Acta Genet Med Gemellol 36: 145-154 (1987)

Longitudinal Research on Temperament in Twins

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Abstract. The changing influence of genetic factors of temperamental individuality has been studied longitudinally in a group of 44 same-sexed twin pairs at four different ages from infancy to puberty. Previous results showed that genetic factors seemed to play an important role in the development of temperamental characteristics when the twins were in infancy and at six years of age. The present report shows that when the within-pair differences in temperament are studied again at age 15 years, the similarity of identical pairs is even higher than at earlier ages. When shared and nonshared stress in the twin pairs was assessed at this age, some interactions were found between within-pair differences in temperament, stress and zygosity.

Key words: Longitudinal study, Twins, Temperament, Gene-environment interaction

INTRODUCTION

In a study of changes and continuities of temperamental development, the twin method can be useful to sort out in what way temperament can be modified by environment. Efforts have been made to estimate the expected interaction between different genotypes and environmental factors of which a review is given by Goldsmith [1].

By comparing differences in DZ twin pairs with differences in MZ pairs and looking at how this pattern changes over time, Wilson found that mental development stabilized in a more permanent pattern in later childhood and also that the intrapair differences changed with age so that MZ gradually became more alike [6]. This method of studying development can also be used to shed light on interactions between temperament and environment.

I will present developmental trends in temperament in a group of twins followed from infancy to the age of 15 showing that MZ pairs get more and more similar in temperament with age, suggesting that environmental factors influence closer identity. Differential similarity over traits in DZ pairs may suggest that some temperamental traits are more influenced by shared environmental factors than others. Tendencies have also been found to support the hypothesis that DZ pairs respond to environmental stress by getting more dissimilar than identical twins.

The follow up study consists of a group of 50 same-sexed twin pairs now aged 15 years. The twins have been studied earlier at 2 months, 9 months and 6 years of age. The genetic influence on temperament at all age levels has been reported to be of significance. The environmental influences on temperament were obvious and of interest for further studies [4,5].

SAMPLE AND METHOD

The follow-up data when the twins were 15 years of age were obtained on 29 of the MZ and 15 of the DZ pairs. As in previous studies, the definition of 9 temperamental categories were those developed by Thomas and coworkers [2,3] in the New York Longitudinal Study.

In order to make the data comparable with previous studies, the same procedures as described in earlier publications were followed. Individual scores in temperament were obtained through semistructured interviews with the mothers. As earlier detailed, objective behavior description of the twins behavior in different routine situations of daily life were obtained. Items within each of the temperamental categories were chosen to cover as much as possible the same behavior as in the six-year study only with age-appropriate changes. Seventy-six items relating to eight of the temperament categories and scorable on a five-point scale were identified.

The scoring was done by the author. Interscorer reliability has not yet been done, but the type of questions and scoring were nearly identical to the procedure in the six-year study, where the interscorer reliability was satisfyingly high. Items not scorable in less than 70% of interviews or with factorial loadings lower than 0.30 on the first factor in a Principal Component Analysis within each category were excluded. The distribution of the remaining 52 items within seven of the categories can be seen in Table 1. The internal consistency (Cronbachs alpha) was satisfyingly high with an alpha ranging from 0.64 to 0.89.

Two kinds of environmental data will be presented in relation to temperament differences: stress shared and stress not shared by the twins within one pair.

The shared-stress score relies on 13 stress factors ranging from no stress to high stress on a three-point scale (one caregiver, new members of the family, family conflicts, several moves, illness or nervous problems in close family, death of close person, divorce of parents, school changes). In the following analysis the twin pairs were dichotomised in a low-stress group and a high-stress group. High-stress included pairs with two or more high-stress scores and included 18 of the 44 twin pairs.

The nonshared stress score relies on five-point difference score ranging from Twin I to Twin II much more within 16 different items (conflicts with different family members, conflicts at school, learning problems, illness, accidents, loss of friends, rejection from twin or friends, loneliness). This gives a difference score from 0 to 2 within each item. The items were dichotomised in a high-difference group and a low-difference group, the former including pairs with six or more high-difference scores.

