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Genetic Influences on Neonatal Temperament

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Abstract. The genetic contribution to temperament was assessed during the neonatal period in 172 newborn infants from 47 pairs of monozygotic (MZ) and 39 pairs of same-sex dizygotic (DZ) twins. Zygosity was not related to the neonatal temperament variables. Examination of the scores for twin concordance indicated significant within-pair concordance in temperament ratings, but MZ twins were not more like each other than DZ twins. The results suggested that neonatal temperament was influenced by environmental factors. Further analyses indicated that neonatal temperament was influenced by perinatal variables such as birth weight, 1- and 5-minute Apgar scores, and number of days spent in the hospital. It was concluded that there was no clear pattern of genetic influence on neonatal temperament, and that nonshared environmental factors were an important source of variance for temperament during this period.

Key words: Neonatal temperament, Twins

A genetic component to temperament development has been demonstrated by assessments made from two months of age to early childhood. For example, using the interview method, Torgersen and Kringlen [7] found that at two months of age MZ twins were more like each other in three of nine temperament categories than DZ twins, whereas at nine months the difference between zygosity groups was observed for all nine categories. Using the parent report method of describing similarities and differences in behavior, Matheny et al [4] found similar levels of concordance for MZ and DZ twins in the first year of life, but by two years MZ twins were significantly more concordant for temperament variables than DZ twins.

Findings on the same order have been observed using more objective methods. Examining factor scores from the Infant Behavior Record from the Bayley [1] Scales of Infant Development in twins from 3 to 24 months of age, Matheny [3]

found higher concordance for MZ twins than for same-sex DZ twins, with the difference in concordance increasing as the twins got older. And, using ratings derived from laboratory observations of behavior from 9 to 24 months of age, Wilson and Matheny [10] reported that ratings of emotional tone were equally concordant for MZ and DZ twins up to 12 months, but for later ages concordance increased for the MZ twins and decreased for the DZ twins. Similar findings of lesser magnitude were observed for ratings of activity and attentiveness.

These studies have demonstrated that genetic influences on temperament are apparent in infancy and early childhood, with the effects increasing with increasing age. The present study was designed to determine, by use of the twin method, if genetic effects on temperament are apparent during the newborn period.

METHOD

Subjects

The sample included 172 newborn twins from 47 pairs of monozygotic (MZ) twins and 39 pairs of same-sex dizygotic (DZ) twins. Zygosity was determined by blood-typing on 22 or more red cell antigens [9]. Twins were classified as MZ if the results were concordant for all antiserum tests, and DZ if the results were discordant for any test. For technical and psychological reasons the twins were not bloodtyped until they were three years old; therefore, all infants were assessed before zygosity was established. Mean birth gestational age was as follows: for MZ twins, 36.7 weeks; for same-sex DZ twins, 37.4 weeks. There were no significant differences in birth gestational age between the MZ and DZ twins.

Procedures

Full-term infants were assessed in the first week of life (mean = 3.7 days). Preterm infants and infants with medical complications were assessed when they were medically stable, just before discharge from the hospital (mean = 16.9 days). There were no significant differences between the zygosity groups on chronological age at test.

The procedures have been presented in detail elsewhere [5,6]. In brief, neonates were examined during a period that extended from one feeding to the next (three to four hours) according to the following protocol:

1. Each neonate was fed at its 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 infant'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

subject, a mean score was determined for activity during this observation period, then transformed to a normalized 5-point scale.

3. Midway between feedings the infant 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 and voice combined; reflexive responses such as foot withdrawal, Moro, and sucking; summary measures of alertness, cuddliness, activity level, and reinforcement value of the infant's behavior; and patterns of irritability and soothability in response to specific items such as the orienting items and reflex testing.

4. Ratings then were made of the infant's response to a potentially stressful stimulus. For this procedure, a metal disc was chilled in ice water for three minutes, then placed against the neonate's left thigh and held there for five seconds. The procedure was repeated five times, and after each presentation the infant'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, and 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 infant's behavior on the attitude of the examiner toward the infant (ie, cuddliness; reinforcement value of infant'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 infant.

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.

RESULTS

The mean scores and standard deviations for the neonatal assessment are presented in Table 1 by zygosity. A comparison of the mean scores by t tests indicated that there were no differences between the MZ and DZ twins on any of the neonatal variables. Thus, zygosity was not related to behavioral scores, per se, during the neonatal period.

Table 1 - Means and standard deviations for neonatal assessment scores

Variable	MZ		DZ	
	M	SD	M	SD
Irritability	2.52	0.85	2.52	0.92
Resistance to soothing	3.14	0.95	3.17	1.02
Activity-awake	3.29	0.90	3.28	0.98
Activity-asleep	3.24	1.06	3.13	0.77
Reactivity	2.93	0.64	2.87	0.68
Reinforcement value	2.99	1.08	2.98	0.96

A comparison also was made to determine if there were differences between the MZ and DZ twins on the following perinatal variables: birth gestational age, birth weight, birth length, 1- and 5-minute Apgar scores, number of days in an isolette, number of days in the hospital, test gestational age, test chronological age, and test weight. The results of t tests indicated that the DZ twins had a higher mean 5-minute Apgar score than the MZ twins, although the difference was small: $t\ (170) \doteq -2.27$, $p < 0.03$ (MZ mean = 8.6, DZ mean = 8.8). There were no significant differences between the zygosity groups on any of the other perinatal variables.

