Empirical Models of Cultural Transmission

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Abstract

This paper discusses several issues concerning an empirical analysis of the endogenous formation of preferences, as well as cognitive and psychological traits. In particular we show by means of examples how, with existing data, it is possible to *i)* identify empirically the distinct influence of family and society at large in the determination of cultural traits, and *ii)* disentangle genetic heritability from cultural and environmental factors determining cognitive and psychological traits.

Keywords: Socialization, cultural transmission, religion, IQ.
JEL: I2, Z1, D9

1 Introduction

The preferences of individuals, their cultural traits and attitudes, as well as the main traits of their cognitive and psychological personality, including their ability to self-regulate and their IQ, are largely formed before the end of elementary school.[1] In part, preferences and cultural or cognitive traits of children are inherited from biological parents by the rules of genetic transmission; in part however they are influenced in a complex manner by the social environment, such as friends, peers, schoolmates, and especially by their cultural family, that is, the family they are raised by. Cultural parents socialize their children to norms of behavior, attitudes, and more generally to cultural

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[1]See Eaves-Eysenck-Martin (1989) for an empirical survey.

traits, like their religious faith or ethnic identity. Further, cultural parents contribute to the development of their children's psychological and cognitive skills.

Most of the socialization occurring in the family is purposeful, that is, parents devote time and resources to several activities in order to influence their children's preferences, and their cultural and cognitive traits. Examples of such activities include reading with one's children, discussing openly how to cope with problems, sending them to schools known to cultivate the desired norms of behavior and attitudes, choosing the family residence, attending and supporting the church, and other cultural groups or sport clubs, and so on. However, socialization is also, in part, indirect and involuntary: children often imitate or learn from their parents' and siblings' behavior, as well as from the behavior of their extended family, their friends, peers, teachers, and even acquaintances.

It is very important for economists and sociologists studying the endogenous formation of preferences and of cultural and cognitive traits to be able to distinguish and measure the relative importance, for specific traits, of these different transmission mechanisms: genetic transmission, direct purposeful family socialization, indirect influence of social relationships at large. It is important both for conceptual reasons and as an empirical question. With regard to the former, for instance, the distinction between genetic and cultural factors in the determination of preferences and behavior is an important element of the nature/nurture controversy, arguably one of the most fundamental debates in the social sciences.[2] Also, the distinction between direct purposeful and involuntary socialization mechanisms has implications for the debate on the relevance of the rational choice paradigm for a large class of sociological issues, also a fundamental, if more recent, debate in the social sciences.[3]

With regard to the latter, measuring the relative importance of different transmission mechanisms is even more important because such mechanisms have very different policy implications. For instance, the impact of policy measures like early childhood education programs depends of course in a fundamental manner on the relative relevance of the inherited genetic component of IQ.[4] Also, the effectiveness of anti-segregation or assimilation policy measures depends significantly on the strength of ethnic and racial identities in the population, which might lead families to undo the policy measures, for example by relocating in segregated or ethnically homogeneous neighborhoods.[5]

In this paper we introduce a recent general model of the transmission of culture,

[2] A good review of the complex debate on nature/nurture is in Ceci-Williams (1999).

[3] See for instance Archer-Tritter (2001) for sociology, Green-Shapiro (1996) and Friedman (1996) for political science, and Hogarth-Reder (1987) for economics and psychology.

[4] See for instance the heated controversy generated by the implications of Herrnstein-Murray's *Bell Curve* for such programs; for an assessment see Cawley-Heckman-Lochner-Vytlacil (2000).

