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Part I

The nature–nurture question: New advances in behavior-genetic research on intelligence

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1 Behavior-Genetic and Socialization theories of intelligence: Truce and reconciliation

Sandra Scarr

Theories should compete. It keeps them fit and trim. Left unchallenged, theories, like people, grow fat and lazy, and they eventually decay into shapeless blobs. Unchallenged theories petrify as "common wisdom," immobilizing critical faculties with intellectually paralyzing assumptions. A challenged theory is a creative network of conscious and considered ideas, casting its nomological net over new observations and predicting where to look for the next catch.

Psychological theories are rarely made to compete, but they can, and they should, be exercised in this way. Competing theories about determinants of intellectual differences offer a challenging opportunity to test theoretically required predictions with available observations. Predictions about crucial research results are generated by Socialization Theory and by Behavior-Genetic Theory, and those predictions are quite different. The critical observations to test the adequacy of predictions from these competing theories have been made. Yet, there has been little, direct theoretical confrontation. That the theories have not been tested with existing data in a systematic fashion is either a sign of mutual ignorance or an aversion to being challenged.

This chapter presents Socialization and Behavior-Genetic theories of intelligence and evaluates the adequacy of the theories' predictions to account for existing observations. The adequacy of the theories to generate new research is also assessed. By posing a stark contrast between theories, I hope to sharpen the debate and to modify developmental theory to fit existing observations about intellectual resemblance in families and to be more productive in future research.

Predictions from both Socialization and Behavior-Genetic theories can be partially correct, with one faring better than the other, or, less likely, one may be the overall winner by excluding the other. The test is whether each theory generates predictions that fit the available observations, and whether each can generate specific hypotheses that can be tested with additional research.

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Most observations about determinants of intellectual differences can be fit to both Socialization and Behavior-Genetic theories and, thus, do not provide a critical test between them. Studies in the tradition of Socialization Theory typically sample one child per family and include only biologically related families, thus confounding genetic with social transmission of behavioral traits from parents to children (Scarr, 1992, 1993). Studies of biological families *only*, even if they include siblings, are not theoretically informative, because the observations of modest similarities among family members and correlations of family environments with children's intellectual differences can be fit as well, or better, to other theories. Other observations, mostly from behavior-genetic studies, do provide tests of different predictions that must be made by the two theories.

Definition of terms

Four definitions are essential at the outset for the terms *observation*, *intelligence*, *socialization*, and *behavior-genetic*.

Observations are scientifically credible (reliable, valid) measurements of phenomena that are the subject matter of a theory. Under the term *observation*, I include all kinds of measurements, such as tests, ratings, self-reports, and behavioral observations. Both Socialization and Behavior-Genetic Theory focus on processes that transmit behaviors from one generation to the next, so that observations of family influences are crucial to both theories. What is observed are co-occurrences or correlations between one event and another.[1] Observations are shaped into facts by theories, by making sense of the observation in terms of the theory (Scarr, 1985). Many observations can be made into different facts by different theories.

Intelligence. For the purposes of this chapter, intelligence is defined as scores on cognitive tests, including standard intelligence tests and factors from tests of specific cognitive abilities. Most often, intelligence will mean *general* intelligence, or *g*. It is assumed that intelligence develops through learning culturally valued knowledge and skills in a human, social environment (Scarr, 1993).

Western, especially U.S., ideas about intelligence refer to the individual learner, who acquires knowledge and skills incidentally from universal schooling, and from interactions with others. European psychologists refer more often to social supports for children's learning (e.g., Vygotsky), but it is the individual who becomes more or less intelligent. Bright children acquire learning sets, or executive functions, that guide their knowledge acquisition. Less bright children must be taught segmented information and skills that bright children acquire spontaneously.

Socialization Theory. For the past 50 years, thousands of articles and

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books have been written in psychology about the effects of parents as socializing agents on their children (see Bandura, 1977; Baumrind, 1993). In the context of Social Learning Theory, socialization researchers stress the many ways that parental behaviors directly affect their children's development, through modeling, social reinforcement, and interactions that promote or discourage learning. Socialization Theory is at root a description of parental behaviors and their association with child outcomes.

In this chapter, parental influences will include the many characteristics of schools, neighborhoods, and communities that parents expose children to as part of the correlated family environment.

Socialization appeals primarily to environmental differences *between families* – differences in the environments parents provide, including the parents themselves. Differences between families are hypothesized to make siblings alike (because they are reared by the same parents in the same household) and different from children reared in other families. Social disadvantage, a frequently evoked concept, is clearly a difference between low income and/or minority families and more affluent and/or majority-group families. Social class is a between-family difference, as are all family characteristics that siblings share but that differ among families.

