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Developmental Research of Twin's Temperament

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Abstract. In the Louisville Twin Study, pairs of 3- and 4-year-old twins were provided with standardized competitive or cooperative tasks in a laboratory setting. Some tasks required a pair of twins to share toys; other fostered a more competitive engagement between the twins. Behavioral ratings identified temperament and social components at both ages, and between the two ages, there were transformations in the links between the components. Parental ratings of the twins' temperament at the same ages were moderately correlated with the laboratory observations, but the pattern of the relations changed from one age to the next. The combined sets of measures were subjected to twin analyses for 43 pairs of twins. The results are discussed in terms of the similarity of MZ and DZ pairs for the dimensions of temperament and the transformations of temperament.

Key words: Temperament, Longitudinal study, Parental rating, Twin concordance

INTRODUCTION

In the Louisville Twin Study, parents of twins have been interviewed to provide contrasts between twins within each pair. During each visit to the research center, parents were asked to report the similarities or differences within the twin pairs for a variety of behaviors pertaining to temperament, and the data from the reports identified a developmental pattern spanning the first three years. When behavioral differences were reported for a twin pair, one twin was seen as being more likely to have outbursts of temperament, more irritable, and more demanding in social interaction with other persons. By contrast the cotwin was seen as being less upset during ordinary routines, easier to soothe, and more content during selfsustained play with toys [6,13].

By the time the twins reached three years, the parents reported a further differentiation

in the developing patterns of temperament. When one twin was reported to be more approachful to strangers and to be likely to smile, the other twin was reported to be more wary around strangers and more somber around others. This emergent cluster of social responsiveness was identified as being largely independent of the twins' negative emotionality, but positive emotionality was clearly linked to the social component. Moreover, twin analyses indicated that the social cluster was influenced genetically [6].

Because the primary source of the data was derived from parental reports that only provided contrast within each twin pair, we turned our attention to the creation of standardized observations of the twins' social behaviors.

The evidence from the parental reports, as well as syntheses of other research [eg, 1,9], led us to develop laboratory observations that were appropriate for twins at 36 and 48 months of age. From a developmental perspective, this period is suitable for the demonstration of the gregarious (outgoing) aspects and the prosocial (sharing or helping) aspects of social behaviors. Morever, during this period, parents of twins report a high percentage of within-pair differences for competitive behaviors. Therefore, we developed a lab-based method that would permit structured observations of the twins when given opportunities to cooperate or compete during commonplace activities.

The purpose of this report is to (1) describe the structured lab observations, (2) demonstrate the convergence between the twins' salient behaviors observed in the lab and parental observations of the twins' behaviors reported at the same ages, and (3) consider the genetic influence on the twins' behavioral measures from the lab parental reports.

MATERIALS AND METHODS

Subjects

The children in this study were twins recruited as part of a longitudinal study of twins. At the time of this report, 45 twin pairs (22 MZ, 23 DZ) provided the data at 36 and 48 months. The zygosity of the twins was established by bloodtyping which was not performed until the twins were at least 36 months old.

The twins were recruited from families in the metropolitan Louisville area. Occupations of head of household, converted to Duncan's scores from socioeconomic status [10], represented the entire distribution of social class, with roughly 25% of the families being found in the lowest two deciles of the 100-point scale. Among the other eight deciles, the remaining families were represented in almost equal proportions.

Laboratory Observations and Rating Scales

The laboratory assessments of temperament at 36 and 48 months were designed to maintain continuity with the previous assessments of infants and toddlers [7,15]. To this end, it was decided to retain the key structure of the tasks (vignettes) provided for the twins, and to retain the core of the behavior rating scales used previously. However, the tasks were expanded to elicit cooperative and competitive engagements between the twins.

A total of 30 minutes was videotaped, including a brief period for the twins and mother interacting, an episode during which the mother separates from the twins, and then a long interval of 24 minutes during which the twins are engaged in a succession of vignettes staged by an examiner.

For the vignettes, a playroom is cleared of toys and the twins are seated at opposite ends of a table. The examiner brings in a toy or play materials and videotaping of the vignette starts as soon as the toy is placed. After a fixed period, the toy is removed and the twins are reseated at the table for the next vignette.