[5] For instance, the assimilation ideology and social policies prevalent in the U.S. in the nineteenth century have often clashed with the demands of immigrants for the preservation of their cultural and religious identity; see Gleason (1980). Consistently, Borjas (1995) finds slow rates of assimilation of immigrants in the U.S. and substantial measures of residential segregation of second generation immigrants by ethnic group.

built on the analysis of biologists, cultural anthropologists, sociologist and economists, and show how this allows us to better conceptually distinguish and, when taken to data, empirically identify the different transmission mechanisms contributing to the determination of preferences, and of psychological and cognitive traits of children. We proceed by reporting by way of example on two instances in which such a model has in fact been taken to data, the different components of cultural transmission have been identified and their parameters estimated, and their relative importance has been assessed and measured with respect to specific traits. In the first example, Bisin-Topa-Verdier (2001) study the transmission of religious traits in the U.S., while in the second example Otto-Christiansen-Feldman (1994) study the cultural and environmental influences on IQ.

2 The Cultural Transmission Model

The cultural transmission model we introduce in this section has been introduced by Bisin-Verdier (2001a). It is based on the previous work of Cavalli Sforza-Feldman (1981) and Boyd-Richerson (1985), to which it adds the endogenous determination of direct purposeful family socialization due to the rational choice of altruistic parents. We distinguish formally the case in which the trait is discrete, e.g., religious or ethnic identity, from the case in which the trait is continuous, e.g., in the form of the intensity of preferences or of a psychological or cognitive trait; but the qualitative analysis is equivalent.

We consider first the case of discrete traits. Suppose for simplicity there are two possible types of cultural traits in the population, $\{a, b\}$. Families are composed of two parents and two children, and are homogamous, that is both parents have the same cultural trait. All children are born without defined preferences or cultural traits, and are first exposed to their parent's trait. The fraction of individuals with trait $i \in \{a, b\}$ is denoted q^i. Family socialization to the parent's trait, say trait i, occurs with probability d^i. If a child from a family with trait i is not directly socialized, which occurs with probability $1-d^i$, he/she picks the trait of a role model chosen randomly in the population (i.e., he/she picks trait i with probability q^i and trait $j \neq i$ with probability $q^j = 1 - q^i$).

Let P^{ij} denote the probability that a child from a family with trait i is socialized to trait j, and hence also the fraction of children with type i parents who have preferences of type j. The socialization mechanism just introduced is then characterized by the following transition probabilities, for all $i, j \in \{a, b\}$:

$$P^{ii} = d^i + (1 - d^i)q^i \quad (1)$$

$$P^{ij} = (1 - d^i)(1 - q^i) \quad (2)$$

If family socialization is purposeful, and results from the socialization effort of parents, then such effort determines endogenously the direct family socialization, d^i. To

model the socialization decisions of parents, and hence the determination of d^i, we assume that parents are altruistic towards their children but wish to socialize them to their own (the parents') specific cultural model. Letting V^{ij} denote the utility to a type i parent of a type j child, $i, j \in \{a, b\}$, the formal assumption is:[6]

$$\text{for all } i, j \text{ with } i \neq j,\ V^{ii} > V^{ij} \tag{3}$$

Socialization is costly. Let $C(d^i)$ denote socialization costs. Parents of type i choose $d^i \in [0, 1]$ to maximize:

$$P^{ii}V^{ii} + P^{ij}V^{ij} - C(d^i) \quad s.t.\ (1-2) \tag{4}$$

Under standard regularity assumptions on preferences and costs the argmax of the socialization problem of a type i parent, problem (4), is represented by a continuous map which we denote $d^i = d(q^i, \Delta V^i)$, where $\Delta V^i = V^{ii} - V^{ij}$ is the subjective utility gain of having a child with trait i; it reflects the degree of 'cultural intolerance' of type i's parents with respect to cultural deviations from their own trait.[7] Given imperfect empathy on the part of parents, $\Delta V^i > 0$, by equation (3).

