants who participated in the study; to the administrators and nursing staffs in the participating hospitals; and to R. Arbegust, E. Harpring, M. Hinkle, P. McNulty, B. Moss, S. Nuss, D. Sanders and K. Sears for their contributions.

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