Complete descriptions and instructions for the vignettes are provided elsewhere [5], however, typical vignettes can be briefly described as follows:

1. *Riding Toy*. The Examiner places a large toy giraffe midway between the twins seated at a table. The toy has a saddle large enough to seat one child. (2-min period).
2. *Wagon*. A metal coaster wagon is placed midway between the twins. The wagon is large enough to seat one child. (4-min period).
3. *Paper - Crayons*. The Examiner covers the table with a sheet of paper and gives each twin a black crayon. A single red crayon is then placed in the middle of the paper. The Examiner encourages the twins to draw a picture to hang on the wall. (4-min period).
4. *Poker Chips*. This vignette occurs in two parts. First, the Examiner carries a tray filled with poker chips toward the table and "by accident" spills the chips in front of the table. The Examiner then encourages the twins to help pick up the chips. (3-min period). Subsequently, the Examiner places the tray of chips in the middle of the table, and gives each twin an empty jar with a slot in the top. The Examiner tells the twins that the game is "a race to see who can fill the jar the fastest." (3-min period).
5. *Dough & Rolling Pin*. The table is covered with paper and the Examiner places a ball of Play-Doh, a rolling pin and a cookie cutter on the table. After a demonstration of rolling out the dough and cutting out a shape, the Examiner gives each twin a ball of dough and places the rolling pin and cookie cutter in the center of the table. (4-min period).
6. *Superbrix Building*. A box of large, lightweight, cardboard blocks is placed in the middle of the table, and the twins are instructed to "see who can build something the biggest and the fastest." (4-min period).

The vignettes described above and their sequence are identical for both 3 and 4 years. After they are completed, a videotape of the twins is used to rate several aspects of behaviors, including the following:

A. *Emotional Tone*. principal emotional state manifested during the rating period: (1) extremely upset .....(9) excited.
B. *Threshold of responsiveness*. Latency of reaction: (1) extremely unreactive, detached ..... (9) plunges in.
C. *Attentiveness*. Degree to which the child alerts to and maintains attention on events: (1) nonfocused .....(9) persistent attention.
D. *Surgency*. Degree to which the child engages in activity: (1) apathetic, zestless .....(9) very vigorous, forceful.
E. *Activity*. Body motion with or without locomotion: (1) stays quietly in one place ....(9) hyperactive.
F. *Assertiveness*. Degree to which child commands or compels the direction of an interaction: (1) very submissive and compliant .....(9) marked assertiveness in taking control of toys or events.
G. *Orientation to twin*: Degree of positive interaction of one twin with the other: (1) negativistic .....(9) strongly positive.

Ratings were made for each 2-minute period of the videotape — resulting in 12 ratings for each rating scale when applied to the full 24 minutes of videotaped vignettes. These 12 ratings for each rating scale were then condensed to a single score by obtaining the averge

value of the ratings. As a consequence of the condensation, 7 scores represented each child's behaviors observed in the playoom. To these scores was added another score — Reaction to physical measurement — that reflected the child's emotionality and cooperation while being measured for weight and height during the latter part of a visit to the lab. Thus, the lab observations at 3 and 4 years were reduced to the following measures:

1. Emotional tone
2. Threshold of responsiveness
3. Attentiveness
4. Surgency
5. Activity
6. Assertiveness
7. Orientation to twin
8. Reaction: physical measures

The means of the ratings for the measures are provided in Table 1.

Table 1. Means of ratings from laboratory observations at 36 and 48 months

Laboratory ratings	36 months		48 months	
	$\bar{X}$	SD	$\bar{X}$	SD
Emotional tone	5.53	0.77	5.98	0.58
Threshold of responsiveness	5.24	1.23	5.68	0.87
Attentiveness	5.37	0.83	5.89	0.62
Surgency	5.94	1.07	6.50	0.85
Activity	5.15	0.54	5.25	0.43
Assertive	3.35	1.63	3.60	1.33
Orientation to twin	6.26	0.77	6.57	0.68
Reaction: physical meas.	6.38	2.07	7.51	1.20

Temperament Questionnaire

Parental reports of the temperament of the twins at 36 and 48 months were obtained from the Behavioral Style Questionnaire [8] that was developed to yield nine scores reflecting the categories of temperament postulated by Thomas and Chess (1977). The questionnaires, one for each twin, were provided during each visit to the lab and the parents typically completed the questionnaires while the twins were being assessed. The means for the 9 scores representing the categories of temperament are provided in Table 2.

Factor Scores

Lab Observations. The scores from the laboratory observations at each age were correlated and condensed by factor analyses with no rotation. Two factors were extracted at 36 months and three factors were extracted at 48 months. The factors and the loadings of the measures comprising each factor are shown in Table 3.