Consider now the case of a continuous trait. The simplest model has the value of the trait of a child h, B_h, constructed as a weighted average between a target value B_h^* and the mean value of the trait in the population $\overline{B}$, where the weight on the target, d^h, represents the direct family socialization component. For instance,

$$B_h = d^h B_h^* + (1 - d^h)\overline{B} + \epsilon_h$$

where ϵ represents a standard normal stochastic component added for simplicity. The target might for instance correspond to the maximum possible value of the trait given the family characteristics. If direct family socialization is purposeful, as in the discrete trait model, parents can spend effort to isolate the influence of friends peers and society at large on their children's value of the trait, that is, by choosing a higher value of d^h. Again, such effort d^h is costly with cost $C(d^h)$, and the objective of parents in the case of a favorable trait (i.e. one that parents like their children to posses in the highest value) is to maximize

$$B_h - C(d^h)$$

[6]The assumption can be interpreted as a form of myopic or paternalistic altruism (hence its name, 'imperfect empathy'): Parents are aware of the different traits children can adopt, and are able to anticipate the socio-economics choices a child with trait i will (optimally) make in his/her lifetime; but parents are not able, though, to altruistically evaluate these choices with the children's utility function (to 'perfectly empathize' with the children), and they are biased by their own (the parents') subjective evaluations.

Some justifications of imperfect empathy, from an evolutionary perspective, are put forth in Bisin-Verdier (2001b).

[7]See Bisin-Verdier (2001a) for details.

Again, under standard assumptions, the solution of the problem is a map $d^h(\overline{B})$.

An important determinant of the process of cultural transmission in the analysis of the population dynamics of the different cultural traits consists of how the social environment, q^i in the case of discrete trait i, or $\overline{B}$ in the case of a continuous trait, affects direct vertical socialization. More precisely, situations where the social environment acts as a substitute or as a complement to direct family cultural transmission technologies have very different implications for the analysis of socialization. Intuitively, we say that direct vertical transmission acts as a *cultural substitute* to oblique transmission whenever parents have less incentives to socialize their children the more widely dominant are their values in the population or the more intense is the mean trait in the population. For the class of endogenous socialization mechanisms introduced in this section, in general, socialization is in fact characterized by cultural substitution (unless socialization costs are decreasing, and importantly so, with the dominance or the intensity of the mean of the trait in the population, that is with q^i or with $\overline{B}$). In the discrete case then the direct family socialization efforts of type i agents are decreasing in the fraction of these individuals in society, $d^i(q^i)$ is decreasing in q^i (and is 0 if $q^i = 1$). In the continuous trait case, similarly, $d^h(\overline{B})$ is decreasing in $\overline{B}$ (and is 0 when $\overline{B} \geq B_h^*$).

3 Empirical Analysis of Transmission Mechanisms

As we argued in the Introduction the main issue arising from any attempt to study the endogenous formation of preferences and of cognitive and psychological traits is the identification of the different mechanisms which drive the determination of such traits; the distinction between genetic and cultural mechanisms, and the distinction between direct family socialization and the influence of social interactions at large. Section 4, based on the work of Bisin-Topa-Verdier (2001), concentrates on the distinction between direct family socialization and the influence of society at large, and hence on the relative importance of the rational choice mechanisms associated with direct family socialization. Section 5, based on the work of Otto-Christensen-Feldman (1996), deals instead with the relative importance of genetic versus cultural transmission mechanisms.

4 Religious Socialization in the U.S.

Consider a pure discrete cultural trait, one for which genetic influences are reasonably absent, like religion or ethnic identity. The main empirical issue in this case consists of identifying direct family transmission: socialization by peers, friends and society at large is then the residual socialization component. If direct family socialization is involuntary, and the socialization by peers, friends and society at large is approximately governed by random matching, then the socialization rate of a homogamous family is simply

determined by equation (1):

$$P^{ii} = d^i + (1 - d^i)q^i$$

Direct family socialization for each trait is in this case measured by d^i and is immediately identified simply with data on the socialization rate, P^{ii}, and the fraction of the agents with trait i in the reference population.

