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Discordant Twin Pairs: The Relation Between Gestational Age and Neonatal Temperament Differences in Cotwins

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Abstract. Temperament differences between cotwins at least 15% discordant for birthweight were compared for a group of 66 preterm twin pairs and a group of 70 fullterm twin pairs, assessed in the neonatal period. The assessment focused on irritability, resistance to soothing, activity, reactivity, and reinforcement value. For the most part, significant differences were not obtained between discordant preterm cotwins. Previous research [10] had demonstrated that the larger fullterm twin of discordant pairs was more irritable, more difficult to soothe, more active while awake and during sleep, less reactive to visual and auditory stimuli, and less reinforcing to the examiner than the smaller cotwin. It was concluded that, for the behavioral variables measured, the fullterm group is at higher risk than the preterm group, and that both the lighter and the heavier discordant twins displayed signs of early behavioral risk. The findings suggested that the continued gestation for cotwins discordant in weight may be a risk period for early temperament development of the twins.

Key words: *Discordance, Gestational age, Neonates, Twins*

INTRODUCTION

A recent study [10] demonstrated that there are temperament differences between fullterm neonate cotwins who were discordant for birthweight. The larger fullterm twin of discordant pairs was found to be more irritable, more difficult to soothe, more active while awake and during sleep, less reactive to visual and auditory stimuli, and less reinforcing to the examiner than the smaller twin. The findings of the study suggested that cotwins who were more discordant in birthweight may be more compromised than twins who are less discordant in birthweight. Furthermore, the results suggested that there were prenatal influences on the early behavioral development of cotwins, related to the growth discrepancy between them.

Although cotwins usually have different birthweights, a difference of 15% to 20% or more between the twins of a pair is considered to be abnormal, and defines discordance for weight [9]. Previous research has compared cognitive development in discordant cotwins, with some studies demonstrating poorer performance for the lighter twin [1, 3, 6, 12], some showing no differences between discordant cotwins [3, 4, 5, 8, 11, 13], and some demonstrating higher performance for the lighter twin [4, 8]. In contrast, relatively little research has examined behavioral and temperament differences in discordant cotwins, with some differences described between the groups [2, 4, 7, 10].

One study [4] specifically evaluated preterm twins for whom, at one year corrected age, the lighter twins were rated as more attentive and more easily soothed. The recent study by Riese [10] is the first to include neonate fullterm infants evaluated in the newborn nursery. The present study was designed to evaluate temperament in a sample of preterm twins discordant for birthweight in order to determine if gestational maturity at birth influences any observed behavioral differences between discordant cotwins. For this purpose, potential temperament differences between discordant preterm cotwins were compared with the previously reported [10] differences between the fullterm cotwins. The fullterm and preterm cotwins were assessed before hospital discharge and, therefore, before family environmental variables could influence behavioral outcome.

MATERIALS AND METHODS

Subjects

The present sample included 66 preterm twin pairs who were at least 15% discordant for weight. The previous sample [10] had included 70 fullterm twin pairs at least 15% discordant for birthweight. Percent difference in birthweight was defined as $[(\text{birthweight of larger twin} - \text{birthweight of smaller twin}) / \text{birthweight of larger twin}] \times 100$ [5, 9]. Percent discordance ranged from 15% to 48%, with a mean of 24% and standard deviation of 7.7%, for the preterm sample, and from 15% to 47%, with a mean of 23% and standard deviation of 7.5% for the fullterm sample. These discordance measures were very similar for the two groups. Mean birthweights for the larger and smaller twins of each group are presented in Table 1.

Procedure

The twins were assessed just prior to discharge from the hospital. 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. 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, which was 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 then were made of the neonate's response to a potentially stressful stimulus. For this procedure, a metal disc was chilled in iced 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 a 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 attribute being measured. 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 and 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, and 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, and reinforcement value of the neonate's behavior during all assessments, but especially for maturational level, sensorimotor status, orienting behaviors and response to handling).

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

Perinatal variables

Table 1 shows the means and standard deviations for perinatal variables for the larger and smaller twins by group (preterm and fullterm neonates). Analyses of variance were computed between the larger and smaller twin subgroups for differences on perinatal variables. The results are presented in Table 1.

