

JOSEF ŠVANCARA

MUTUAL INFLUENCES OF GENETIC AND ENVIRONMENTAL FACTORS IN LIFE SPAN-DEVELOPMENTAL RESEARCH¹

INTRODUCTION

This paper will (1) be concerned with historical perspectives of human evolution, (2) summarize the present state and emerging perspectives of psychological twin studies and (3) consider the position, goals and approaches of "behavior genetics". In the 4th part new approaches will be suggested. The data basis for this paper comes from the review of the relevant literature, both European and American, both genetic and psychologic, and from the results of author's own twin study of about 300 pairs of school age.

The framework of this paper is a developmental one. To understand and interpret human development it is, of course, necessary to take into account information on historical, physical, biological, psychophysiological, socioeconomic, cultural and other changes. Determining exactly how all these various factors interact in the process of life span development is usually impossible. It is not surprising, therefore, that there are still different approaches and theories, each of which emphasizes a particular interpretation of the same developmental change.

In 1859, when Charles Darwin published *The Origin of Species*, he promised that in his book "light would be thrown on the origin of man and his history". More light is still needed to explain the individual human life history. Darwin did much to generate the 19th century's persuasive interest in development of all kinds. Abstract speculation about the child's "nature" was replaced by the empirical effort to record and study the behaviour and its developmental changes (cfr. Preyer, 1882). Darwin's books „cured“ man of his superiority complex about his origin. The feature of a species was shown to reflect the cumulative memories of past generations. Human individuality results from the gradual engraving upon this inherited background of personal memories (including biochemical memories) as they are acquired during a single life span. It is interesting that Karl Marx considered heredity

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to have been the gift of nature to society. The problem of the interaction between nature and society has always held an important place in the thinking of various eras.

Prior to Gregor Mendel's discoveries there was no explanation of the diverse and seemingly contradictory observed facts of inheritance. The general assumption was that the hereditary materials of the mother and father were blended in the offspring. Modern genetics began with the work of G. Mendel in Brno, 1865. The distinction between an individual's genetic composition, or genotype, and the observed traits, or phenotype, was perhaps Mendel's ingenious insight. Mendel discovered that the hereditary substance is composed of individual elements which exist in alternate forms; they do not blend with each other. It is interesting for developmental psychologists to know that Mendel aimed to discover material factors of development — according to him "Elemente", now called genes. Let me recall that in 1970 we organized an internationally attended *Colloquium on Human Behaviour Genetics*. Thus, it is appropriate to ask: What have we started to learn about biological and social determinants of psychological development, about the processes behind the behaviour, cognition and personality traits, that we didn't know 14 years ago?

NEW IMPLEMENTATIONS OF OLD PRINCIPLES

Surveying the relevant literature from Socialist countries (cfr. Lomov and Ravits-Shtserbo, 1978, Golubeva and Ravits-Shtserbo, 1981) we can see that developmental psychologists concentrate their attention upon the decisive role of social, educational and cultural influences. Of course, this is not a manifestation of environmentalism but the conceptualization of How? organism and environmental influences interact. Heredity is seen to contribute to psychological development and personality formation along a continuum of indirectness — that means within the context of particular environmental and educational circumstances. In order to demonstrate that this approach was assimilated not only by Marxist investigators, let us quote an eminent western geneticist T. Dobzhansky (1966): "We do not inherit culture biologically. We inherit genes which makes us capable of acquiring culture by training, learning, imitation of our parents, teachers, playmates, newspapers, books, advertisements, propaganda, plus our own choices, decisions and the products of reflections and speculation. Our genes enable us to learn and to deliberate. What we learn comes not from the genes but from the associations, direct and indirect, with other men." Presumably all learning theorists might be satisfied to hear such a conviction of a geneticist. And let us add another quotation: "Psychological development occurs in a biosocial matrix through a continuous interaction of the biological and social. Mental functioning, whether adaptive or maladaptive, is always simultaneously biological and cultural. Operating as a dialectical unity of opposites, one cannot be separated mechanically from the other." You may think that it was written by Lomov and colleagues in the cited book *Biological and Social in the Human Development* (1977), but it is by the New York develop-

mental theoretist Alexander Thomas (1981). We can see all over the world the growing need to conceptualize psychological development as interactive in nature, as dialectical unity. Already Heinz Werner (1957) pointed out in the connection with the ortogenetic principle that psychological development is characterized by a synthesis, an interweaving of two apposing processes: differentiation is discontinuity and hierarchicalization is thus continuity. Through the life span there is a *dialectical integration between discontinuous differentiation (thesis) and continuous hierarchical organization (antithesis)*.