If instead direct family socialization is purposeful, and determined by the choices of the parents, then it depends in general on q^i, and the deep preference parameters of the model, the intolerance levels, ΔV^i. In this case the identification of direct family socialization requires data on different populations with the same preferences. More precisely, what is needed is some variation in the distribution of the population, that is, in q^i, which is necessary to recover the form of the dependence of P^{ii}, and hence of d^i, on q^i.[8]

With such data it is in principle also possible to identify different transmission mechanisms than random matching for the influences of society at large. Finally, one can test the hypothesis that d^i is constant across the different reference populations, and hence assess the relevance of purposefulness and rational choice in direct family socialization.

This is the objective of the analysis in Bisin-Topa-Verdier (2001) (henceforth BTV). Using General Social Survey (GSS) survey data for the U.S. over the period $1972 - 96$, BTV study cultural transmission and socialization for a specific trait, religious identity (and, in particular, for Protestants, Catholics, Jews, and for the residual group, 'Others'). While the GSS data contains accurate information on the religious identity of the responder and his/her spouse, the data regarding both parents and their children is unfortunately only available for a small sub-sample of respondents,[9] and hence estimated socialization rates are very noisy. BTV therefore augment the model introduced in the previous section with a model of endogenous marriage decisions. They identify the different socialization mechanisms by exploiting the general correlation between homogamy in marriage along a trait and socialization of children to the same trait.[10] This strategy has the advantage of concentrating the empirical study on one important mechanism of direct family socialization, namely homogamous marriages. In other words, it explains the very low documented intermarriage rates across religious groups in the U.S. (see Table 1) as a rational decision of individuals which correctly expect it to be easier to socialize their children to their own religious faith whenever both parents share such faith (see Table 2).[11]

The implications of such a model interacting socialization and marriage is that not

[8] One can estimate directly $d^i(q^i, \Delta V^i)$ or else estimate a flexible socialization cost function and the parameters ΔV^i under the assumptions of the choice model introduced in the previous section.

[9] The data on socialization come only from a special module of the GSS, collected in 1988, that asks respondents to report the religious identity of their parents.

[10] See Bisin-Verdier (2000) for the underlying theoretical analysis.

[11] Consistently, cohabitation relationships, whose expected fertility is not significantly different from that of single women, are also much less homogamous than marriages; see Schoen-Weinick (1996).

only socialization rates, but also homogamous marriage rates and more generally the whole composition of marriages (e.g., the share of Protestant-Catholic marriages, or Protestant-Jew, and so on) depend on the distribution of the population by trait, that is, on q^i, and hence the variation of such composition by state in the U.S. can be used to identify the direct family component of marriage and socialization and to estimate the deep preference parameters of the model, i.e. the intolerance levels.

The estimated choices of direct socialization of homogamous families, d^i, are quite large. For Protestants and Catholics, the direct socialization levels of homogamous families when fully minority ($q^i = 0$) are significantly positive: d^i is above 75 percent.[12] Direct socialization for both Protestants and Catholics first increases and then decreases, peaking at about $q^i = .5$; a consequence of a form of cultural complementarity arising from the estimated dependence of socialization costs on q^i (the more a given religious faith is a minority in the population of reference, the harder it is to socialize one's children to that particular faith or to segregate in marriage). Jews socialize much more than Catholics and Protestants in the whole relevant range of q^i. For example, when Jews are a small minority, the probability of direct socialization levels for homogamous Jewish families is roughly 90 percent.

As we noted, the empirical strategy adopted by BTV allows the authors to study to some extent flexible forms of indirect socialization, different than random matching. In fact they document a significant bias in matching probabilities in favor of the residual group Others, inducing a sizeable distortion: the implied probability of becoming 'Other' in society at large, once direct family socialization failed, exceeds on average the share of Others in the population by about 16 percentage points.[13] Such bias can be perhaps accounted for by conversions. Finally, BTV's estimation results overwhelmingly reject the cultural transmission model in which direct family socialization is involuntary (and constant across states by religion) in favor of the rational choice model of endogenous socialization and marriage.