Table 1. Numbers of tems and inner consistency (α) within each temperamental category

Temperamental category	Number of items	α
Activity	4	0.64
Approach/Withdrawal	4	0.81
Adaptability	7	0.75
Intensity	12	0.88
Threshold	6	0.74
Mood	11	0.88
Attention span persistence	8	0.89

RESULTS

Genetic Factors

An analysis of the within-pair variances (Vandenberg F-ratio) in the two zygosity groups can be seen in Table 2. The DZ twins were significantly more different within pairs than the MZ twins on all the temperamental categories studied.

Table 2. F values of the twin variances in temperament at 15 years

Temperamental category	F values of intrapair variance	P <
Activity	6.25	0.001
Approach/Withdrawal	5.02	0.001
Adaptability	3.93	0.001
Intensity	3.19	0.01
Threshold	6.88	0.001
Mood	4.42	0.001
Attention span persistence	3.69	0.001

Temperament Development

The significantly higher within-pair similarity in temperament in MZ than DZ twins was expected and supports findings at earlier ages. It is of interest to look at the development of this similarity over time. In Fig. 1, the median within-pair difference in each of the zygosity groups is calculated for each of the seven temperament categories at the four ages.

In addition to median within-pair difference in each of the two zygosity groups, the median difference within nonrelative pairs was calculated. This is a difference-score calculated from differences between each single child and each of the other children except the twin. This gives a group of more than 3000 comparisons between nonrelatives. By relating median differences within the MZ group and the DZ group to the distribution of differences within