Parental rearing styles would seem to be primarily between-family differences, because siblings share the same parents. Socialization research has rarely included siblings, so that characterizations of parental rearing styles have been based on parent reports and behaviors with one child per family and, thus, are de facto between-family differences. It is not clear whether parents' basic style is expected to vary much from one child to another. The theory is moot on this issue. Increasingly, socialization researchers have written about within-family environmental differences (e.g., Hoffman, 1991), but their studies have not included siblings or twins until very recent collaborations with behavior geneticists (e.g., Plomin et al., 1993; Plomin, Reiss, Hetherington, & Howe, 1994).

Behavior-Genetic Theory, derived from evolutionary theory, is focused on causes of individual variation in intelligence and other characteristics in populations (see Plomin, DeFries, & McClearn, 1990). Behavior genetics is not the study of species invariants or of gene action pathways that affect behaviors; rather, behavior genetics studies sources of variation in populations. It makes predictions about parental influences on children from both genetic and environmental (both biological and social) transmission (see Rowe, 1994). Environmental transmission includes both socialization differences between families and other, often unknown environmental differences between siblings in the same family. Behavior-genetic studies aim to sort out which influences have which effects in what populations.

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In truth, generalizations from both socialization and behavior-genetic research are limited to the populations, measures, and methods sampled in studies. This limitation applies to all behavioral research, although it is often ignored in socialization studies.

Behavior-genetic explanations appeal to four major sources of variation to explain individual differences in intelligence.

1. Additive genetic effects refers to the combined effect of many genes, each contributing a small amount to phenotypic diversity. It is likely that human intelligence relies on many gene loci, as more than 100 genes have been identified, where abnormal variants can interfere with normal intellectual development. Roughly half of the genetic variation in a population occurs within families (except for identical twins, first-degree relatives share about half of their genes), and half occurs between families. An assortative mating correlation between spouses of about .3 for intelligence slightly reduces genetic variation within families and increases it between families.
2. Nonadditive genetic effects include dominance effects (where the heterozygote phenotypically resembles one of the homozygotes) and other major gene effects, genotype–environment correlations, genotype-environment interactions, and epistasis [the nonadditive effects of certain gene combinations, which Lykken, McGue, Tellegen, and Bouchard (1992) called *emergenesis*, because sometimes one individual in a family appears with an unusual characteristic, such as extraordinary musical talent, which is not shared with other family members; see Jensen, this volume]. Genotype–environment correlations are ubiquitous, nonrandom associations between one's personal characteristics and one's environment (Scarr, 1992; Scarr & McCartney, 1983). Gene–environment interactions occur when one genotype develops better in one environment, whereas a second genotype develops better in a different environment.
3. Between-family nongenetic effects make siblings more similar than children reared in different families. Nongenetic effects are usually thought of as psychosocial environmental differences between one family versus another. Social class and parental differences in rearing style can be considered between-family differences. But such differences may be prenatal and biological as well (see Jensen, chapter 2, this volume). Between-family environmental differences can be thought of as differences in *opportunities*. Children from lower social classes are said to have fewer opportunities to develop higher intelligence than those from higher social class families, not only in the home itself but in the correlated schools, neighborhoods, and communities in which they live.
4. Within-family nongenetic variance refers to those aspects of the environment, biological and social, that make siblings in the same family different from one another and that make genetically identical twins reared in the same home less than identical in all respects [although they are nearly as similar in intelligence as the same person tested twice (the limitation of test–retest reliability)]. Within-family, nongenetic differences include prenatal and biological environmental, as well as psychosocial environmental, events that affect one sibling in a different way from another (see Jensen, chapter 2, this volume).

Behavior genetic theory includes these four sources of potential intellectual variation. To make the contrast with Socialization Theory sharp and

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clear, I will stress the role of *genetic transmission* to account for individual differences in intelligence.

Why do individuals vary in intelligence?

The observation of differences in intelligence has many explanations, only a few of which we refer to in any one discussion. For example, if we ask why one person scores higher on an intelligence test than another, psychologists are unlikely to think first of differences in serotonin levels, or room temperature, or what each person had for breakfast, although in some circumstances all these could cause a difference in test performance. We are more likely to look for previous learning opportunities and motivation to perform or at how intelligent their parents are. Hesslow (1987) noted that when a house catches fire, we do not normally refer to the presence of oxygen as the cause of choice, although we would all accept the idea that oxygen plays a role in fires. Rather, we would refer to a lighted match as the cause of the fire.

How do we choose causes? The answer to this question will explain a lot about differences between Socialization and Behavior-Genetic theories. There must be a connection between the event and the putative cause, but a single cause is selected from an almost infinite variety of possible causes. Primarily, the selection of causes depends on the question asked; for example, if I ask why Down's syndrome children have lower than average IQ scores, I am not likely to refer to their diet, although I know that adequate nutrition plays some role in mental development. I am more likely to appeal to the chromosomal cause of their retardation. Theoretical and practical preferences also play important roles in causal selection, so that an educational researcher might focus on unmet stimulation needs of Down's syndrome children, whereas a genetic counselor might search for familial causes.

