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Genetic and Environmental Parent–Child Transmission of Value Orientations: An Extended Twin Family Study

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Despite cross-cultural universality of core human values, individuals differ substantially in value priorities, whereas family members show similar priorities to some degree. The latter has often been attributed to intrafamilial socialization. The analysis of self-ratings on eight core values from 399 twin pairs (ages 7–11) and their biological parents (388 mothers, 249 fathers; ages 26–65) allowed the disentanglement of environmental from genetic transmission accounting for family resemblance in value orientations. Results indicated that parent–child similarity is primarily due to shared genetic makeup. The primary source of variance in value priorities represented environmental influences that are not shared by family members. These findings do not provide evidence for parental influences beyond genetic influences contributing to intrafamilial similarity in value priorities.

The term *value* is commonly used to describe evaluations of the worth of more abstract entities (Saucier, 2013). It can be defined as a relatively stable standard, principle, or belief that serves as a guide to cope successfully with the requirements of human life (Rokeach, 1973). Values can vary in importance between individuals and help to explain individual differences in specific attitudes, everyday decisions, and behavior in general.

Universal Structure of Basic Values

Schwartz (1992) proposed a comprehensive set of 10 basic values that have been identified across sexes as well as different societies, languages, age groups, and cultures (Bilsky, Janik, & Schwartz, 2011; Davidov, Schmidt, & Schwartz, 2008; Schwartz, 2006). These basic values can be arranged in a circular two-dimensional value space (see Figure 1) that portrays that some values are compatible and statistically associated (e.g., conformity and security), whereas others conflict with one another and are negatively correlated (e.g., conformity and self-direction).

The circular value structure can be described economically with two orthogonal core dimensions: openness to change versus conservation and self-transcendence versus self-enhancement (Schwartz, 1994). Openness to change values (self-direction and stimulation) encompass strivings for autonomy and growth as well as advocating new ideas and change, whereas conservation values (conformity, tradition, and security) emphasize self-restriction, order, protection of the status quo, and resistance to change. Self-transcendence values (benevolence and universalism) emphasize interests and welfare of other people, whereas self-enhancement values (power and achievement) encompass pursuing one's own interests, goals, and dominance over others.

This value model has been validated in a large number of studies using different measurement instruments and data from different countries and adult age groups, providing a high level of consensus regarding the structure of these values across cultures and age (Schwartz, 2012). Therefore, these values are widely considered universal among humans.

Developmental Perspective on the Universal Structure of Values

The consistent findings on the universality of human values were primarily based on adult samples, raising the question of what point in life individual values are established. From a

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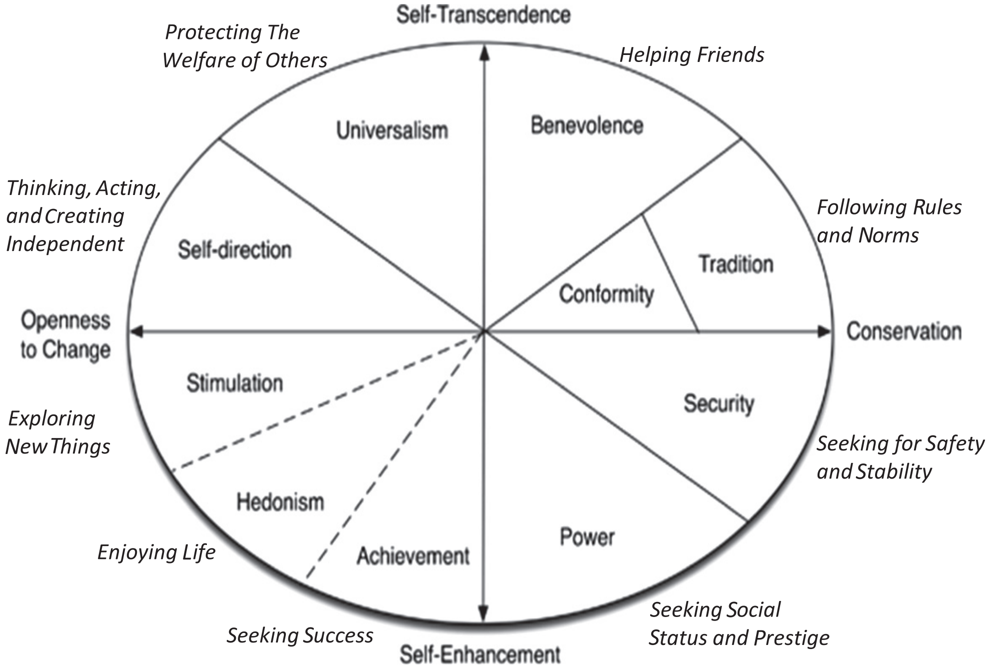