Predictably, there was a significant difference in birthweight between the larger and smaller twins of each group. There were no other significant differences between the preterm cotwins with respect to any of the other perinatal variables. In the previous study of fullterm twins, however, the one-minute Apgar score was found to be significantly

Table 1 - Means and Standard Deviations (SD) on perinatal variables for larger and smaller twins within pairs by group

Variables	Larger		Smaller		F	p Value
	Mean	SD	Mean	SD		
<i>Preterm</i>						
Birthweight (g)	2279	538	1747	442	38.59	.0001
1-minute Apgar	6.50	2.03	6.41	1.88	0.07	NS
5-minute Apgar	8.11	1.18	8.09	1.08	0.01	NS
Age at test (days)	16.23	19.45	18.14	18.55	0.33	NS
<i>Fullterm^a</i>						
Birthweight	3122	383	2400	355	142.00	.0001
1-minute Apgar	7.85	1.06	7.41	1.42	4.45	.04
5-minute Apgar	8.90	0.53	8.73	0.80	2.49	NS
Age at test (days)	3.31	1.53	4.69	4.31	6.74	.02

Key: NS = Not Significant

^a From Riese (1994)

higher for the larger than for the smaller twins, and the smaller twins were significantly older than the larger twins at the time of testing (due to their later hospital discharge, related to the lower birthweight of these smaller infants). For all further analyses for the fullterm group, therefore, the potential influence of these two variables on the outcome measures was controlled by analysis of covariance, which adjusts the variable means after controlling for the covariates, and tests for the equality of adjusted means.

Neonatal assessment scores and birthweight discordance

To determine if there were differences between the larger and smaller twins of each group in the neonatal temperament assessment scores, analyses of variance were computed between the two sets of scores. The mean scores for the behavioral variables are presented separately for the fullterm and preterm groups in Table 2.

The results of the analyses indicated that, for the preterm group, there were no significant differences between the larger and smaller cotwins on any of the temperament variables. In contrast, the previous results [10] for the fullterm group had indicated that there was a significant difference between the larger and smaller cotwins on all of the neonatal variables. When compared with the smaller twin, 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.

Table 2 - Mean scores and Standard Deviations (SD) for temperament variables for larger and smaller twins within pairs for preterm and fullterm (adjusted) groups

Variables	Larger		Smaller		F	p Value
	Mean	SD	Mean	SD		
<i>Preterm</i>						
Irritability	2.28	0.95	2.21	0.76	0.21	NS
Resistance to soothing	2.82	0.97	3.00	0.95	1.11	NS
Activity-awake	3.22	1.01	3.25	0.95	0.03	NS
Activity-asleep	3.23	1.21	3.34	1.02	0.28	NS
Reactivity	2.91	0.72	2.77	0.69	1.19	NS
Reinforcement value	3.29	0.99	3.06	0.81	2.18	NS
<i>Fullterm^a</i>						
Irritability	2.70	0.76	2.30	0.89	8.12	.005
Resistance to soothing	3.43	0.96	3.06	0.96	4.83	.03
Activity-awake	3.61	0.89	3.15	0.93	7.94	.006
Activity-asleep	3.25	0.96	2.94	0.86	3.70	.06
Reactivity	2.90	0.68	3.16	0.54	5.13	.03
Reinforcement value	2.93	1.03	3.41	0.99	6.84	.01

Key: NS = Not Significant

^a From Riese (in press)

These earlier findings had indicated, therefore, that there are temperament differences in the neonatal period between fullterm cotwins discordant for weight. The present findings of no neonatal temperament differences in the preterm group have demonstrated that gestational age at birth is related to neonatal behavioral differences between cotwins discordant for birthweight.

Extreme groups on birthweight discordance

The previous analyses also had addressed the question of whether the degree of discordance in birthweight influenced earlier temperament differences between cotwins. To determine whether the extremes of birthweight discordance were differentially related to the temperament differences observed between the fullterm cotwins, extreme groups for birthweight differences were created. For a comparative analysis, similar extreme groups were determined for the present preterm sample. The lower and upper quartiles of percent of birthweight discordance were designated as the extreme groups. For the preterm sample, these quartiles were defined as 15% to 17%, $N = 16$ pairs for the lower quartile, and 29% to 48%, $N = 17$ pairs for the upper quartile. For the previous sample of fullterm infants, the quartiles were defined as 15% to 17%, $N = 18$ pairs for the lower quartile, and 29% to 47%, $N = 18$ pairs for the upper quartile.

Analyses of covariance (again controlling for one-minute Apgar scores and age at test) had been computed separately for each extreme group in the fullterm sample. For comparison, analyses of variance were computed for each extreme group in the preterm sample. The mean scores on the neonatal variables and the percentiles for the upper and lower quartiles for the extreme groups for both the preterm and fullterm samples are presented in Table 3.