5 Heritability of IQ

Consider a continuous cognitive or a psychological trait, like IQ, neuroticism or extroversion, which in general have both a genetic and a cultural component. In this case, a trait of individual h, P_h is influenced by a genetic component, A_h and a cultural component, B_h; the simplest model has

$$P_h = hA_h + bB_h,$$

[12] Also, homogamous marriages result in large part explained in the data by their expected future advantages for socialization.

[13] The residual group Others includes a majority of individuals with no religious preference (over 70 percent on average in the U.S. of our residual group in the sample) and a minority which includes major religious faiths not largely represented in the U.S. (Islam, Buddhism, Hinduism), and religious sects.

where all variables are normalized for simplicity in terms of deviation from the mean, so that P_h, A_h, B_h, have zero mean and unitary variance.

The genetic component of the trait of a child, A_h, is also in general determined linearly from the mother's and father's, A_{m_h} and A_{f_h}, and a noise term, S_h:[14]

$$A_h = \frac{1}{2}A_{f_h} + \frac{1}{2}A_{m_h} + \sigma S_h$$

The cultural transmission factor could instead be determined as in Section 2.

In general, if direct family socialization is voluntary, as in Section 5, A_h and B_h are correlated, and $\text{var}(P_h) = h^2 + b^2 + 2bh\text{cov}(A_h, B_h)$. The standard measure of the genetic component of the trait, or heritability factor, is h^2, that is the share of the variance of P_i due to the genetic factor A_h, under the assumption that genetic and cultural components are uncorrelated, $\text{cov}(A_h, B_h) = 0$.

To identify the genetic from the cultural component of a psychological or cognitive trait, that is, its heritability factor h^2, one could exploit the existing data on the correlations of cognitive and psychological characteristics of identical twins reared apart, that is, of twins with identical genetic make-up (monozygotic twins) adopted by different families.[15] Consider in fact the covariance between the cognitive of psychological traits of two individuals:

$$\text{cov}(P_1, P_2) = \text{cov}(hA_1 + bB_1, hA_2 + bB_2).$$

In the case of identical twins, $\text{cov}(A_1, A_2) = 1$, as they have the same genetic make-up; if the twins have been reared apart, the crucial identifying assumption is that $\text{cov}(B_1, B_2) = 0$, that is that the cultural environments in which the twins have been raised are uncorrelated. Therefore, we conclude that the covariance of, e.g., measured IQ of identical twins reared in uncorrelated cultural environments measures the heritability factor of IQ in general: $\text{cov}(P_1, P_2) = h^2$. This correlation in the data is very high for IQ, .72.

In fact the identifying assumption that the cultural environment of the identical twins reared apart for which the data is available is uncorrelated is rather problematic:[16] for instance, the correlation between the foster mothers' education in the sample is significant, .412, as is the correlation between the foster families' measure of wealth in the sample, .402 (from Bouchard-Lykken-McGue-Segal-Tellegen (1990)).

[14]This model is the standard additive model of Mendelian inheritance; non-linear extensions can be introduced to include the analysis of dominance and epistasis, see Falconer (1989).

[15]See again Eaves-Eysenck-Martin (1989); and Bouchard-McGue (1981), Pedersen-Plomin-Nesselroade-McClearn (1992), as well as Herrnstein-Murray (1994), specifically for IQ.

[16]Some of the literature on IQ mistakenly identifies lack of a common cultural environment between the twins with no statistical correlation of their environments; see e.g., Herrnstein-Murray (1994), p. 107: 'Identical twins share all their genes, and if they have been raised apart since birth, then the only environment they shared was that in their womb. Except for the effects on their IQs of the shared uterine environment, their IQ correlation directly estimates heritability.'