To what extent and under what circumstances does education and culture determine individual and social behaviour? Anastasi (1958) pointed out that the question "Which one?" and "How much?" simply overlook the fact that an individual's hereditary endowment and the environment to which he or she is exposed must interact in order to produce psychological processes. Because both biological and social factors make an absolutely necessary contribution to behaviour, questions which presume that these influences simply differ in quantity or importance are not likely to be fruitful. Instead, we ultimately should ask "how", "in what manner" biological and social influences combine for various traits of personality. Fig. 1 shows according

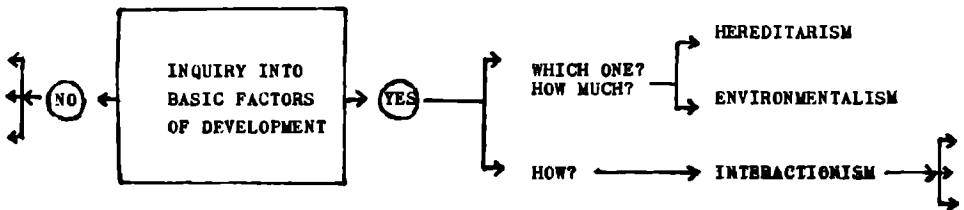


Figure 1. Basic questions of biological and social factors in relevant theories

to the answer as to the question of the basic factors of development the differentiation of respective theories. The old nature versus nurture debate is still around, although in somewhat subtle form. Emphasis on biological factors, although justified by the empirical evidence, should not be presented as discounting the decisive role of environment and education/selfeducation in the formation of personality. We believe that the interactionist and dialectical viewpoint offers the most appropriate conceptualization of the basic determinants of psychological development.

THE CONTRIBUTION OF TWIN STUDIES

Up till now, twin studies have tended to emphasize genetic variables in development. Since Galton's pioneering study in 1875 there have been about two hundred published studies comparing the relative similarity of identical and fraternal twins on a great variety of psychological variables. Nancy Breland and Robert C. Nichols reviewed twin literature up to 1971 (neglecting

many European papers) and extracted 756 pairs of intraclass correlation (cfr. Švancara, 1982). We would be able to gather some other seven hundred pairs which include the researches of Ravits-Shtserbo et al., Švancara, Drábková and others. Analogous survey of investigations of twins in motor abilities was carried out by Kovář (1981); he presented one of the largest amount of heritability coefficients evaluating the results of selected motor tests.

It is a query, however, whether the future twin studies do not mean carrying „coals to Newcastle“. The mentioned review of the psychological twin literature found identical twin correlations by about 0.20. This was interpreted as indication that about half of the variation among people in a broad spectrum of psychological traits is due to differences among the people in genetic characteristics. The average correlation involving an ability measure was higher by about 0.25 than that involving a personality measure. It seems to us that these findings yielded more information and implications for genetics than for psychological disciplines. The real value of the present and future psychological twin studies reveals — in our opinion — from the question as to how they should contribute to the solution of urgent problems of general, developmental, physiological and social psychology and how their conclusions could be applied in education, counselling and in clinical practice.

On the basis of a critical review of results hitherto, and of the methodology in this area, we came to the conclusion that there are at least three broad problems under attack which can be solved still advantageously by means of a twin method:

1. the age variability of personality structure in the extent of the whole life cycle,
2. the dyadic relations as a model of a least natural social group,
3. the biological determinants of selfregulatory mechanisms at work regulating the interaction between the organism of the learner and the specific features of learning processes.