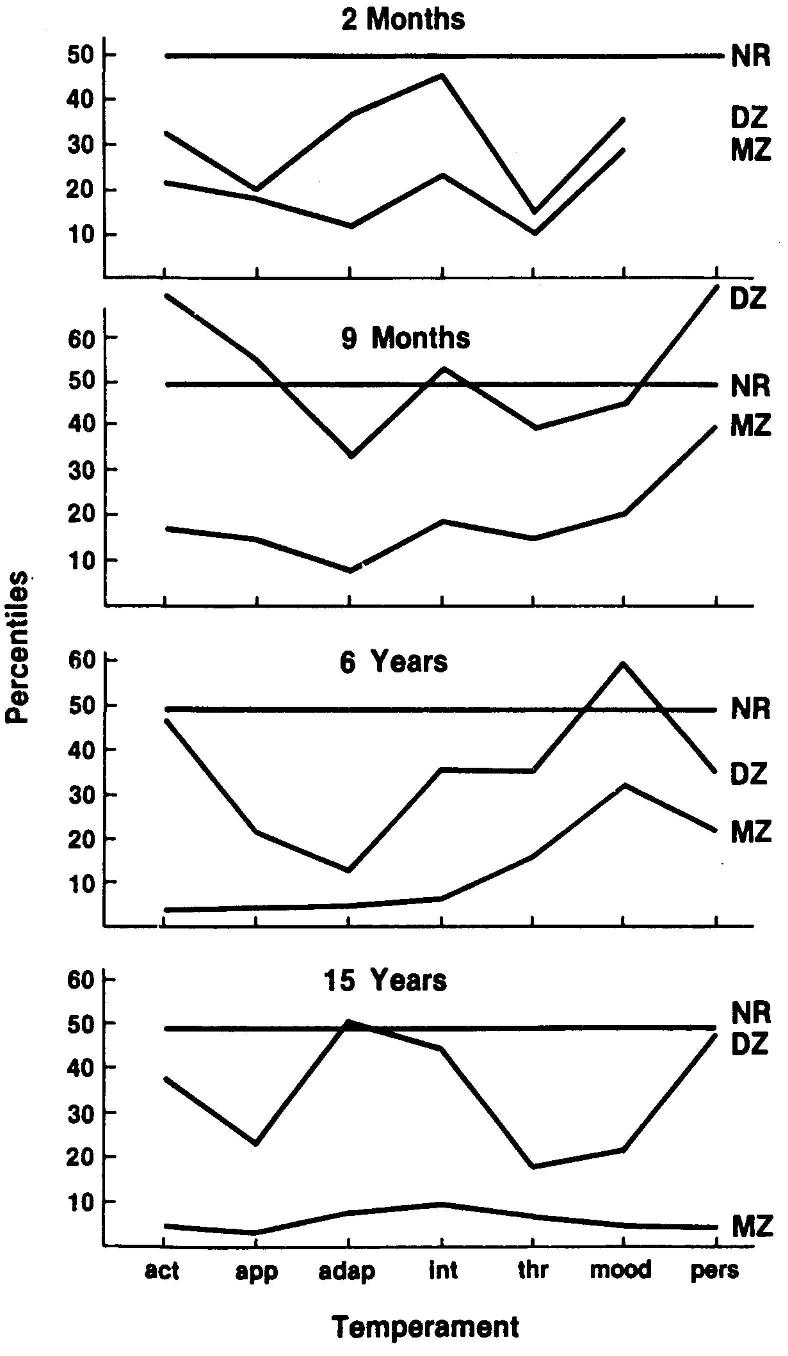

Fig. 1. Median within-pair differences in temperament in MZ and DZ twins and in nonrelative pairs (NR) presented as percentiles of the distribution of within-pair differences in NR. 2 months, 9 months, 6 years, 15 years.

the nonrelative pairs, the scores are comparable across time and temperamental category, because they are always related to a common norm. Median within-pair differences are presented as percentiles of the distribution of within-pair differences in nonrelatives. Fig.1 shows that 20% of nonrelatives happen to be as similar as MZ twins in activity at two months.

Compared to differences within nonrelative pairs, MZ twin pairs get increasingly similar up to the age of 15 when the within-pair differences are small in all temperamental categories. Median differences in the DZ pairs are always larger than in the MZ group and sometimes even larger than within the nonrelative group.

Fig. 2 shows the same calculated differences, separated for each temperamental category to show developmental trends from infancy to 15 years. For activity, intensity and persistence, the difference within the DZ pairs at all ages is almost at the same level as in nonrelatives, who share neither genes nor environment. This suggests that shared environment in general is of less importance for these temperamental categories. In threshold at all ages and in approach and adaptability at three ages, DZ twins are much more similar than nonrelatives. This may be due to an effect of shared genes, but may also be due to similarity produced by shared environment. For mood and adaptability genetic factors and environmental factors seem to be of different importance at different age periods.

We have seen that MZ twins get more similar in most temperamental categories at the age of 15, while the differences within DZ pairs vary some times to an unexpected high level. One explanation may be that there is an interaction between zygosity, environment and time.

Temperament and Stress

There were no significant differences between the two zygosity groups in amount of shared stress experienced. There were also no significant differences in temperament in children from the high-stress group as compared to those in the low-stress group.

Fig. 3 shows that when the shared stress is high, the difference in nonshered stress is significantly higher between DZ than between MZ twins. There are no differences between the twin group if shared stress is low. One explanation may be that, while under high shared stress, MZ twins use the same coping strategies, the DZ twins, being different, also choose dfferent ways of coping. This results in success sometimes, and in failure and higher individual stress at other times.

Temperament and Shared Stress

The same interaction effect is found between temperament and shared stress, as can be seen in Fig. 4 where a two-way analysis of variance is used for testing the interaction.

If DZ twin pairs experience a shared high-stress situation, they are also more different in temperament within the pair. The same situation seems not to make any differences within MZ pairs. This tendency is clear for activity, approach, threshold and persistence, but the interaction effect is statistically significant ($P < 0.006$) for activity only. For intensity and mood (closely related categories at this age, 0.71), DZ twins tend to be more like each other within a pair in the high-stress group than in the low-stress group. MZ twin pairs still remain similar, but with a slight tendency to differ. For adaptability, no zygosity $\times$ stress interaction is found.

