



Acta Genet Med Gemellol 36:155-163 (1987)
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Nature-Nurture Interaction in Different Types of School Environments A Longitudinal Study

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Abstract. A model of nature-nurture interaction in school situations emanating from a longitudinal Swedish twin project is presented. This model implies that interactional effects measured by MZ-DZ within-pair comparisons over time are related to the type of behavior studied, as well as teacher and pupil influences at different levels. In a more permissive and stimulating school situation, hereditary factors are hypothesized to be more influential (decisive for behavioral variation) than in a more restrictive and nonstimulating situation. A study of such interactional effects will require longitudinal measurements of pupil behavior as well as teacher and parental influences. To acquire a variation in permissiveness/restrictiveness and stimulation/nonstimulation at the societal level, comparisons are made between twins attending grade 4-6 in compulsory schools in Sweden and twins of the same age attending Israelian Kibbutz schools.

Key words: School, Permissive environment, Restrictive environment, Kibbutz, Longitudinal study

INTRODUCTION

A longitudinal twin material has been collected in Sweden during a ten-year period. The investigation started in 1965, when the twins were approximately 10 years old attending grade 3 in the Swedish compulsory school. The twins, around 300 pairs, were followed through school from grade 3 to grade 9, at approximately 16 years of age. Several types of data were collected, including physical growth measurements and IQ, as well as school achievement test

results. For the boys, some additional measurements were taken, when they enrolled in military service.

The main conclusions that were found from the within-pair comparisons of the MZ and DZ twin pairs in the Swedish twin study were the following [2]:

1. The influence of hereditary and environmental factors will vary for different characteristics. For instance, hereditary factors will be more influential for height growth than for weight growth during puberty. Also, some types of ability measurements, such as logical reasoning, will be more sensitive to hereditary influences, than, for example, achievement test results, which will be influenced more by home and school environments.
2. The influence of hereditary and environmental factors will vary for the *same* characteristic, depending upon environmental permissiveness/restrictiveness. School achievement, for instance, seems to be a variable that is more influenced by hereditary factors for children whose parents are manual workers, while environmental factors seem to be more influential in higher social classes. This can be explained by the restrictiveness exercised by these parents towards their children concerning school work activities.

In addition to these results found for the Swedish twin sample, it can also be hypothesized that not only permissive and restrictive factors, but also stimulating and nonstimulating factors in the school environment will be of importance for behavioral variation.

It will also not be sufficient to study these two dimensions in the actual classroom situation without taking into consideration environmental influences at other levels, which also have an impact on the school situation. In the following, an extended model for studying heredity-environment interaction in educational settings will therefore be presented [3].

MODEL OF HEREDITY-ENVIRONMENT INTERACTION IN EDUCATIONAL SETTINGS

Educational settings can be more or less “permissive”, depending not only on teacher and pupil characteristics, but also on factors emanating from differences between schools, regions and societies. The whole context in which the teacher-pupil interactions take place is therefore of the utmost importance. The more “permissive” the environment, the more pupil behavior will be affected by interactional processes, which implies that hereditary factors will be more decisive for behavioral variation. This would mean that in an educational setting characterized by freedom of choice for the participants, their individual prerequisites and preferences will interact with teacher characteristics and organizational factors to produce the educational outcome. In a more “restrictive” educational setting, on the other hand, environmental factors, such as, for instance, type of subject matter, intermediated by the teacher, will be more decisive for determining the outcome of the educational process.

The stimulating quality of the environment will also be a pertinent factor for influencing development and educational outcome, whether in a “permissive” or a “restrictive” situation. Optimal individual stimulation can be assumed, however, not only to consist of a quantitative dimension (too much - too little stimulation), but also of meaningfulness for the individual of the experienced environmental impact, that is, a qualitative dimension (type and quality of stimulation).

It will thus be necessary to study two pertinent dimensions of the environment in order to investigate the interactional effects of hereditary and environmental influences. Table 1 shows those dimensions with examples taken from the educational field.

