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Genetic Variance and Heritability of Temperament Among Chinese Twin Infants

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Abstract. In order to examine the genetic variance and heritability of temperament among Chinese infants in Taiwan, a total of 62 pairs of same-sexed twin infants given birth in four major general teaching hospitals in Taipei City were studied. Based on placentation and 12 red blood cell antigens, 44 MZ and 18 DZ pairs were identified. Temperament was assessed at the age of six months by the Chinese edition of Carey's Temperament scale. Significant genetic variance was observed for activity level, approach or withdrawal, intensity of reaction, quality of mood, and threshold of responsiveness, with a heritability of 0.64, 0.56, 0.74, 0.39, and 0.45, respectively. There was no significant intrapair difference in temperamental characteristics between monozygotic and dizygotic MZ twins.

Key words: Heritability, Temperament, Infants, Twins

INTRODUCTION

Genetic and environmental factors are both known to be involved in the determination of child temperament, but it remains controversial whether there exists a significant genetic contribution to the temperament of neonates and infants. The relative importance of genetic and environmental factors may change with time, especially during the period of rapid physiological and psychological development, and should be evaluated at different ages. Although temperament assessment is a routine procedure in well-baby clinics in Taiwan, there has never been a twin study on infant temperament in the

Table 1 - Mean scores of temperamental characteristics of monochorionic MZ (MZMC), dichorionic MZ (MZDC) and DZ twin pairs

	MZ pairs			DZ pairs (N = 18)	t' test	
	Monochorionic (N = 35)	Dichorionic (N = 7)	Total (N = 44)		MZMC vs MZDC	MZ vs DZ
Activity level	3.97	4.04	4.00	3.97	-0.37	0.23
Rhythmicity	3.28	3.36	3.30	3.32	-0.34	-0.09
Approach or withdrawal	2.98	2.95	3.00	2.84	0.14	0.87
Adaptability	2.68	2.83	2.73	2.43	-0.53	2.10*
Reaction intensity	3.72	3.91	3.77	3.57	-0.70	1.44
Quality of mood	3.43	3.70	3.48	3.38	-1.03	0.64
Attention span and persistence	3.09	2.82	3.02	2.95	0.95	0.36
Distractibility	2.78	2.59	2.72	2.80	0.85	-0.53
Threshold of responsiveness	4.06	4.17	4.11	3.86	-0.42	1.59

* $p < 0.05$ (all other t-values are nonsignificant).

Table 2 - Within-pair mean squares (MSW) and among-pair mean squares (MSA) of temperamental characteristics in MZ and DZ twin pairs

	MZ pairs (N = 44)		DZ pairs (N = 18)		F' test for total variance ^a	F test for genetic variance
	MSW	MSA	MSW	MSA		
Activity level	0.09	0.42	0.28	0.42	1.66 +	3.20**
Rhythmicity	0.05	0.59	0.09	1.56	2.61*	0.42
Approach or withdrawal	0.10	0.95	0.28	0.88	1.09	2.65**
Adaptability	0.11	0.59	0.14	0.48	0.87	1.21
Intensity of reaction	0.11	0.66	0.23	0.46	0.89	2.01*
Quality of mood	0.06	0.57	0.15	0.63	1.23	2.49**
Attention span and persistence	0.10	1.28	0.17	0.74	0.66	1.66
Distractibility	0.08	0.51	0.14	0.57	1.20	1.68
Threshold of responsiveness	0.07	0.70	0.15	0.61	1.00	2.30**

+ : $p < 0.20$, * : $p < 0.05$, ** : $p < 0.01$.

^a F' tests for the differences in total variance of activity level and rhythmicity between MZ and DZ twins being significant, among-pair rather than within-pair genetic variance was estimated and tested for these two characteristics.

Chinese population. The specific aim of this paper was to assess the genetic variance and heritability of temperament at the age of six months, as well as to compare the intrapair similarity in temperament between monozygotic and dizygotic MZ twins.

MATERIALS AND METHODS

Twin neonates delivered in four teaching general hospitals in Taipei city during the period, 1 October 1985 to 31 December 1988 were recruited as the study population. Parents of twins were asked for their agreement to examine the temperament of their twin infants at the age of six months. A total of 62 same-sexed twin pairs participated in this study.

Zygosity was diagnosed by placental pattern and red blood cell antigen markers A, B, C, c, D, E, e, M, N, Le^a, Le^b, and P₁. Monozygotic twin pairs as well as pairs concordant in all the above markers were classified as MZ, while dizygotic pairs and pairs with no information on placental pattern were classified as DZ if they were discordant for one or more markers. Accordingly, among 62 same-sexed twin pairs studied, 33 were MZ and 18 DZ. The MZ to DZ ratio was consistent to what we reported previously [2].

The temperamental characteristics, including activity level, rhythmicity, approach or withdrawal, adaptability, intensity of reaction, quality of mood, attention span and persistency, distractibility, as well as threshold of responsiveness, were assessed by the Chinese edition of Carey's Temperament Scale [1]. Mothers or baby sitters who took care of twin infants were asked to assess the temperament of the cotwins following the instruction of one public health nurse during home interview. All assessments were made at age of six months.

For each temperament characteristic, a *t*' test [4] was first used to assess the difference in mean values between MZ and DZ twins. A two-tailed *F*' test [6] was then used to examine the equality of the total variance in MZ and DZ twins: if there was no significant difference, within-pair genetic variance [7] and Falconer's heritability index [5] were calculated. The difference in intrapair similarity of temperament between MZ and DZ twins was tested by *F* test.