The effect of zygosity on differences in temperament is statistically significant at the 0.001 level for all temperamental categories.

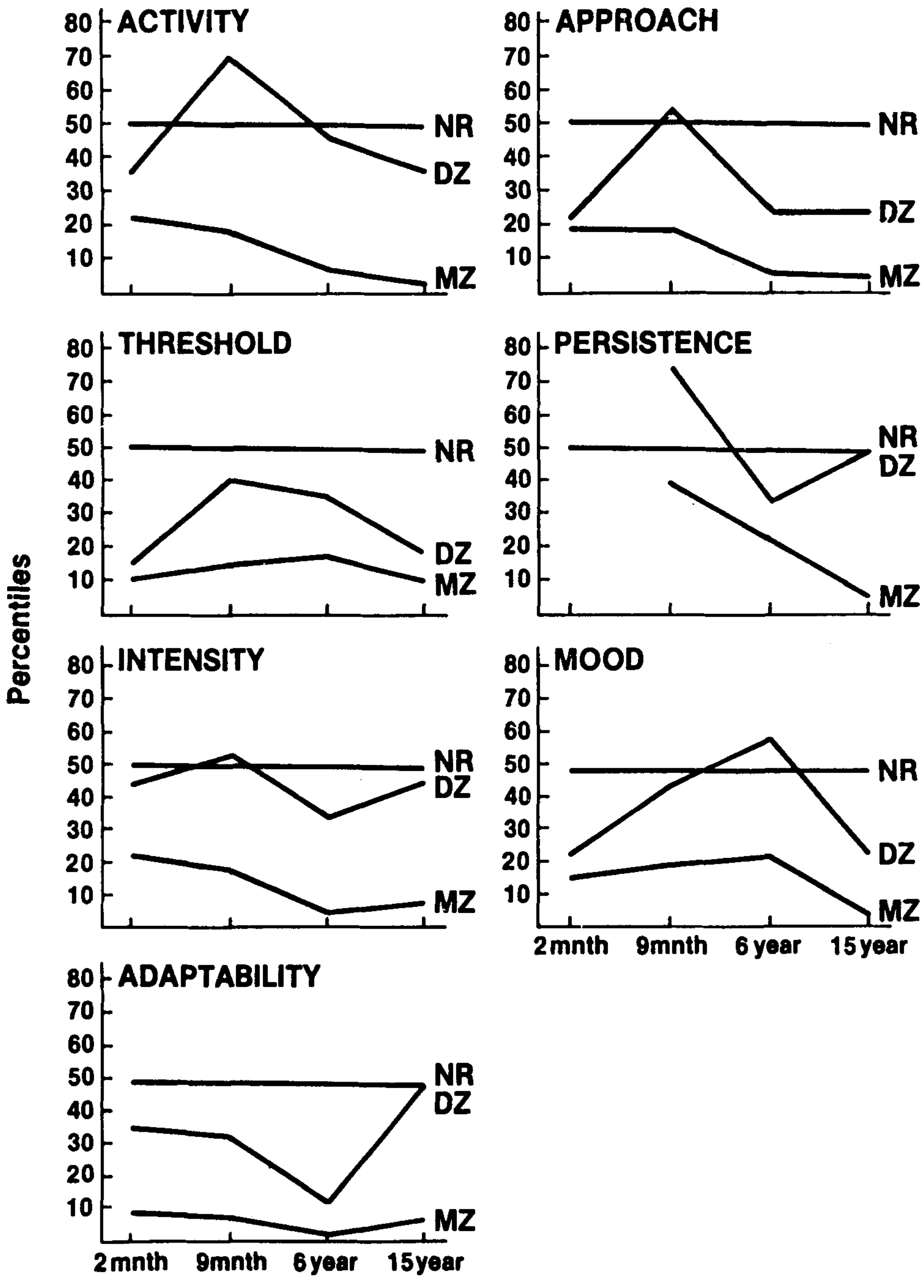

Fig. 2. Median within-pair differences in temperament in MZ and DZ twins and in nonrelative pairs (NR) presented as percentiles of the distribution of within-pair differences in NR. 2 months, 9 months, 6 years, 15 years.