John Stuart Mill was the first philosopher to recognize that conditions which causally determine an event usually far outnumber the conditions mentioned in a causal explanation. Since the 18th century, many philosophers have pondered causal selection (Hesslow, 1987). There are six major reasons for selecting one cause over others.

1. *Unexpected or abnormal conditions.* Some conditions are already known and need not be mentioned (such as the presence of oxygen in a fire or adequate nutrition in retarded children). We do not need explanation of things that behave according to expectations. We ask "Why?" when something unexpected happens. Abnormal conditions that seem to make a difference between normal or expected functioning and the abnormal conditions that brought the event to our notice are prime candidates for causal selection. Lighted matches in a fire and a chromosomal defect in Down's Syndrome fall into this category.

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2. *Precipitating causes*. conditions that immediately precede an event are more often selected than permanent or background causes, which may indeed be causes that have more impact than the precipitating events, as I will later show.
3. *Deviation from a theoretical ideal*. Ideals of how things are and how they work guide causal selection and promote as causes conditions that deviate from the ideal. When we observe children in economically deprived circumstances not doing well on IQ tests, we conclude that poverty must be the cause of poor test performance, because poverty deviates from our theoretical ideal of child-rearing circumstances. When we find a child with a background of poverty doing well on IQ tests and in school, we do not attribute good performance to poverty; rather, we look for other causes, such as resilience, that fit our theory about poverty. This causal selection can also be called *responsibility*: Conditions that deviate from what is good or right can be selected as causes of bad events, because on moral grounds they should not be allowed to occur. Poverty is associated with many poor social outcomes. Is poverty the cause?
4. *Predictive value*. We prefer those causes that would enable us to predict events. These are causes that are necessary, and perhaps sufficient, for the event to occur.
5. *Manipulability*. We have strong preferences in psychology to identify as causes those conditions that will allow us to bring about a desired goal or prevent an undesirable one. Hesslow (1987) proposes that predictability and manipulability are most often selected in science – predictability, because in science we want to control events, and manipulability (in more applied sciences such as medicine and clinical psychology), because fixing bad outcomes is highly valued.
6. *Theoretical or practical interest*. We also tend to select as causes those conditions that we know more about or know how to fix or deal with. With child intellectual failure, pediatricians see medical causes, psychologists see family or peer problems, and educators see poor instruction. All, some, or none may be causes of the event to be explained.

Hesslow (1987) proposes two principles to explain causal selection: the *difference* between objects with respect to a certain property, and *explanatory relevance*. The example he offered illustrates these principles very well. Causes selected to explain different wing lengths of fruit flies, shown in Figure 1.1, vary depending upon the relevance of the cause to the observed difference.

There is always an implied, if not explicit, comparison in any causal explanation, and the appropriateness of the choice depends upon the comparison. In Figure 1.1, mutant and normal flies are reared under three temperature conditions. The mutant has shorter wings under conditions of lower temperatures. If we ask the question "Why does M1 have short wings?", the causal explanation will depend *entirely* on which fly is the relevant comparison. If M1 is compared to N1, then genetic difference is the only possible explanation, as they were reared in the same temperature. If M1 is compared to M3 or M2, the explanation is entirely the temperature differences, as they have the same genotypes. If M1 is

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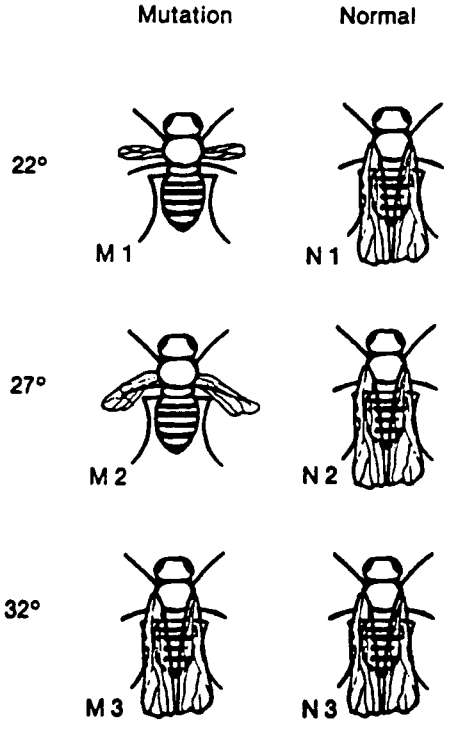

Figure 1.1. Wing length in mutant and normal flies reared in three temperatures (Hesslow, 1987).