RESULTS

The mean values of the nine temperamental characteristics, by twin zygosity and placentation, are shown in Table 1. Mean values are quite similar for monozygotic and dizygotic MZ twins, as well as for MZ and DZ twins, except for adaptability, which is significantly lower in DZ than MZ twins.

Table 2 compares within-pair and among-pair mean squares of temperamental characteristics in MZ and DZ twins. Within-pair mean squares are significantly smaller than among-pair mean squares for all temperamental characteristics in both MZ and DZ twins. The total variance is not significantly different between MZ and DZ twins except

for rhythmicity. There is a significant genetic variance for activity level, approach or withdrawal, intensity of reaction, quality of mood, and threshold of responsiveness.

A similar comparison is made in Table 3 between monochorionic and dichorionic MZ twins. No differences are found in total variance or within-pair mean square, and the latter are always significantly smaller than among-pair mean squares.

Intrapair correlations and heritability values are shown in Table 4. Monochorionic and dichorionic MZ twins show similar intrapair correlations for all temperamental characteristics, while the correlations of MZ twins are consistently higher than those of DZ twins except for rhythmicity.

Table 3 - Within-pair mean squares (MSW) and among-pair mean squares (MSA) of temperamental characteristics in monochorionic and dichorionic MZ twins

	MZ pairs (N=35)		DZ pairs (N=7)		F' test for total variance ^a	F test for genetic variance
	MSW	MSA	MSW	MSA		
Activity level	0.09	0.41	0.07	0.45	0.96	1.29
Rhythmicity	0.04	0.57	0.03	0.83	0.71	1.33
Approach or withdrawal	0.10	0.85	0.13	0.55	1.40	0.77
Adaptability	0.08	0.51	0.10	1.09	0.80	0.50
Intensity of reaction	0.11	0.65	0.06	0.84	1.83	0.77
Quality of mood	0.04	0.49	0.07	0.87	0.57	0.61
Attention span and persistence	0.08	1.37	0.03	0.90	1.56	2.67
Distractibility	0.08	1.37	0.09	0.58	0.89	0.82
Threshold of responsiveness	0.07	0.63	0.05	0.98	1.40	0.68

^a All tests nonsignificant.

DISCUSSION

This paper reports the first twin study on temperament in Chinese infants. Significant genetic variance was observed for activity level, approach or withdrawal, intensity of reaction, quality of mood, and threshold of responsiveness, with a heritability of 0.64, 0.56, 0.74, 0.39, and 0.45, respectively. Also, the values for attention span and persistence and for distractibility were only slightly below significance ($p < 0.10$) with a heritability of 0.45 and 0.22, respectively. However, it has been reported that the temperament of neonates is mainly determined by pre- and postnatal environments rather than genetic factors [8]. The discrepancy may be explained by the difference in the age at which temperament is assessed. As infancy is a period of rapid growth and development, several

Table 4 - Intrapair correlation and heritability of temperamental characteristics

	Intrapair correlation				Heritability (Falconer's h^2)
	MZ-MC pairs	MZ-DC pairs	MZ pairs	DZ pairs	
Activity level	0.64	0.74	0.66	0.34	0.64
Rhythmicity	0.88	0.93	0.85	0.90	–
Approach or withdrawal	0.79	0.61	0.80	0.52	0.56
Adaptability	0.74	0.83	0.67	0.55	0.25
Intensity of reaction	0.71	0.86	0.71	0.34	0.74
Quality of mood	0.84	0.86	0.81	0.61	0.39
Attention span and persistence	0.89	0.94	0.85	0.62	0.45
Distractibility	0.70	0.74	0.72	0.61	0.22
Threshold of responsiveness	0.81	0.91	0.83	0.60	0.45

MZ-MC: Monozygotic monochorionic; MZ-DC: Monozygotic dichorionic.

genetic and environmental factors must be involved in the determination of infant behaviors. But the relative importance of these two components may vary from time to time. In the early infant life, residual intrauterine and postnatal effects may play a major role, whereas at the age of six months, these effects may subside and the genetic component becomes important instead. This is consistent with what we have observed for anthropometric development during infancy [3].

However, rhythmicity and adaptability show no significant genetic influence at all. This may be due to the interaction between mothers and twin neonates, mothers being likely to try to make their infants live in a more rhythmic and adaptative way. This is confirmed by the high intrapair correlations of DZ twins: 0.90 for rhythmicity and 0.55 for adaptability.

The effects of genetic and environmental components in the determination of temperament may vary in different ethnic groups, ages and sociocultural backgrounds. Cross-cultural comparison of the development of temperament through a follow-up study may therefore prove highly informative on the genetic variance and heritability of temperament.

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REFERENCES

1. Carey WB (1970): A simplified method for measuring infant temperament. *J Pediatr* 77:188.
2. Chen CJ, Lin TM, Chang C, et al (1987): Epidemiological characteristics of twinning rates in Taiwan. *Acta Genet Med Gemellol* 36:335.
3. Chen CJ, Yu MW, Wang CJ, Tong SL, Tien M et al (1990): Chronological changes in genetic variance and heritability of anthropometric characteristics among Chinese twin infants. *Acta Genet Med Gemellol* 39:479-484
4. Christian JC (1979): Testing twin means and estimating genetic variance: Basic methodology for the analysis of quantitative twin data. *Acta Genet Med Gemellol* 28:35.
5. Falconer DS (1960): *Quantitative Genetics*. New York: Ronald.
6. Haseman JK, Elston RC (1970): The estimation of genetic variance from twin data. *Behav Genet* 1:11.
7. Kempthorne O, Osborne RH (1961): The interpretation of twin data. *Am J Hum Genet* 13:320.
8. Riese ML (1990): Genetic influences on neonatal temperament. *Acta Genet Med Gemellol* 39:207.

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