Undoubtedly, we may add some other possibility of implementation. Especially a complex longitudinal project would provide an ideal design for the verification of developmental hypotheses. A promising longitudinal research is going on in Louisville by R. S. Wilson (1978), another one in Prague by Drábková. The results of the Brno twin study with 250 pairs aged 6 to 16 years were reported at the 3rd Prague Conference (J. Švancara, 1977). The basic strategy of concerns the age variability of psychological results in twins. We can see that in most twin studies reported the ratio of genetic and environmental factors is constant. A. R. Luriya was the first in Soviet psychological genetics who examined the role of age in this investigation of memorization in twins; he found support for the hypothesis that the role of *environmental influences increases* in the process of development. Some new results reported in the volume by Lomov and Ravits-Shtserbo (1978) and by Golubeva and Ravits-Shtserbo (1981) would support Luriya's hypothesis too. Our own results, relying on a longitudinal following-up of some MZ and DZ pair till adolescence and some single pairs till senescence, would support a modified model represented by the next Figure 2. The verification of this hypothesis is our work for the next future. It is important to avoid a possible over-generalization.

Our further investigation would also have the goal of elucidating the process of socialization in every pair of twins. The recent work of R. Zazzo leaves no doubt that here are still some possibilities for a creative application of the twin method. There is no doubt that we often neglect the intrapair variability of each single pair. It may be appropriate to introduce complex twin profiles thus enables to fix and compare the cotwins in a number of characteristics (cfr. Švancara, 1982). Somebody might find it to be a step back to the $N = 1$ methodology. We don't think backwards but

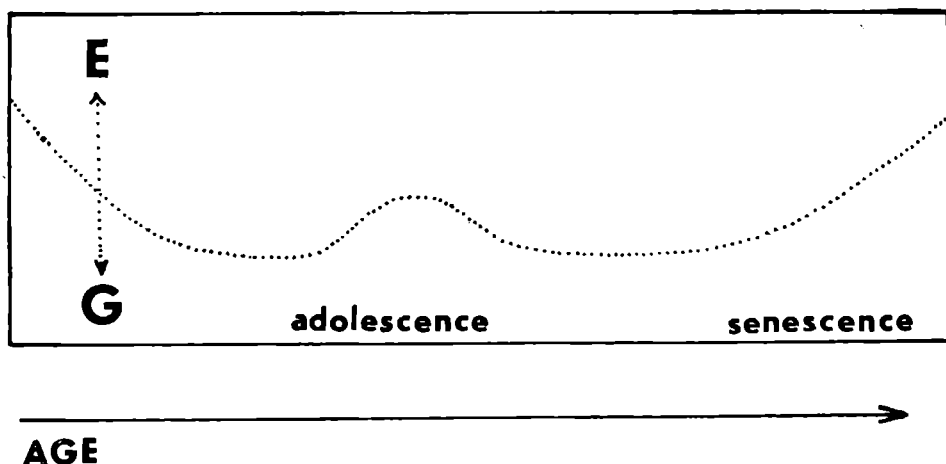


Figure 2. A schematic model of changing genotype \pm environment ratio during the whole life cycle. According to Švancara, 1971

forwards. Lienert's configural frequency analysis could be an appropriate statistical tool for the future evaluation of the proposed twin profiles.

The comparative analysis of dyadic relations² makes possible new conceptualization of personality development, both theoretical and practical.³ One of the practical issues is the utilization of experiences for education and self-education of twins themselves. Simply, the twins are here and their parents and teachers, too, should receive a constructive guide for unusual situations of the twinship based on modern psychological and educational results.

² In *Contemporary Psychology*, No. 5, 1982, we can find an interesting review by Gleason about *Twins' Speech*. Svaka Savić, a Serbo-Croatian Psycholinguist, examined the notion that twins often develop a private language, called "autonomous speech" by Luriya and Yudovich (1956). Savić suggests that autonomous speech does not occur as a natural outcome of the twin situation, but rather as a result of special circumstances where twins have very limited access to adults during the period of language acquisition. The secret speech is according to her based on what the children have heard from adults, and it is not language created *de novo*. Thus, there is a strong evidence for the interactionist view of language acquisition.