1. A permissive and stimulating educational setting could be characterized by a “project-based” education, where the primary initiative and activity emanates from the pupils,

Table 1. Environmental dimensions influencing behavior variation

	Permissiveness ←————→ Restrictiveness				
Stimulation ↑ ↓ Nonstimulation	<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="text-align: center; padding: 5px;">“Project-based” education</td> <td style="text-align: center; padding: 5px;">Authoritative education</td> </tr> <tr> <td style="text-align: center; padding: 5px;">Laissez-faire education</td> <td style="text-align: center; padding: 5px;">Authoritarian education</td> </tr> </table>	“Project-based” education	Authoritative education	Laissez-faire education	Authoritarian education
“Project-based” education	Authoritative education				
Laissez-faire education	Authoritarian education				

- and the teacher functions mainly as the tutor, guiding and supervising, but not deciding the ultimate goal.
2. The permissive and nonstimulating setting, on the other hand, will not give the support that is needed for stimulation. Instead, the pupils may be free to decide, but also feel that nobody really cares about what they are accomplishing. This situation could be called a “laissez-faire” education.
 3. The restrictive and stimulating setting is characterized by the authoritative teacher, who sets the goal, but at the same time shows respect for and listens to the pupils, so that they feel that they can influence the outcome.
 4. The restrictive and nonstimulating educational setting, finally, is dominated by the authoritarian teacher, who is striving towards a predefined goal, without taking pupil views into consideration.

One way to study heredity-environment interactions would be to follow MZ and DZ twin pairs over a time period in educational settings, characterized by the different approaches above. The DZ pairs would be expected to become more dissimilar in permissive and stimulating environments, compared to restrictive and nonstimulating environments [4].

The appropriateness of the approaches illustrated will, of course, vary with the type of variable studied. For one and the same variable, however, all approaches can still occur.

The examples given are taken from a micro-level perspective, eg, what is actually happening in the classroom. It is obvious, however, that the interaction taking place at this level is also influenced by other levels.

If we define the classroom level as the micro-level, we can call the next level the meso-level. It includes the surrounding school environment, and the home environment of each child participating in the classroom interaction. Schools tend to differ depending upon the recruitment of teachers and the areas where they are situated. In some areas with a stable group of teachers and very little movement of families in and out of the district, there tend to exist homogeneous educational views which often stress the value of basic knowledge. These areas are also often characterized by more “restrictiveness” in the sense of using more control systems and having closer contact with the parents. In other areas, however, there is more movement, both of school personnel and pupils, and often there are also large groups with different ethnic origins. This implies more pluralistic values and less contact between parents and teachers. Schools in these areas tend to put more stress on social competence and cooperation, and use fewer formal control mechanisms. At this meso-level, we thus have both the variation of schools and that of families in permissiveness/restrictiveness and stimulation/nonstimulation, which in turn affect the contribution of hereditary and environmental factors to behavioral varia-

tion in the classroom [1].

Another level influencing both school and classroom variation is the regional level, which could be called the *exo-level*. Regions, for instance, distribute financial and other resources differently, and are more or less inclined to support pupils with specific difficulties. An example of this is the tendency in Sweden of some school boards to allocate equal amounts of resources to all pupils, irrespective of difficulties (eg, having fewer pupils in each class), and other boards to specific groups of pupils (eg, various ethnic groups or presumptive dropouts).

Not only allocation of school resources, but also housing planning and distribution of other financial means in the region tend to be decisive for the choices offered to the inhabitants. We can thus see that also at the regional level, there tends to be more or less individual freedom of choice (permissiveness) and educational stimulation related to both policy and financial assets in the form of taxes and fees [5].

At the macro-level finally, there are large differences between societies concerning their educational systems. Some societies offer a more diversified individual freedom of choice irrespective of educational ability, while others apply more segregation at an earlier level. The segregation of the school system is also related to the use of marks and other control instruments [6].

