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Temperament Development to 30 Months of Age in Discordant Twin Pairs

M. L. Riese

Louisville Twin Study, University of Louisville School of Medicine, Louisville, Kentucky

Abstract. Twins within pairs often have different weights at birth. A difference of 15% or greater is defined as discordance for weight and is considered to place one or both infants at risk. Temperament differences had been found in the neonatal period for fullterm discordant cotwins, but not for preterm discordant cotwins, suggesting that continued gestation for discordant twins was a risk variable for early behavior. 30 pairs of fullterm and 17 pairs of preterm discordant pairs were followed at 6, 9, 12, 18, 24, and 30 months of age. Group differences were observed for the longitudinal maintenance of cotwin discordance in physical measures, with preterm cotwins becoming more like each other. In laboratory assessments, temperament differences no longer were observed between the larger and smaller cotwins. Questionnaires indicated that mothers generally did not differentiate between their larger and smaller cotwin children in temperament ratings, except for ratings of mood for the fullterm pairs. Thus, emotionality was the only temperament dimension that differentiated between the fullterm discordant twins both in the neonatal period and at later ages. In the main, it was concluded that the fullterm discordant twins overcame the adverse in-utero influences on early behavioral development.

Key words: Twins, Temperament, Discordance, Birth weight, Development, Risk, Preterm

INTRODUCTION

It is typical for twins within pairs to have different weights at birth. Birth weight differences up to 10% between cotwins are considered to be the norm, and 15% to 20% or more is considered to be abnormal and, therefore, defines discordance for weight [8]. A question relevant for the developmental integrity of the cotwins is whether this discordant intrauterine growth of the twins is meaningful for the behavioral development of one or both infants.

Previous research had demonstrated differences in neonatal temperament for fullterm twins discordant for birth weight [12], but not for preterm twins discordant for birth weight [13]. The larger fullterm twin was more irritable, more difficult to soothe, more active while awake, more active during sleep, less reactive to visual and auditory stimuli, and less reinforcing to the examiner than the smaller fullterm cotwin.

The differences observed between the fullterm cotwins, particularly for irritability, were similar to those that had been found to differentiate between high– and low-risk infants, both in the neonatal period and in predicting later temperament development [9, 10]. Moreover, the direction of the differences between the cotwins suggested that both the smaller and the larger twins were at behavioral risk in relation to the different temperament characteristics. It was concluded that the intrauterine variables that influenced the relative growth of the discordant cotwins also influenced brain development and, subsequently, the measured behaviors [12]. The absence of similar differences between the preterm cotwins led to the conclusion that the continued exposure to the intrauterine environment until fullterm status may present a risk for early behavioral development for discordant twins [13].

As referred to above, earlier research had demonstrated differences in neonatal temperament between low-risk and other high-risk neonates. Temperament involves a relation between the nervous system and behavior, and includes constitutional differences in reactivity [14]; therefore, the study of early temperament can provide insight into some of the developmental effects of the intrauterine variables related to the discordant birth weight.

The studies by Riese [12, 13] were the first to examine potential differences in neonatal temperament for discordant cotwins. A few studies have examined potential behavioral differences in older cotwins. In one study, mothers rated behavioral characteristics of their discordant cotwins between infancy and 8 years of age [6]. Twins with larger birth weight discordance were found to have more differences in behavioral characteristics than twins with smaller birth weight discordance, with the lighter twin of the more discordant group having more problem behaviors. In a study with older teenage twins, parents described the heavier twin as making less effort and being more easygoing and more self-assured than the lighter twin [1]. For preterm twins at one year corrected age, the heavier twin was rated as less attentive and more difficult to soothe than the lighter twin [3].