Figure 1. Schwartz's (1992) model of universal human values.

developmental perspective, McAdams (2015; see also McAdams, 2013; McAdams & Olson, 2010) proposed that around ages 7–8 a second layer of personality begins to form, called the *agentic self* (layered over dispositional traits such as temperament characteristics, called the "social actor").

> Developmental research shows that even babies act to achieve momentary needs. But it is not until the grade-school years that children begin to organize their daily lives and their future dreams in terms of self-chosen goals, values, plans, and projects. (McAdams, 2015, p. 6)

According to this perspective, children begin to articulate their own goals, motives, interests, attitudes, and value priorities (i.e., what a person wants and values) when they are primary school aged.

Even though several studies have investigated values in adolescence (e.g., Barni & Knafo, 2012; Cieciuch, Döring, & Harasimczuk, 2013; Daniel et al., 2012), the study of value structures and priorities in middle childhood is still in its early phase. The few existing studies that were conducted based on the conceptual framework of universal human values have found only slight differences in the structure of values between the ages 7 and 12 (Bilsky et al., 2013; Döring, Blauensteiner, Aryus, Drögekamp, & Bilsky, 2010) and a recent study of the structure of children's (aged 7–11) broader values revealed patterns similar to those of adults (Döring et al., 2015).

Developmental Perspective on Individual Differences in Value Priorities

Despite the universality of basic values, individuals differ substantially in their value priorities (Schwartz, 2011). That is, the importance people ascribe to certain values as guiding principles in their lives varies substantially among individuals, providing some guidance for individual differences in behavior. Thus, they can be described as personality characteristics and as elements of the individual self-perception and social reputation (Bilsky & Schwartz, 1994; Eder, 1989, 1990; Kandler, Zimmermann, & McAdams, 2014).

The development of individual differences in value priorities has often been hypothesized to be due to environmental sources, such as cultural influences, social and learning contexts, and individual life experiences (Bandura & Walters, 1963; Rogers & Freiberg, 1993; Schwartz, 2011). In fact, studies have found evidence for those influences (e.g., Bardi, Lee, Hofmann-Towfigh, & Soutar, 2009; Maio, Pakizeh, Cheung, & Rees, 2009; Schwartz & Rubel-Lifschitz, 2009). In addition, studies on parent–child similarity in value orientations provided support for value socialization in families, which in turn increases the similarity of siblings regarding value priorities (Barni & Knafo, 2012; Knafo & Schwartz, 2001, 2008; Roest, Dubas, & Gerris, 2009). That is, the development of individual differences in value orientations may be due to different intrafamilial socialization.

Parent–child resemblance and the similarity of siblings can also be a result of genetic similarity due to the genetic relatedness of biological family members. Twin studies have found evidence for both genetic and environmental influences accounting for the twin similarity in values (Knafo & Spinath, 2011; Renner et al., 2012; Schermer, Feather, Zhu, & Martin, 2008). Thus, genetic sources as well as familial influences may account for the development of individual differences in children's value priorities.

Aims of the Current Study

Because studies solely relying on data of twins cannot disentangle genetic from environmental parent–offspring similarity, it is largely unknown to what degree parent–child transmission of value priorities is genetically and (or) environmentally mediated. The current study bridges this gap by investigating the nature of family resemblance in eight basic human values and two core value dimensions on the basis of an extended twin family study (also known as nuclear twin family design [NTFD]; Keller, Medland, & Duncan, 2010), which included data from twins and their parents. This design allows a disentanglement of genetic from environmental transmission between parents and their offspring.