Table 2 presents an extended model of person-environment interaction at the different levels described above. Educational influences set up at different levels can be more or less directive (permissive/restrictive) concerning educational achievement and this ultimately affects teacher behavior in a permissive or restrictive direction. This in turn will influence individual variation in the sense that individual factors at different levels, such as inheritance, home background, housing area and ultimately ethnic origin, will be more or less influential on educational outcome. Relatively speaking, the more permissive the classroom situation, the more these individual factors will contribute to behavior variation in educational achievement.

What is stimulating for different individuals in different educational settings will depend upon both personality, home background, earlier experiences, etc. It must be pointed out that there is also a reciprocal relationship between educational goals and the pupil-parent dimension. The pupils will both be influenced by and influence their school environment.

THE PLANNING OF A NEW TWIN STUDY

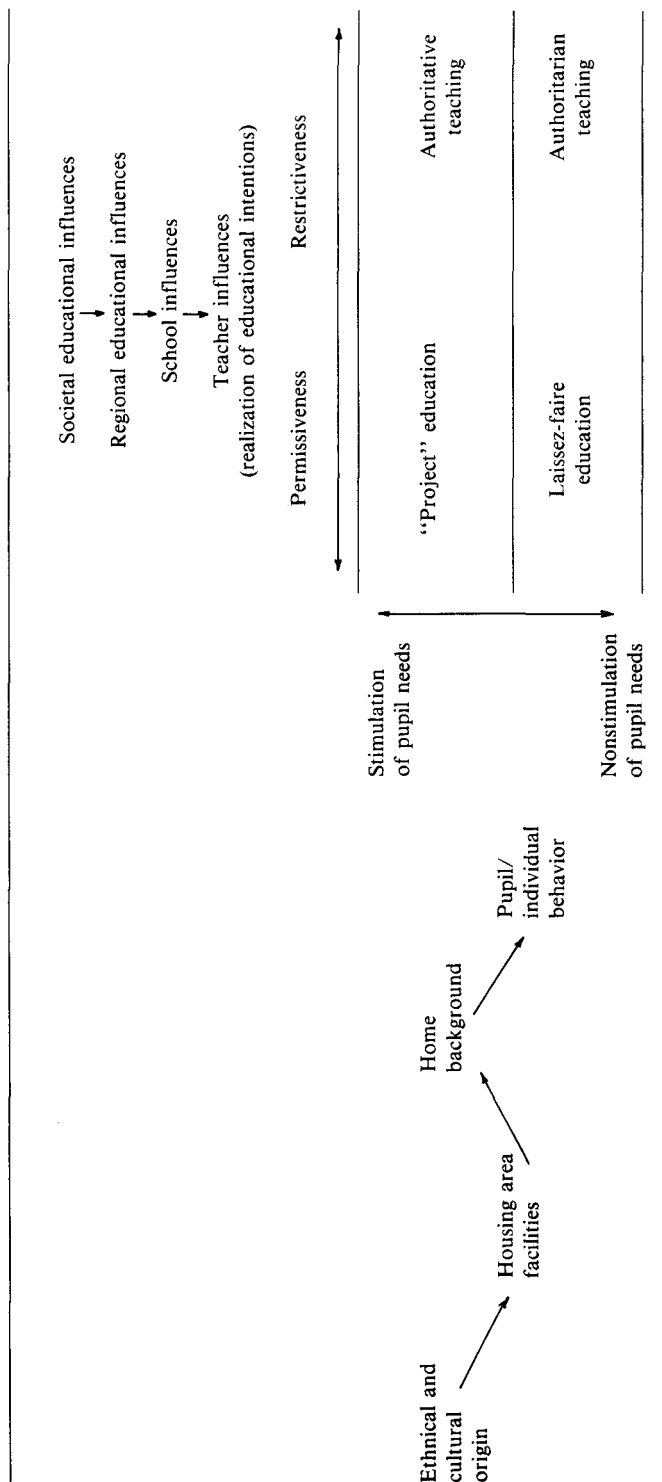
On the basis of the model described above, a new twin study has been planned in collaboration with Ruth Guttman at the Hebrew University and Michael Nathan at the Institute of Research on Kibbutz Education.