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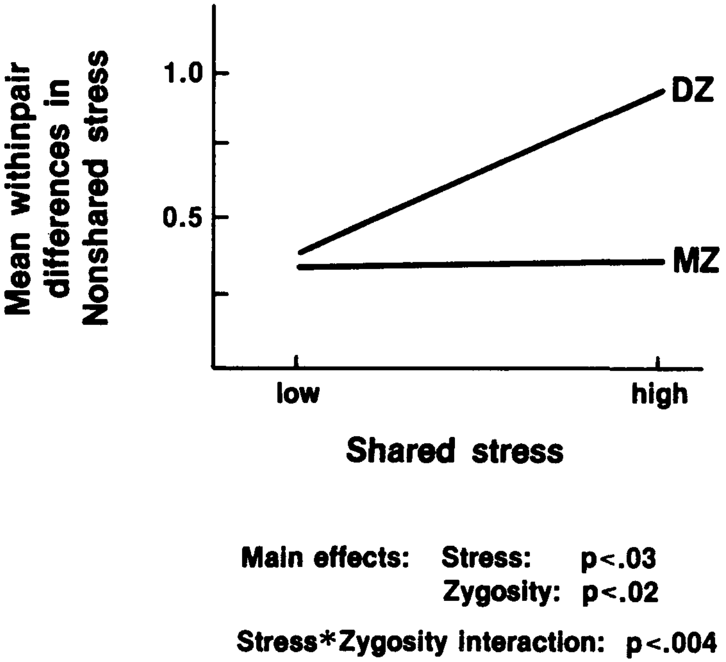

Fig. 3. Interaction between degree of shared stress and within-pair difference in nonshared stress in MZ and DZ twin pairs. 15 years.

Temperament and Nonshared Stress

There are no significant interaction effects of within-pair differences in nonshared stress and zygosity on temperament. The tendency towards a main-effect of within-pair differences in nonshared stress on temperament is clear, except for the two categories, activity and approach. With greater differences in nonshared stress within a twin-pair, the within-pair differences in temperament are also greater both in MZ and DZ pairs. This tendency is statistically significant for mood and persistence only. With the exception of mood, the effect of zygosity is statistically significant for all categories.

CONCLUSIONS

The greater differences in temperament within DZ than MZ pairs at the age of 15 was expected. The disentangling of how temperament can be modified in interaction with environmental factors is of greater interest, but more complicated to study. When within-pair differences in twins have been used to shed light on these questions, some tendencies have been found that lend support to such an interaction theory. Because of the small group of twins in this study, tendencies in the same directions are of greater importance than high levels of statistical significance. The fact that within-pair differences in DZ twin-pairs were smaller than within nonrelative pairs does however lend some support to the reliability of the data.

Even if the results can vary sometimes in directions difficult to make sense of, the results for some temperamental categories is more consequent. Activity was a category where the low within-pair differences in MZ and high within-pair differences in DZ were stable at all ages from nine months on. The zygosity × shared stress interaction for this same category shows