Table 1.1. *Causes of variation in reading skills for two groups of children in three instructional conditions*

	Reading Skills	
Reading Instruction	Group A	Group B
1. Excellent	High	Low
2. Mediocre	Moderate	Low
3. Poor	Low	Low

compared to N3, the cause of the differences must be both genetic and environmental.[2]

An example from the educational domain can be invented with similar parameters (see Table 1.1). If we ask why children in Group A have high reading skills, the answer depends on which other group of children is

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chosen for comparison. If we compare Group A1 to B1 children in the same instructional conditions, the explanation has to be differences between personal characteristics (such as genetic differences) of the children. If the comparison is between Groups A1 and A2, similar children with excellent versus mediocre instruction, the explanation must lie in instructional differences.

Usually, both personal and instructional differences, or genetic and environmental differences, are involved. Complex causation requires causal parsing in order to determine *quantitatively* how much effect is caused by each of several factors. The theoretical and methodological abilities to parse causation is the major challenge of Behavior-Genetic Theory to Socialization Theory.

Explanatory power versus manipulability

I want to add another criterion for causal selection to Hesslow's criteria of difference and explanatory relevance. *We should prefer as explanations those conditions that account for more of the variation in the phenomenon to be explained, causes that have more* ***explanatory power****, even if they are not presently manipulable.*[3] In only the most applied, practical sciences is manipulability the most appropriate cause to be preferred above others. From a theoretical perspective, more important causes are those that give a more complete account of, or explain more about, the phenomenon. This proposal is intended to make human developmental science a more thoroughly scientific and multidisciplinary enterprise rather than being a front for advocacy of humane causes and social justice.

By contrast, Baumrind (1993) advocates causal selection based on manipulability. Her tone is that of a moral crusade against identifying and referring to causes that are not presently manipulable.

> For psychologists, as for medical researchers, the purpose of identifying undesirable predispositions of individuals *should be* to devise more effective health-promoting interventions, not to discourage such attempts on the supposition that these predispositions are *genetically based and therefore intractable*. . . . Given limited resources, many socialization researchers choose to focus on those factors that are most susceptible to change – on how parents and educators can provide optimum environments for optimum development or optimum human behaviors [p. 1313, emphasis added].

Socialization researchers appeal almost exclusively to causes that can potentially, if not actually, be manipulated. Parents *should* be taught better parenting; teachers *should* become better instructors; children *should* be given safer and healthier environments in which to grow up. I applaud social advocacy and, as a citizen, participate in such movements. As a scientist, however, my role is to explain human development. In that context, causes that explain the phenomena more fully, even if they are not

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presently manipulable, are preferred. *Confusion between the legitimate but different goals of science and social advocacy is dangerous to both* (Marshall, 1992; Ernhart, Scarr, & Geneson, 1993; Scarr, in press).

Competing theories

Important aspects of Socialization and Behavior-Genetic theories can be contrasted and tested. Figure 1.2 shows statements of general theory, middle-level theory, and some specific predictions derived from theory. At the general theoretical level, Socialization Theory states that parental child-rearing styles or techniques are powerful determinants of children's intellectual development. Brighter children have parents who treat them in specific ways that are not common to parents who produce less bright children. At a middle theoretical level, more specific hypotheses are generated. To illustrate, Figure 1.2 shows two theoretical statements about socialization effects: (1) that parenting practices can be characterized as authoritative, authoritarian, permissive, and uninvolved; and (2) that specific child-rearing practices and proximal interactions produce more and less intelligent children.

From these middle-level statements, specific predictions can be made about what will be observed in family studies. By family studies, I do not mean the study or ordinary biological families only, because, taken alone, they are not at all informative about the putative effects of socialization practices (see Rowe, 1994; Scarr, 1993). A requirement for theory-relevant observations is that they must allow a critical test of the theory; to wit, if socialization practices are critical to children's intellectual development, then genetic transmission of intelligence from parent to child must be controlled or varied in order to rule out the major competing hypotheses from Behavior-Genetic Theory.

Thus, the specific predictions that differentiate Socialization Theory from Behavior-Genetic Theory are that (1) children reared by different parents, in different homes, will not resemble each other, even if they are genetically related, unless their parents use similar rearing practices, (2) genetic relatives reared in different homes will not be similar in intelligence unless their parents use similar rearing practices, and (3) authoritarian rearing style causes children to have low intelligence and poor academic achievement, regardless of parents' intelligence.

Behavior-Genetic Theory, at a general level, states that genetic differences are a major source of intellectual differences among children, regardless of parental rearing styles, unless parents are abusive or seriously neglectful (Scarr, 1992, 1993). At a middle level, the theory proposes that in societies such as Western democracies, where opportunities for learning

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