To be able to investigate societal influences varying in permissiveness/restrictiveness, twins were sampled in grades 4 to 6 in the Swedish compulsory school and of the same age in Israelian kibbutz schools. Interaction effects will be investigated through a follow-up after two years.

In the following, a description will be given of the Swedish part of the study, while Ruth Guttman, responsible for the Israelian part, will give a description of that.

At the macro-level (Table 2) there is a hypothesized variation in permissiveness/restrictiveness between Sweden and Israel. At the *exo-level*, the twins participating in the Swedish research study have been selected from different parts of Stockholm (North-South) to assure a variation in regional influences and housing area facilities. At the *meso-level*, school and home influences have been investigated by interviewing the teachers in the classes attended by the twins and giving a questionnaire to the twin parents. Both the teacher and the parent

Table 2. Patterns of educational influences and pupil behavior



questions have been constructed to cover the permissiveness/restrictiveness dimension, eg, we have asked them how much the twins can decide their own activities related to their school work, and how much they are decided by teachers and parents, respectively.

To sample pupil behavior variation in different respects, the twins and their classmates have been given a logical reasoning test (Raven), a verbal test (Opposites), a reading test, and a mathematics test. In addition to this, all the pupils have answered a questionnaire concerning their views on the permissiveness/restrictiveness dimension at school (how much can they themselves decide what to do). They also answered a self-rating questionnaire indicating if they are satisfied with themselves or not.

As can be seen from this brief description, the tests are selected to sample both activities that are actually trained at school and at home, and those that are not (eg, Raven).

Finally, a test leader rating has been made of the permissiveness/restrictiveness and the stimulation/nonstimulation dimension in the classroom.

A total of 221 mothers of twins were contacted and asked if they wanted to participate in the investigation. Of these mothers, 127 agreed. Finally, it was possible for us to include altogether 75 twin pairs in the study, due to financial and other reasons.

SOME PRELIMINARY RESULTS

Data have been collected during the spring term of 1986 for 25 classes containing twins in grade 6, 25 classes in grade 5 and 3 classes in grade 4. Approximately 30 additional classes will be sampled during the autumn term of 1986. Table 3 shows the number of pupils (including the twins) participating in grades 4, 5 and 6 as well as means and standard deviations for the different tests.

As expected, there is a continuous increase in average test results for all the tests. This is, however, particularly evident for the verbal test, which indicates that during this age (12-13) verbal ability develops very rapidly.

Table 4 shows the variation in test results for the participating classes in the different grades. In Table 4, we see that there is a considerable variation in average test results for all the tests. It can be seen, however, that the two tests that sample activities at school, reading and mathematics, show the smallest variation. The mathematics test also seems to be the most sensitive to training at school, since there is a definite increase in the lower range of average test results, depending upon which grade the pupils are attending.

Some preliminary twin results will also be presented here. Table 5 shows within-pair differences for the four types of tests for MZ and DZ twins in grades 4 and 5 together and grade 6 separately. As can be seen from Table 5, the MZ twins show smaller within-pair differences than the DZ twins, except for the mathematics test in grade 4 + 5. According to earlier twin results and the theoretical model presented above, MZ and DZ within-pair differences would be expected to be of approximately the same magnitude for the mathematics test, due to the training given at school with respect to this subject.

A preliminary classification of twin pairs according to permissiveness/restrictiveness in the classroom situation has been made, based on the rating made by the test leader. It has unfortunately not been possible to classify them according to stimulation/nonstimulation, due to the small number of pairs.

Table 6 shows the average within-pair differences in the results for MZ and DZ twins classified according to classroom situation. It must be stressed that the results shown in Table 6 are very preliminary and only based on the test leader rating of the classroom situation.