The present study was designed to determine if there were temperament differences in development between 6 and 30 months of age in a subset of the fullterm and preterm infants assessed in the neonatal period. To determine if there are long-term consequences of birth weight discordance for temperament development for twins, assessments were made to determine if the temperament differences that were observed between the fullterm neonate cotwins are maintained for the older infant and toddler. It also is of interest to determine if, in the same developmental time frame, temperament differences appear between the discordant preterm cotwins for whom no differences were observed in the lying-in period. Unlike some procedures in previous studies with older twins, the present study evaluated the fullterm and preterm groups separately, had separate evaluations at specific ages, and defined birth weight discordance by percent difference in birth weight between the twins [4, 8].

MATERIALS AND METHODS

Subjects

The sample included 30 pairs of fullterm twins and 17 pairs of preterm twins who were at least 15% discordant for birth weight. Percent difference in birth weight was defined as [(birth weight of larger twin - birth weight of smaller twin)/birth weight of larger twin] x 100 [4, 8]. For the fullterm group, percent discordance ranged from 15% to 44%, with a mean of 23% and standard deviation of 7.1%. For the preterm group, percent discordance ranged from 15% to 48%, with a mean of 23% and standard deviation of 7.7%. Birth weight information for the larger and smaller cotwins within groups follows: Fullterm means – larger: 3217g, smaller: 2460g; standard deviations – larger: 380g, smaller: 348g; Preterm means – larger: 2505g, smaller: 1940g; standard deviations – larger: 508g, smaller: 440g.

Procedure: Laboratory Assessment

At 6, 9, 12, 18, 24, and 30 months of age the infants were engaged in a standardized series of age-appropriate vignettes in the laboratory [15] using a structured sequence of play activities and interactions. The activities were videotaped according to a pre-set schedule. Ratings were made from the videotape of the following behaviors for successive 2-minute episodes, and then summed into one composite score for each rating scale.

1. emotional tone: Refers to the principal emotional state exhibited during the rating period, ranging from extreme distress to animated laughter;
2. attentiveness: Refers to the degree to which an infant was alert to and maintained attention on objects and events;
3. activity: Refers to body motion with or without locomotion; may involve whole or partial body movements;
4. social orientation to staff: Refers to the positive and negative aspects of social orientation of the infant in relation to others; places some emphasis on approach-avoidance behaviors.

Also at each visit each twin was measured for weight, height, and head circumference.

Temperament Questionnaires

Mothers completed the Infant Temperament Questionnaire [2] when the twins were 6 and 9 months of age, and the Toddler Temperament Scale [5] when the twins were 12, 18, 24, and 30 months of age. These questionnaires contain 95 and 97 items, respectively, which are combined to yield nine scores representing nine temperament characteristics, as follows:

1. activity level: motor activity during daily routines as well as motility during the sleep-wake cycles;
2. rhythmicity: regularity of vegetative functions;
3. approach/withdrawal: initial positive or negative response to a new stimulus;
4. adaptability: ease of transition to new or altered situations;
5. intensity of reaction: degree of response;
6. quality of mood: amount of positive or negative affect;
7. persistence: degree to which an interest is maintained or an activity is pursued in the face of obstacles;
8. distractibility: effectiveness of extraneous stimuli to shift ongoing behavior;
9. threshold of responsiveness: level of sensory stimulation required to evoke a response.

RESULTS

Cotwin Size Variables

The means and standard deviations for measures of weight, height, and head circumference are presented in Tables 1, 2, and 3, respectively for the larger and smaller twins within pairs for the fullterm and preterm groups. The means between the larger and smaller twins were compared separately for the fullterm and preterm cotwins by analyses

Table 1 - Means and standard deviations for Weight (in Pounds) for larger and smaller twins within pairs