Taking these correlations seriously implies that the data on the correlation of cognitive and psychological traits of identical twins reared apart is not sufficient to identify the genetic component in the cognitive and psychological traits of individuals, that is, h^2. This is the starting point of Otto-Christiansen-Feldman (1994)'s analysis of the inheritance of IQ. To identify the heritability factor, they exploit the existing wealth of data on familial IQ correlations which complements the data on identical twins reared apart; IQ correlations, for instance, between siblings, half-siblings, parents and children, parents and adopted children (see Table 3, from Bouchard-McGue(1981); reported in OCF). In fact, by modelling explicitly the influence of the cultural component on IQ, as in Section 2, they can derive the implications of the model regarding the correlations of the cultural factor across different classes of individuals, and hence regarding the familial correlations of IQ in the data. They can therefore estimate the parameters of the model by fitting the data on the correlations of measured IQ reported in Table 3.

For different versions of the cultural transmission model in Section 2, in which both direct family socialization and the influence of the environment and society at large are exogenous, OCF estimate the heritability factor of IQ in the range of .29-.42; this is significantly lower than the estimate that results from the twin studies (when the correlation of the cultural environment of the twins is disregarded) which, as we have seen, is .72.

6 Conclusions

In this paper we aimed at demonstrating, simply by means of examples, that the empirical analysis of the determination of preferences and of cognitive and psychological traits is possible with the existing survey data that sociologist and economists have been collecting e.g., on attitudes and beliefs; and with the data on familial correlations of psychological and cognitive traits available in the literature.

We believe such analysis to be important for their policy implications on a range of issues, from immigration and assimilation to the effectiveness of early age educational programs, and to narrow down the answers to important debates in the social science which are too often dealt with on a ideological basis, like the nature/nurture debate or the debate on the relevance of rational choice theory.

While recently the transmission model introduced in this paper has been used to study several preference traits e.g., the transmission of attitudes towards corruption (Hauk-Saez Mart' (2002)), attitudes towards gender discrimination (Escriche (2002)), or male attitudes towards educated and working women (Fernandez-Fogli-Olivetti (2002)), many important issues are left to study, in particular in the realm of psychological characteristics, like the ability to self-control, and more generally to self-regulate.

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TABLE 1

Intermarriage Rates across Religions*

	Protestants	Catholics	Jews	Others
Protestants	0.8791	0.0731	0.0039	0.0439
Catholics	0.1586	0.7894	0.0049	0.0472
Jews	0.0669	0.0814	0.8198	0.032
Others	0.3128	0.1564	0.0171	0.5137

*: Each cell IK reports the sample probability that an individual of religion I marries an individual of religion K, in the US.

TABLE 2

Socialization Probabilities for Selected Marriage Types

	Protestants	Catholics	Jews	Others
PP Marriage	0.9179	0.0284	0	0.0537
CC Marriage	0.0850	0.8571	0.0034	0.0544
JJ Marriage	0.0370	0	0.9259	0.0370
OO Marriage	0.3231	0.0462	0	0.6308
PC Marriage	0.5116	0.3140	0	0.1744
PO Marriage	0.7100	0.1000	0	0.1900
CO Marriage	0.1667	0.5000	0	0.3333

Each cell reports the sample probability that a child in the row marriage is a member of the column religious group.

P = Protestants; C = Catholics; J = Jews; O = Others.

TABLE 3

Familial correlations in IQ from Bouchard & McGue (1981).

Relationship	Symbol	Number of Pairs	Correlation
MZ Twins (Together)	MZT	4672	0.86
MZ Apart	MZA	65	0.72
DZ Twins (Together)	DZT	5546	0.60
Sibs (Together)	SST	26473	0.47
Sibs Apart	SSA	203	0.24
Adopted/Biological Sibs	SFB	345	0.29
Adopted/Adopted Sibs	SFF	369	0.34
Half Sibs	HSS	200	0.31
Offspring-Parent	OPT	8433	0.42
Offspring-Midparent	OMT	992	0.50
Midoffspring-Midparent	MMT	410	0.72
Offspring-Parent Apart	OPA	814	0.22
Foster Offspring-Parent	FOP	1397	0.19
Foster Offspring-Midparent	FOM	758	0.24
Cousins	CZl	1176	0.15
Spouses	m	3817	0.33