At both ages, the first factor extracted was structurally similar, and each twin's factor score for this factor was used for further analyses. The twins with higher scores on this factor could be described as quick to respond to the introduction of each event, forceful during the interactions, active, attentive, and positive in emotional tone. The twins with lower score were

Table 2. Means of ratings from the Behvioral Style Questionnaire at 36 and 48 months

Categories of temperament	36 months		48 months	
	$\bar{X}$	SD	$\bar{X}$	SD
Activity	4.16	0.73	4.02	0.68
Apporoach/Withdrawal	4.01	0.93	4.18	0.97
Adaptability	4.14	0.68	4.35	0.59
Intensity	4.66	0.67	4.68	0.59
Mood	3.54	0.72	3.59	0.65
Attention/Persistence	3.44	0.78	3.75	0.72
Distractibilty	4.00	0.80	3.14	0.83
Threshold response	3.18	0.69	3.16	0.52

Table 3. Factors from the laboratory ratings at 36 and 48 months

Laboratory ratings	Loadings				
	36 months		48 months		
	I	II	I	II	III
Emotional tone	0.72	....	0.73	-0.34	....
Threshold of responsiveness	0.84	....	0.86	....	....
Attentiveness	0.68	-0.34	0.36	0.66	....
Surgency	0.88	0.32	0.92	....	....
Activity	0.79	0.36	0.86	....	....
Assertive	....	0.77	0.45	-0.64	....
Orientation to twin	....	-0.57	....	....	0.95
Reaction: physical meas.	0.53	-0.33	....	0.59	....
Total variance (%)	44.9	18.2	41.3	17.2	13.0

Note: Loadings less than 0.30 omitted.

more self-restrained: they delayed before participation, were less energetic and involved in the activity, and less positive emotionally. These two extremes, as determined by the laboratory procedures, represented a dimension that was labeled Lab-Surgency and it became the core dimension for the direct observations made within the structured lab setting.

Questionnaire. The nine scores for the categories of temperament were subjected to factor analysis at each age and the unrotated solutions were retained for interpretation. At 36 months two factors were extracted, and at 48 months three factors were extracted (see Table 4). The factor of interest for further analyses was Factor II, which at 36 months and 48 months was somewhat similar. The factor was defined by higher loadings from Approach, Adaptability, and Mood — characteristics reflecting the positive, socially outgoing features of the child's behavior as described by the parents. Factor analyses of the categories of temperament per-

Table 4. Factors from the Behavioral Style Questionnaire at 36 and 48 months

Categories of temperament	Loading				
	36 months		48 months		
	I	II	I	II	III
Activity	0.48	-0.54	0.61	....	0.58
Approach/Withdrawal	....	0.77	....	0.65	....
Adaptability	-0.56	0.61	....	0.82	....
Intensity	0.63	....	0.47	....	-0.31
Mood	-0.70	0.51	....	0.82	....
Attention	-0.55	....	-0.51	....	-0.67
Distractibility	0.57	-0.48	0.72	....	....
Threshold response	-0.71	0.33	-0.73	....	0.52
Total variance (%)	32.7	23.5	25.1	23.0	15.8

Note: Loadings less than 0.30 omitted.

formed for previous ages [7,14] have produced factors similar in structure; therefore, in keeping with the label given to the factors extracted previously, the questionnaire factor at 36 and 48 months was labeled Questionnaire-Tractability.

RESULTS

The products of the procedures for data reduction permitted each child to be identified by two factor scores at each age. One score represented the child in the laboratory setting; the other score represented the child as depicted by parental reports of somewhat analogous characteristics as detected by the temperament questionnaire.

Convergent Validity and Stability. Table 5 provides the convergent correlations between Lab-Surgency and Questionnaire-Tractability at 36 and 48 months. While the correlations are modest, there is a significant overlap between a behavioral dimension derived from the observations and a behavioral dimension from the parental reports. Children observed in the laboratory as being quick to participate in the vignettes and less-restrained during the vignettes were described by their parents as more approachful, adaptable, and positive in mood.

Table 5 also shows the stability of the behavioral dimensions between 36 and 48 months. It is apparent that the behavioral dimension derived from parental reports is more stable over the 12-month interval than the lab-based behavioral dimension; however, the lab and parental reports both provided evidence that the ordering of the twins' individual differences was retained at a moderate level from 36 to 48 months.