	Fullterm				Preterm			
	Larger Twins		Smaller Twins		Larger Twins		Smaller Twins	
AGE	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Birth	6.88 ***	.84	5.29 ***	.78	5.02 ***	1.19	3.85 ***	.97
6 Months	17.05 **	1.96	14.89 **	2.15	15.34 *	1.22	14.19 *	1.29
9 Months	19.59 **	2.12	17.42 **	2.37	17.99 *	1.53	16.58 *	1.69
12 Months	21.74 **	2.16	19.51 **	2.74	20.05 [a]	1.49	18.89 [a]	1.79
18 Months	25.04 **	2.68	22.37 **	2.96	22.77	1.37	21.94	1.94
24 Months	27.57 **	2.86	24.61 **	3.08	25.45 *	1.86	23.87 *	1.75
30 Months	31.20 **	3.42	27.95 **	2.55	28.16 *	2.10	26.33 *	2.10

F for Means: [a] $p < .06$; * $p < 0.3$; ** $p < .003$; *** $p < .0001$

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Table 2 - Means and standard deviations for Height (in centimeters) for larger and smaller twins within pairs

	Fullterm				Preterm			
	Larger Twins		Smaller Twins		Larger Twins		Smaller Twins	
AGE	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Birth	49.86 ***	2.35	46.95 ***	3.11	47.52 *	3.53	44.15 *	3.45
6 Months	66.25 **	2.27	63.52 **	2.98	64.06	1.90	62.89	2.17
9 Months	70.78 **	2.28	68.04 **	3.23	68.94 [a]	2.28	67.31 [a]	1.98
12 Months	74.84 **	2.31	72.51 **	3.04	72.99 [a]	2.32	71.51 [a]	2.06
18 Months	81.18 *	2.62	78.89 *	3.33	79.26	2.69	78.82	2.39
24 Months	87.21 *	2.63	84.82 *	3.62	84.45	2.50	83.91	2.65
30 Months	91.04 *	3.06	88.95 *	2.82	88.02	2.24	87.52	2.81

F for Means: [a] $p < .07$; * $p < 0.4$; ** $p < .004$; *** $p < .0001$

Table 3 - Means and standard deviations for Head Circumference (in centimeters) for larger and smaller twins within pairs

	Fullterm				Preterm			
	Larger Twins		Smaller Twins		Larger Twins		Smaller Twins	
AGE	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Birth	34.29 **	1.47	33.22 **	1.75	32.45 **	1.92	30.61 **	1.98
6 Months	43.76	1.18	43.02	2.06	42.96	1.17	42.39	1.62
9 Months	45.48	1.41	44.74	2.08	44.83	1.09	44.06	1.37
12 Months	46.58	1.50	45.80	2.16	46.36 *	1.04	45.40 *	1.27
18 Months	48.20	1.46	47.37	2.14	47.93	1.20	47.39	1.70
24 Months	48.96	1.29	48.07	2.21	48.96	1.29	48.29	1.61
30 Months	49.75	1.45	49.13	1.49	49.46	.98	48.82	1.32

F for Means: * $p < .03$; ** $p < .01$

of variance and Welch and Brown-Forsythe Equality of Means tests in which variances are not assumed to be equal.

By definition, there were significant differences between the larger and smaller twins of both groups in the physical measures at birth. For both fullterm and preterm groups, the larger twin weighed more than, was longer than, and had a larger head circumference than the smaller cotwin.

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After the neonatal period, significant differences between larger and smaller cotwins were maintained for weight up to 30 months (except for preterm cotwins at 18 months) (Table 1). For height, in the fullterm group the larger twin consistently was taller than the smaller twin through 30 months of age (Table 2). For the preterm twins, significant differences in height were not obtained past the neonatal period, although trends in differences were observed at 9 and 12 months of age (Table 2). For head circumference (with an exception for the preterm cotwins at 12 months), significant differences were not observed between cotwins past the neonatal period (Table 3). For the physical measures from 6 to 30 months, then, weight and height differences were maintained consistently for the fullterm cotwins, but not for the preterm cotwins.

Laboratory Assessment and Birth Weight Discordance

Analyses of variance and Welch and Brown-Forsythe Equality of Means tests were computed between the composite laboratory scores for the larger and smaller twins to determine if there were differences between the discordant cotwins on the temperament variables assessed in the laboratory. Separate analyses were computed for the fullterm and preterm groups at each age. (Because of the large number of comparisons due to the many ages for each group, the means and standard deviations for all measures are not presented here. These data are available from the author).