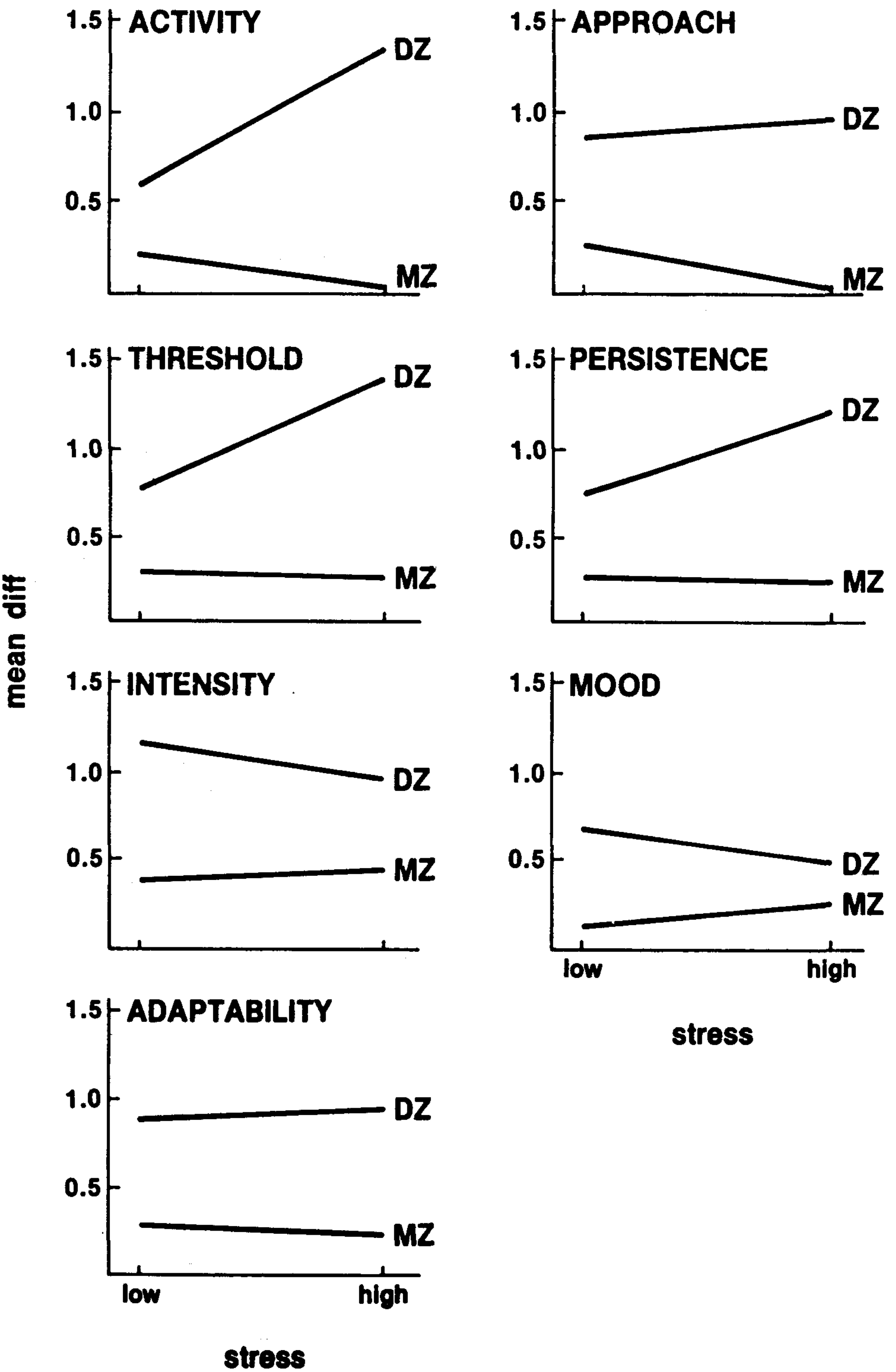

Fig. 4. Interaction between within-pair differences in temperament and shared stress in MZ and DZ twins.