³ One of the most dramatic findings in this area was reported by Koluchová (1976). She observed an unusual case of monozygotic boys who had been living in almost complete social isolation from the age of 18 months to 7 years of age.

INNOVATIONS IN BEHAVIOUR GENETICS

All these innovations are highly dependent on the formation of basic concepts of personality development. In recent Soviet papers (Dubinin, Bulayeva and others) it is asserted that biological factors influence the dynamic aspect of the personality whereas the contents of the human mind are determined by the social environment and education. The dynamic characteristics are determined by the properties of the nervous system, the properties of which present one of the fundamental organization levels at which the influence of genetic factors is essential. Therefore Soviet investigators try to demonstrate, using both twin method and interpopulation studies, the existence of significant genetic influences on the properties of the human nervous system. From the review of western literature we can extract two major aims of modern behaviour genetics: 1. to define the degree to which genetic factors determine or predispose to specific behavioral phenotypes, and 2. to describe the mechanisms through which environmental variables interact with genetically programmed variation in cellular and metabolic functions to produce such behavioral or more precisely the psychological phenotype.

I have read somewhere that geneticists share with poets and psychologists a consuming interest in the uniqueness of the individual. Practically at the molecular and biochemical level one can demonstrate quite readily the appearance of individuality. According to our opinion it would be fruitful to compare Williams's concept of „biochemical individuality“ with Anan'yev's *psychological concept of individuality* in the framework of the life span development. The requirement of intermodal compatibility actually relates to the need that a psychological model of personality development, although by necessity developed by fits and starts, must be capable of functioning as a coherent whole. Hebb (1949) emphasized this point very well in his classical book. Articulating the interrelationship between various subsystems of personality at the level of computational structure and processes is actually one of the central problems of behaviour genetics, psychological genetics or genetic psychology respectively.

Despite the rapid growth of results in behaviour genetics in the last two decades, the utilization in developmental psychology has been notably lacking. For example, psychologists have long toyed with the hypothesis that certain skills or behaviours can be learned only at certain age level. An appropriate model of specific educational influences reaching their optimum at a certain stage of development is shown in the Figure 3. In this model, however, the influence of organismic variables seems to be neglected. Perhaps a complex longitudinal study of twins in the extent of the whole life cycle shall provide data for better understanding of sensitive phases in personality development.

Behaviour genetics have become identified as a significant field of study over the past two decades. The seminal book was Fuller and Thompson (1960) with subsequent papers by Hirsch, Vandenberg, McClearn, DeFries, Parsons and others. In 1970 the journal Behavior Genetics was established. Meantime in Moscow the term „psychological genetics“ is used (see Dubinin and Bulayeva, 1981). Unfortunately, the excellent volume by Fuller and Thompson

presents no clear definition of behaviour genetics. This term is not acceptable to many European psychologists, and this is not only because of the association with behaviorism. First, behaviour genetics is not a part of genetics but should be a psychological discipline in the unified system of psychological sciences. In agreement with Plomin, DeFries and McClearn (1980) we can say that nongenetic sources of behavioral variation include that behavioral ge-

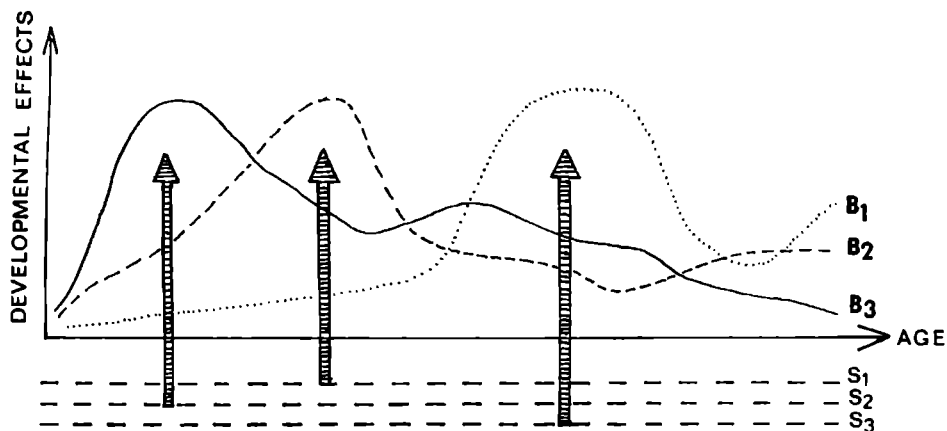


Figure 3. A schematic model of sensitive periods in human development by H.-D. Schmidt (1970) showing the effects of specific learning procedures S_1 , S_2 , S_3 at certain stages of development

netic analysis must deal with a whole new set of intraindividual variations in addition to the classical set of variations of morphological phenotypes, since behaviour or personality are not another phenotype but a specific phenotype.