There were no significant differences between the cotwins on any of the laboratory measures at any age between 6 and 30 months, for either the fullterm or the preterm groups. Thus, birth weight discordance between cotwins was not associated with temperament as measured in the laboratory at 6, 9, 12, 18, 24, or 30 months of age. These results are in contrast to those observed in the neonatal period in which differences in a laboratory (in-hospital) assessment of temperament were observed between larger and smaller cotwins in the fullterm group.

Temperament Questionnaires and Birth Weight Discordance

Analyses of variance and Welch and Brown-Forsythe Equality of Means Tests also were computed between the nine temperament questionnaire characteristics for the discordant cotwins to determine if mothers differentiated between their twin children on the temperament ratings. Again, separate analyses were computed for the fullterm and preterm groups at each age. (Because of the large number of comparisons due to the many ages for each group, the means and standard deviations for all measures are not presented here. These data are available from the author.)

For the most part, mothers did not differentiate between their larger and smaller twin children in temperament ratings. There were a few significant differences, however. For the fullterm twins, mothers rated the twin with the larger birth weight as more negative in mood than the smaller cotwin at 9 and 24 months of age (9-month larger mean = 3.63, smaller mean = 3.19, $F[1,36] = 5.58$, $p < .03$; 24-month larger mean = 3.44, smaller mean = 3.09, $F[1,42] = 4.37$, $p < .05$). For the preterm twins, mothers indicated that the smaller cotwin was more easily distracted than the larger cotwin at 6 months of age (larger mean = 2.03, smaller mean = 2.51, $F[1,22] = 5.15$, $p < .04$).

Discussion and Conclusions

The findings for the temperament measures are interesting in light of the continued difference between the cotwins in some physical measures, and the contrasting results in cotwin height differences for the fullterm and preterm groups. Follow-up of the discordant twins indicated that, through 30 months of age, some physical differences between the larger and smaller cotwins continued to be observed. The larger twin continued to weigh more than the smaller cotwin within both the fullterm and preterm groups. Interestingly, height differences were maintained for the fullterm discordant twins but not for the preterm discordant twins. And, in the main, differences in head circumference no longer were observed past the neonatal period. Thus, the physical differences between cotwins, particularly for height, were becoming smaller for the preterm infants. Within their group, the prenatal effects on size variables did not persist as long as they did for the fullterm group.

Despite maintaining some differences in the physical measurements, there were no differences between the discordant cotwins in the objective measures of temperament in the laboratory for either the fullterm or the preterm groups. Thus, while the objective measures of temperament in the neonatal period indicated that there were differences between fullterm larger and smaller cotwins suggesting risk for both infants, the follow-up laboratory measures suggested that the fullterm discordant twins overcame the adverse in-utero influences on early behavioral development. Similar to the results obtained in the neonatal period, there were no differences between the preterm discordant cotwins in the later laboratory assessments.

In general, the mothers' ratings of temperament on the questionnaires agreed with the longitudinal findings from the laboratory assessment that indicated no differences in temperament between discordant twins. The differences in mothers' ratings of mood at 9 and 24 months for the fullterm twins may be meaningful, however. But a caveat is in order because there only were two statistically significant differences out of 54 tests and these differences may represent chance findings. However, previous research had demonstrated a predictive relation between neonatal and 9-month laboratory ratings of emotionality (7) and between neonatal and 24-month laboratory ratings of emotionality [11]. These same predictive associations had not been observed between neonate and 12- or 18-month ratings [11].