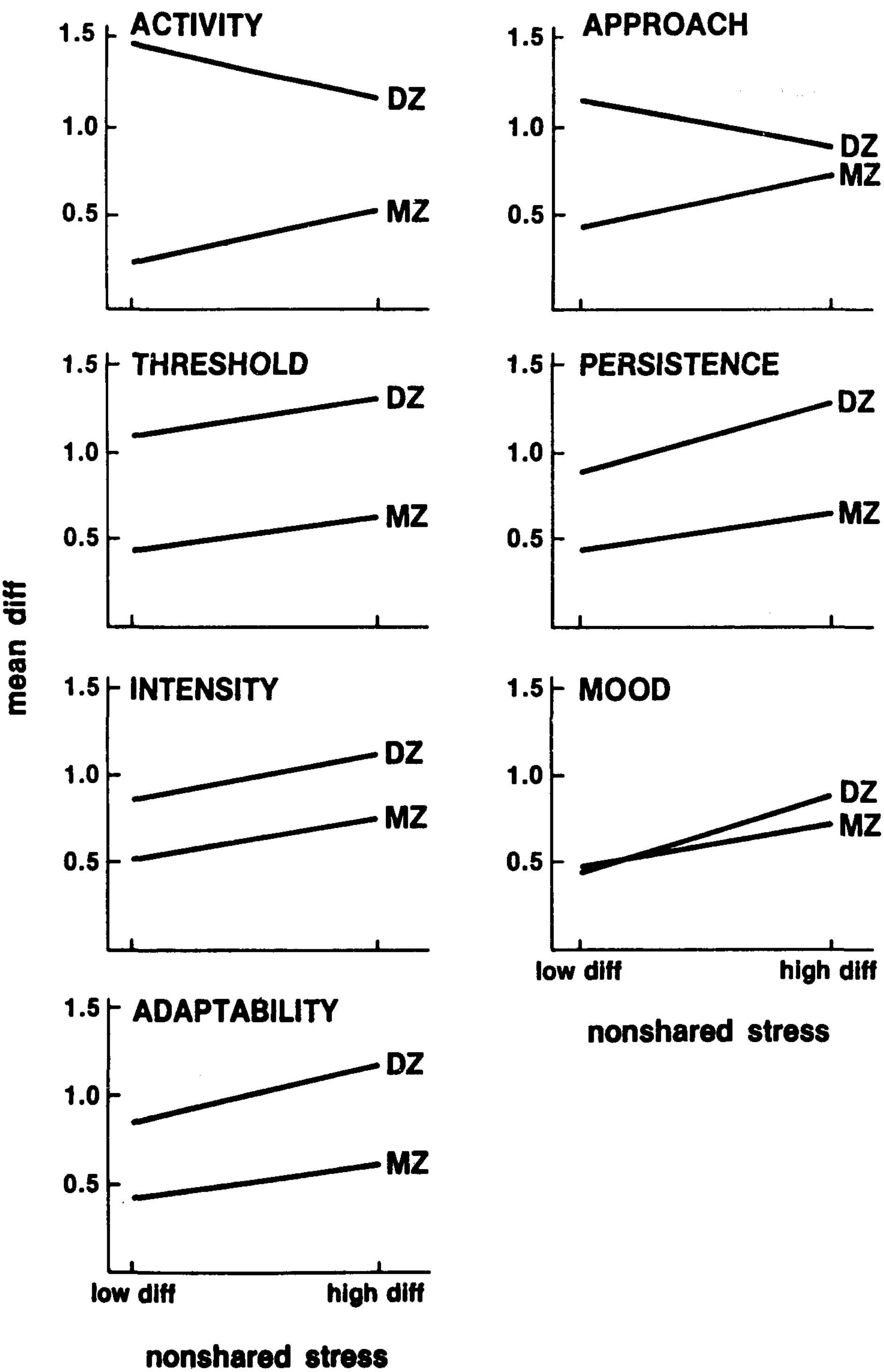

Fig. 5. Interaction between within-pair differences in temperament and within-pair differences in nonshared stress in MZ and DZ twins.

https://doi.org/10.1017/S0001566000004372 Published online by Cambridge University Press

that environmental factors can decrease heritability indices, but also that children with different genotypes pick up different reinforcements from their environment.

Furthermore, the results show that high differences in nonshared stress do not influence differences in activity in the same way, but are of clear importance for most of the other temperamental categories. To explain these results, further research is needed on more detailed differences in environmental factors.

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