To determine if there was a genetic influence on the expression of temperament during the neonatal period, the behavioral scores were examined for concordance between twins within zygosity groups. For this analysis a repeated-measures analysis of variance adapted for twin data [8] was used. The within-pair concordance is expressed in the form of a correlation coefficient. The results are presented in Table 2.

The twins of each pair were like each other in certain behavioral areas, but not in all behavioral areas assessed. Significant within-pair concordance in average scores was observed for irritability, resistance to soothing (DZ twins only), and reinforcement value. If one twin of a pair was generally irritable during the neonatal period, its cotwin was likely to be irritable. Twins within pairs were not like each other on average ratings of activity and reactivity.

Table 2 - Twin correlations for neonatal assessment scores

Variable	MZ (No. of pairs)		DZ (No. of pairs)	
Irritability	0.30*	(47)	0.45**	(39)
Resistance to soothing[a]	0.06	(47)	0.59**	(39)
Activity-awake	0.09	(47)	0.12	(39)
Activity-asleep	0.22	(47)	0.21	(38)
Reactivity	0.12	(45)	0.06	(39)
Reinforcement value	0.31*	(46)	0.49**	(39)

* $p < 0.05$, ** $p < 0.01$
[a] $DZ_R > MZ_R$ ($p < 0.01$).

To determine if the average scores for MZ twins were more similar to one another than the average scores for DZ twins, the correlation coefficients were transformed to z scores, and statistical analyses were performed between the z coefficients [2]. As expected, MZ twins were not more like each other in the behavioral areas than DZ twins. However, for resistance to soothing, same-sex DZ twins were more similar to each other in average scores than MZ twins ($CR = 2.80$, $p < 0.01$).

These results suggested that neonatal temperament is influenced by environmental factors. Therefore, analyses were conducted to begin to look at environmental factors that might account for differences within twin pairs on the temperament measures. Relations between specific perinatal variables and temperament were explored for the MZ and DZ twins. The perinatal variables, which provided an index of potential environmental factors to be related to intrapair behavioral differences, were birth weight, 1- and 5-minute Apgar scores, number of days the infant was in an isolette, and number of days the infant was in the hospital. Because of the sample size, it was not feasible to separate the infants by types of neonatal complications; therefore, these perinatal variables were used as gross estimates of perinatal complications and neonatal clinical status.

Table 3 - Twin correlations for perinatal variables

Variable	MZ (No. of pairs)		DZ (No. of pairs)	
Birth weight	0.83**	(47)	0.76**	(39)
1-minute Apgar	0.45**	(47)	0.05	(39)
5-minute Apgar	0.21	(47)	0.35*	(39)
Days in isolette	0.84**	(23)	0.86**	(14)
Days in hospital[a]	0.80**	(47)	0.93**	(39)

* $p < 0.05$, ** $p < 0.01$
[a] $DZ_R > MZ_R$ ($p < 0.05$).

As a first step, twin correlations for the perinatal variables were computed for MZ and DZ twins. These are presented in Table 3. The degree of similarity within twin pairs varied across the perinatal variables for the MZ and DZ twins. Twins within pairs tended to be more like each other in the longer-term indexes of clinical

status than in the more immediate indexes of status, probably reflecting differences in stress during delivery for the twins within a pair. DZ twins were more like each other in the total number of days spent in the hospital than MZ twins (CR = 2.52, $p < 0.05$), possibly reflecting more long term complications for one of the MZ twins of a pair. These values for number of days in hospital are influenced, however, by medical policies in which an attempt is made to discharge the twins at the same time.

The next step was to determine if the intrapair differences in temperament differed as a function of the perinatal indicators. Difference scores were created by subtracting the second twin's score on each behavioral category from the first twin's score on that category. These difference scores then were correlated with the perinatal variables. The resulting correlations indicated a pattern of modest relations between these difference scores for two behavioral categories – activity during sleep and reinforcement value – and the perinatal variables. Larger differences in activity during sleep were significantly related to lower birth weight, lower 1-minute Apgar scores, more days spent in an isolette, and more days spent in the hospital ($r = -0.28$, $p < 0.05$; $r = -0.24$, $p < 0.05$; $r = 0.27$, $p < 0.05$; $r = 0.25$, $p < 0.05$, respectively). Larger differences in ratings of reinforcement value were significantly related to lower 1- and 5-minute Apgar scores, and more days spent in an isolette ($r = -0.26$, $p < 0.05$; $r = -0.35$, $p < 0.01$; $r = 0.25$, $p < 0.05$, respectively). In addition, larger differences in ratings of irritability were significantly related to higher 5-minute Apgar scores ($r = 0.24$, $P < 0.05$). It is clear, then, that perinatal indicators of risk accounted for some of the intrapair differences observed in neonatal temperament, although much of the variance in the scores for some behavioral variables remains unexplained.

CONCLUSIONS

These data indicate that there is no clear pattern of genetic influence on temperament in the neonatal period. Thus, this study is an extension of previous studies demonstrating an increasing genetic influence on temperament with increasing age [3,4,7,10]. Nonshared environmental factors (including perinatal variables) are an important source of variance for neonatal temperament, and obscure genetic influences on temperament during this period.

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