These previous studies demonstrated the importance of the 9 and 24 month age periods for the expression of emotionality. Furthermore, the direction of the differences in mood at 9 and 24 months was the same as that obtained for irritability differences in the neonatal period, with the larger twin rated as more irritable and negative in mood than the smaller twin. The present findings, therefore, may reflect true differences in mood between the larger and smaller cotwins as seen by the mother at ages during which emotionality likely will be expressed more powerfully. The direction of the ratings, both for irritability and for mood, suggest that measures of emotionality might provide a measure of risk for the smaller fullterm discordant twin. Longer-term studies are necessary to determine if emotionality continues to differ in the fullterm discordant group.

For the preterm cotwins, with only one significant difference observed in the questionnaire ratings, and no statistical trend or theoretical frame, this difference appears to

be a chance finding. The absence of temperament differences observed in the neonatal period for the preterm cotwins was maintained on follow-up through 30 months of age.

Emotionality, then, was the only temperament dimension that differentiated between the fullterm discordant cotwins both in the neonatal period and at later ages. Intrauterine variables associated with discordant birth weight for fullterm twins may be meaningful for early emotionality development. As was found in the neonatal period, the preterm discordant cotwins displayed no pattern of risk relative to size for early temperament development. With the one possible exception for the fullterm group, then, risk based on relative birth weight does not appear to be a predictor of future temperament differences for discordant twins.

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REFERENCES

1. Babson SG, Phillips DS (1973): Growth and development of twins dissimilar in size at birth. N. Engl J Med 289:937-940.
2. Carey WB, McDevitt SC (1978): Stability and change in individual temperament diagnosis from infancy to early childhood. American Academy of Child Psychiatry 17:331-337.
3. Field T, Walden T, Widmayer S, et al (1982): The early development of preterm discordant twin pairs: bigger is not always better. In Lipsitt LP, Field TM (eds.): "Infant Behavior and Development: Perinatal Risk and Newborn Behavior". Norwood, NJ: Ablex, pp. 153-163.
4. Fujikura T, Froehlich LA (1974): Mental and motor development in monozygotic cotwins with dissimilar birthweights. Pediatrics 53:884-889.
5. Fullard W, McDevitt SG, Carey WB (1984): Assessing temperament in one- to three-year-old children. Journal of Pediatric Psychology 9:205-217.
6. Matheny AP Jr, Brown AM (1971): The behavior of twins: effects of birthweight and birth sequence. Child Dev 42:251-257.
7. Matheny, AP Jr, Riese ML, Wilson RS (1985): Rudiments of infant temperament: newborn to nine months. Developmental Psychology 21:486-494.
8. Patterson RM, Wood RC (1990): What is twin birthweight discordance? Am J Perinatol 7:217-219.
9. Riese ML (1983): Behavioral patterns in full-term and preterm twins. Acta Geneticae Medicae et Gemellologiae: Twin Research 32:209-220.
10. Riese ML (1987a): Longitudinal assessment of temperament from birth to 2 years: a comparison of full-term and preterm infants. Infant Behavior and Development 10:347-363.
11. Riese ML (1987b): Temperament stability between the neonatal period and 24 months. Developmental Psychology 23:216-222.
12. Riese ML (1994a): Neonatal temperament in fullterm twin pairs discordant for birth weight. Journal of Developmental and Behavioral Pediatrics : 15: 343-347.

13. Riese ML (1994b): Discordant twin pairs: The relation between gestational age and neonatal temperament differences in cotwins. Acta Geneticae Medicae et Gemellologiae: Twin Research 43:165-173.
14. Rothbart MK, Derryberry D (1981): "Development of individual differences in temperament". In M. E. Lamb & A. L. Brown (eds.): Advances in developmental psychology (Vol. 1, pp 37-86): Hillsdale, NJ: Erlbaum.
15. Wilson RS, Matheny AP Jr (1983): Assessment of temperament in infant twins. Developmental Psychology 19:172-183.

Correspondence: Dr. Marilyn L. Riese, Louisville Twin Study, Child Development Unit, Health Sciences Center, University of Louisville, Louisville, Kentucky 40292, U.S.A.