The methodology of behaviour and or psychological genetics is now well worked out. But a re-evaluation of many conclusions is necessary since they were formulated in the framework of different theoretical conceptions. We must deal with determinants of behaviour, personality and development in one theoretical framework and not have one approach for behaviour genetics another for learning and third for personality development.

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ИССЛЕДОВАНИЕ ВЗАИМООТНОШЕНИЙ, ВНУТРЕННИХ И ВНЕШНИХ ФАКТОРОВ В ТЕЧЕНИИ ЖИЗНЕННОГО ПУТИ ЧЕЛОВЕКА

Статья есть расширенной версией доклада для „4-ой пражской конференции о психологическом развитии, учении и формировании личности 1982“. В ней обсуждаются вопросы исследования эволюции человека с точки зрения ретроспективного и проспективного, сумируется современная ситуация и следующие возможности психологических исследований близнецов и характеризуются специфики новой психологической дисциплины, возникшей соединением психологических и генетических тичек зрения. Выражается взгляд, что существующие до сих пор результаты „генетики поведения“, „психологической генетики“ или „генетической психологии“ приносили больше употребляемых имплементаций генетике чем психологии.

Это касается прежде всего вклада психологических исследований близнецов. На основе анализа существующих в этой области работ приходит автор к выводу, что психологию именно в трех областях может исследование близнецов обогащать

1. исследование возрастной вариабильности черт личности в течении всего жизненного цикла,
2. диадические отношения как модель меньшей социальной группы,
3. биологические детерминанты регуляционных механизмов в процессе обучения, включая в то тоже социальное обучение.

Из обзора знаний в этой области следует, что является желательным соединить подходы теории обучения, теории развития личности и поведенческие, или же психологической генетики в единую теоретическую концепцию диалектического, трансакционного отношения внутренних и внешних факторов развития.

ZKOUMÁNÍ VZÁJEMNÝCH VZTAHŮ VNITŘNÍCH A VNĚJŠÍCH ČINITELŮ V PRŮBĚHU ŽIVOTNÍ DRÁHY ČLOVĚKA

Text je rozšířenou verzí příspěvku na 4. pražské konferenci o psychologickém vývoji, učení a formování osobnosti 1982. Zabývá se otázkami zkoumání evoluce člověka z hlediska retrospektivního i prospektivního, shrnuje současný stav a další možnosti psychologických zkoumání dvojčat a charakterizuje specifika nové psychologické disciplíny, která vznikla ze spojení psychologických a genetických hledisek. Vyjadřuje názor, že dosavadní výsledky „behaviorální genetiky“, „psychologické genetiky“, resp. „genetické psychologie“ přinášely doposud více užitečných implementací genetiky než psychologii. Týká se to zejména přínosu psychologických zkoumání dvojčat. Na základě analýzy dosavadních prací v této oblasti dospívá autor k názoru, že zkoumání dvojčat může být nadále značným přínosem pro psychologii zejména ve třech oblastech: 1. zkoumání věkové variability rysů osobnosti v rozsahu celého životního cyklu, 2. dyadické vztahy jako model nejmenší přirozené sociální skupiny, 3. biologické determinanty regulačních mechanismů v procesu učení, včetně sociálního učení.

Z přehledu poznatků v této oblasti vyplývá, že je žádoucí sjednotit přístupy teorie učení, teorie vývoje osobnosti a behaviorální, příp. psychologické genetiky do jednotné teoretické koncepce dialektického, transakčního vztahu vnitřních a vnějších činitelů vývoje.