Twin Analyses

The foregoing results were based on the twins considered as individuals. The next question concerns the degree to which the twins, reconstituted into MZ and DZ pairs, provide evidence

Table 5. Relations among Participation Factors and Tractability Factors at 36 and 48 months

Age (months)	Factors: Participation: lab — Behaviors	Loadings		Factors: Tractability: Behavioral Style Questionnaire — Behaviors	Loadings
36	Surgency	0.88		Approach/Withdrawal	0.77
	Threshold: Responsiveness	0.84		Adaptability	0.61
	Activity	0.79	(r = 0.36)	Activity	-0.54
	Emotional tone	0.72	<-------->	Mood	0.51
	Attentiveness	0.68			
	Reaction: physical meas.	0.53			
	(r = 0.45) ↕			(r = 0.63) ↕	
48	Surgency	0.92		Adaptability	0.82
	Threshold: Responsiveness	0.86	(r = 0.26)	Mood	0.82
	Activity	0.86	<-------->	Approach/Withdrawal	0.65
	Emotional tone	0.73			

Note: Only loadings ≥ 0.50 provided. All correlations are significant, P ≤ 0.05.

for a genetic influence on the behavioral measures. In addition, because behavioral differences among the twins were reordered from one age to the next or from lab to parental reports, comparison between MZ and DZ twin pairs for change could provide evidence of a genetic influence on this feature of the results.

Within-pair Correlations. The first step was to compute intraclass (within-pair) correlations for the MZ and DZ twin pairs for each set of scores at each age. The results are presented separately for the MZ and DZ pairs in Table 6.

The correlations indicate in every instance that the within-pair similarity of the MZ twins was greater than that of the DZ pairs. The differences between the MZ and DZ correlations were only signficant for the questionnaire factors, however. Apparently, for these small samples, the genetic influence on the behavioral factors was demonstrated only for observations provided by the parents.

Profile Analyses. The similarity of the behavioral measures of the MZ and DZ pairs from 36 to 48 months or from lab scores to parental reports was determined by an analysis of variance specifically adapted for twin data involving congruence of the profile of scores [12]. However, the analyses were based on each twin's profile of score from one age to the next or from one set of factor scores to the other, and the degree to which the twins within the MZ or DZ pairs had congruent profiles.

The profile Rs, shown in Table 6, indicate that the MZ pairs are more similar than the DZ pairs for profiles, generated across age or across measures. Once again, the significance

Table 6. Twin analyses for Lab and Questionnaire Factors at 36 and 48 months

	Intraclass correlations				Profile R	
	Lab		Questionnaire		Lab-Questionnaire	
	MZ	DZ	MZ	DZ	MZ	DZ
36 months	0.64	0.36	0.74*	-0.16	0.72*	-0.12
48 months	0.52	0.11	0.70*	0.06	0.69*	-0.14
Profile R						
36-48 months	0.35	0.08	0.50*	-0.05		

* $P < 0.05$ for $R_{MZ} > R_{DZ}$

of the results was attributed to the analyses involving measures dependent on parental observations. If one recalls that the correlations between measures (from 36 to 48 months or from lab to questionnaire) indicate some degree of reordering (ie, change) of the children, then the profile Rs suggest MZ twin pairs change more in concert than the DZ twin pairs. In this instance, the results are consistent with a previous study by Matheny and Dolan [4] who concluded that although " ... the measures ... are subject to change across settings or across time, the changes do not appear to be capricious. Rather, the changes that occur seem to be partially regulated by genetic influences." [4: p 1110].

COMMENT

This report is a preliminary study dealing with two substantive issues: the first being methodological; the second pertaining to sociability as a facet of temperament.

Regarding the methodological issue, the development of a relatively short laboratory procedure for directly observing the twins as a social dyad seemed to capture a dimension of sociability within that context. While the interaction between the twins was not examined for the present report, it is evident that, for some twin pairs, one twin may take command of the setting or control events at the expense of the other twin. In fact, the observational procedures were deliberately arranged to permit this type of interaction to occur. The methodology may impose limitations on the degree of similarity to be expected from twin pairs, however. If one twin is more likely to jump in and gain access to the toys, the other twin may be relatively constrained within the same context. Consequently, the within-pair correlations for the Lab-Surgency scores may be limited as a function of the procedure.

The second issue, concerning the scope of sociability in temperament, is addressed less directly in this report. The analyses did not examine the interactions between the twins in the lab setting, and the "social" items in the temperament questionnaire are not stated in terms of twins' interactions. Aside from the twins' interaction, it is not evident that the tendency to affiliate with others — the fundamental aspect of temperament identified by Diamond [3] and endorsed by Buss and Plomin [2] — is a salient feature of the lab procedures. The tempera-

ment questionnaire deals with sociability as affiliation in the category of approach/withdrawal; however, the participatory aspects of sociability, including competition and cooperation, are not sampled. Consequently, the connection between affiliative sociability and participatory sociability can be only presumed. It remains to be seen if this empirical approach provides evidence that there is such a connection and if the connection is related to other characteristics of temperament.

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