The percent of birthweight discordance defining the lower and upper quartiles for the fullterm and preterm groups was almost identical. In contrast, the relation between degree of weight discordance between twins of a pair and neonatal temperament differences between cotwins was not the same for the groups, particularly for cotwins in the upper quartile of weight discordance. The previous analyses for the fullterm infants did suggest a relation between degree of discordance and temperament differences within the pairs. For fullterm twins in the upper quartile of weight discordance, temperament differences between cotwins were observed in four areas, where the larger twin was observed to be more irritable, more active while awake (trend), less reactive to visual and auditory stimuli, and less reinforcing to the examiner than the smaller cotwin. In contrast, for fullterm twins in the lower quartile of weight discordance, temperament differences between cotwins were observed only in one neonatal area, where the larger twin was rated as more irritable than the smaller twin. These differences in findings by extremes of weight discordance were concluded to be suggestive of a relation between degree of difference in temperament scores and degree of compromise for the twins (that is to say differences in neonatal temperament scores were more likely to be observed in those cotwins exposed to a higher degree of intrauterine insult that resulted in greater birthweight discordance, than in those cotwins exposed to less intrauterine insult).

For the preterm infants, there was a marked statistical trend for the smaller twin of the more extreme discordant group to be more difficult to soothe than the larger cotwin

Table 3 - Mean scores for temperament variables for extreme groups on birthweight discordance for preterm and fullterm (adjusted) groups

Variables	Lower Quartile (15% to 17%)				Upper Quartile (29% to 48%)			
	Larger Mean	Smaller Mean	F	p Value	Larger Mean	Smaller Mean	F	p Value
<i>Preterm</i>								
Irritability	1.78	2.03	1.29	NS	2.18	2.42	0.57	NS
Resistance to soothing	2.86	2.79	0.05	NS	2.68	3.38	3.84	.06
Activity-awake	3.13	3.13	0.00	NS	3.06	3.53	1.93	NS
Activity-asleep	2.88	3.44	2.74	NS	3.25	3.12	0.09	NS
Reactivity	3.06	2.75	1.17	NS	3.10	2.86	0.71	NS
Reinforcement value	3.31	3.21	0.14	NS	3.54	2.98	2.95	NS
<i>Fullterm^a</i>								
Irritability	2.79	2.35	4.18	.05	2.69	2.06	6.75	.02
Resistance to soothing	3.38	3.07	0.91	NS	3.57	3.19	1.60	NS
Activity-awake	3.33	2.90	1.94	NS	3.96	3.36	3.66	.07
Activity-asleep	3.45	3.02	2.19	NS	3.29	3.12	0.21	NS
Reactivity	2.83	3.08	1.10	NS	2.73	3.28	6.35	.02
Reinforcement value	3.22	3.55	1.40	NS	2.85	3.63	5.66	.03

Key: NS = Not Significant

^a From Riese (1994)

of that group. This behavioral difference between cotwins was not observed for the more extreme discordant fullterm group and is the opposite of the significant difference observed for the fullterm group as a whole. No other significant differences were obtained between the preterm cotwins of either extreme group. Analysis of degree of discordance in relation to early temperament differences within the twin pairs, therefore, did not differentiate between the preterm cotwins as it had between the fullterm cotwins.

CONCLUSIONS

Research comparing fullterm and preterm infants in the neonatal period typically demonstrates that the preterm group is at higher risk than the fullterm group. The present findings are significant because they suggest that, for the variables measured, the fullterm group appears to be at higher risk than the preterm group. In the previous study [10], it had been concluded that, because the neonatal temperament differences obtained for the discordant fullterm twins were similar to those observed when comparing other high-risk/low-risk groups (eg., fullterm versus preterm groups, or appropriate-for-gestational-age versus small-for-gestational-age groups), both the heavier and the lighter

fullterm discordant twins displayed signs of early behavioral risk. It was suggested that intrauterine factors relating to the relatively smaller, as well as larger, size of the cotwins were related to the behavioral differences between the twins and, in general, to the integrity of the twins.

Finding these temperament differences between cotwins for the fullterm but not for the preterm group suggests, then, that the continued gestation for twin pairs who are discordant for weight may be a risk period for early behavioral development, especially for pairs with extreme weight discordance. The prenatal environment for extremely discordant twins that results in the large weight differences may also affect brain development and subsequent related neonatal behavioral development. While planned delivery of twins earlier in gestation is not recommended, because of the medical risks associated with preterm deliveries, knowledge of extreme size discrepancies between the fetuses should lead to consideration of the consequences of continued intrauterine stresses for early behavioral outcome of the discordant cotwins. Advances in measures that determine the cause of and, subsequently, the means to eliminate, the responsible intrauterine stresses clearly would lessen the potential problem. In lieu of the availability of prenatal intervention, early counselling of parents in order to help them recognize the behavioral differences of their twins, and adjust their interaction with each infant accordingly, as suggested previously [10], should be encouraged. This counselling would promote more appropriate interaction with each twin and help to stimulate better behavioral adjustment of each infant.

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