Table 3. Test results for participating pupils in grades 4, 5 and 6

Grade No of classes	Raven		Opposites		Reading		Mathematics	
	M	N	M	N	M	N	M	N
4	35.3	47	17.0	48	23.9	43	9.7	47
5	38.5	542	21.3	548	24.6	542	12.2	543
6	39.7	554	24.0	529	25.0	528	14.0	526

Table 4. Variation in test results (range of means) for the participating classes in grades 4, 5 and 6

Grade	Raven	Opposites	Reading	Math
4	35-36	16-18	24-25	7-10
5	34-42	18-25	23-26	10-14
6	30-42	16-28	22-26	11-16

Table 5. Within-pair differences in test results for MZ and DZ twins attending grades 4 + 5 and 6

Test	Grade 4 + 5						Grade 6					
	MZ pairs			DZ pairs			MZ pairs			DZ pairs		
	M_{diff}	s	N	M_{diff}	s	N	M_{diff}	s	N	M_{diff}	s	N
Raven	4.20	3.8	10	4.33	3.0	15	2.07	1.9	14	4.82	2.6	11
Opposites	3.00	2.3	10	4.40	3.7	15	3.21	3.5	14	5.09	6.1	11
Reading	1.40	1.2	10	2.33	3.0	15	1.15	1.0	13	2.00	1.5	11
Mathematics	2.20	1.4	10	1.80	2.2	15	2.36	1.5	14	4.00	3.0	11

Table 6. Within-pair differences in test results for MZ and DZ twins in permissive/restrictive classroom situations

Test	Permissive situation						Restrictive situation					
	MZ pairs			DZ pairs			MZ pairs			DZ pairs		
	M_{diff}	s	N	M_{diff}	s	N	M_{diff}	s	N	M_{diff}	s	N
Raven	2.54	1.9	11	5.09	2.5	11	3.27	3.9	11	3.20	2.9	10
Opposites	2.45	2.7	11	3.81	5.2	11	3.81	3.3	11	4.90	3.9	10
Reading	1.10	0.8	10	3.30	3.1	11	1.54	1.2	11	1.20	1.3	10
Mathematics	2.27	1.7	11	2.72	2.4	11	2.45	1.1	11	2.00	1.6	10

There seems, however, according to this small material, to be a trend towards smaller within-pair differences in restrictive classroom situation for the DZ pairs for Raven as well as the reading and mathematics test results. For the latter types of tests, this finding would be hypothesized on the basis of earlier twin results and the previously described model.

DISCUSSION

On the basis of earlier twin results, a model for studying heredity-environment interaction in educational settings has been presented. This model implies that permissive/restrictive as well as stimulating/nonstimulating factors in the school and home environment will affect this interaction. Such factors at different levels in the school and society will also be of importance.

On the basis of the model, a twin material has been collected in Israelian kibbutzim and the Swedish compulsory school. A brief description has been given here of the Swedish part of this study. Permissive/restrictive as well as stimulating/nonstimulating factors in the home and school environment have been investigated through parent and teacher questioning, as well as test leader ratings. The behavioral variation in the classroom has been sampled by different types of tests and a self-rating questionnaire.

Some preliminary results from the Swedish study indicate smaller within-pair differences in school related to achievement tests for the DZ pairs in restrictive school situations, compared to permissive. This would also be expected from the model.

It must be underlined, however, that these results are very preliminary and that it will be necessary to analyze the parent and teacher questions, as well as pupil experiences thoroughly, in order to get a clearer picture of environmental influences. Nor is it possible to estimate interactional effects without a follow-up of the twin group. In addition to this, factors at regional and societal levels will be investigated by means of the work done in collaboration with the Israelian research team.

REFERENCES

1. Arfwedson G (1985): School Code and Teacher Work. Studies in Education and Psychology, No. 17. Malmö: Liber.
2. Fischbein S (1979): Heredity-Environment Influences on Growth and Development During Adolescence. Lund: Liber.
3. Fischbein S (1986): Person-Environment Interaction in Educational Settings. Report No. 1 from the Department of Educational Research at the Stockholm Institute of Education.
4. Ljung B-O (1966): Intraklass-Korrelation (Intra-class correlation). Report No. 16 from the Department of Educational Research at the Stockholm Institute of Education.
5. Odin B, Ahs K (1985): Den Dolda Styrningen (The hidden restrictiveness). Lund: Studentlitteratur.
6. Postlethwaite, N (1967). School Organization and Student Achievement. Stockholm: Almqvist & Wiksell.

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