The NTFD also takes spouse similarity of twins' parents regarding value priorities into account. Although spouse similarity has not been found for some values, such as power and achievement, it seems to be at least moderate for others, such as tradition and conformity (Watson et al., 2004). Spouse similarity may reflect assortative mating, which has to be considered in twin family studies of value orientations because it may not only be due to shared social backgrounds (i.e., social homogamy) but may also be attributable to the genetic similarity of spouses because of active assortment (Kandler, Bleidorn, & Riemann, 2012). This source of nonrandom mother–father similarity would act to increase the genetic and, as a consequence, the observable similarity between parents and offspring as well as within siblings except for monozygotic (MZ) twins who are genetically identical. Because genetic influences are indicated when MZ twins are more similar than other first-degree relatives and estimates of shared environmental contributions increase with decreasing differences in the similarity between MZ twins and other first-degree relatives, environmental influences shared by family members could be overestimated if assortative mating is not taken into account.

In addition, the NTFD design allows estimates of the contributions of a specific form of gene–environment interplay: passive genotype–environment correlation (i.e., association between parents' genetic makeup and twins' shared parental environments; Scarr & McCartney, 1983). This is an important extension to classical twin studies, because the latter cannot take associations between genetic influences and environmental influences shared by twins into account.

Finally, the NTFD extends the classical twin design with regard to the analysis of contributions of shared environmental influences or nonadditive genetic effects to the similarity of siblings beyond parent–child transmission. Siblings may share environments beyond parental influences, enhancing their similarity in comparison to the parent–child similarity. Alternatively, shared nonadditive genetic influences may act to increase siblings' similarity. Additive genetic influences can be shared by family members as a function of their genetic relatedness, whereas nonadditive genetic influences can only be shared by siblings to the degree of the probability they can share genetic dominance effects (genetic dominance effects within gene loci: 100% for MZ and 25% for dizygotic (DZ) twins; genetic dominance effects between gene loci: 100% for MZ twins and 0% for DZ twins).

In sum, the current study investigated family resemblance in value orientations and the sources of variance in value priorities of primary school-aged children, a time in which value orientations emerge and children begin to articulate their own value priorities. The study examined the contributions of additive and nonadditive genetic differences, environmental transmission from parents to offspring, siblings' shared environmental influences beyond parents' influence, passive genotype–environment correlation, and individual-specific environmental influences not shared by core family members.

Method

Participants and Procedure

The sample was drawn from the first wave of the German twin study on Cognitive Ability, Self-Reported Motivation, and School Achievement conducted in 2005 (CoSMoS; Hahn, Gottschling, & Spinath, 2013). Contact information of the twin families was obtained through individual inquiries from registration offices of two German federal states (North Rhine-Westphalia and Thuringia). Families were contacted by phone or mail and parents provided informed consent prior to the participation of the twin family. A set of questionnaires including a measure on value priorities was mailed to the families (see Spinath & Wolf, 2006, for more details on the recruitment procedure).

Participants were 805 twin siblings (50% girls) including 138 complete MZ and 261 complete DZ twin pairs. The sample consisted of 77 (19%) male and 61 (15%) female MZ twin pairs, 58 (14%) male and 75 (19%) female DZ pairs, 128 (32%) opposite-sex DZ pairs, and 7 (1%) unmatched twin siblings. Twins were between 7 and 11 years old (M = 9.08, SD = 0.81). In addition, data from 388 biological mothers and four stepmothers (97%; ages 26–51, M = 39.82, SD = 4.29) and 249 biological fathers and 38 stepfathers (71%; ages 29–65, M = 42.40, SD = 5.17) were available. The socioeconomic status distribution (upper middle class: 26%; middle class: 64%; lower middle class: 10%) was comparable across zygosity, sex, and age groups.

Measurement Instrument

Even though the configuration of values may be different between the life stages, the differential structure of values is observable from an early age (Bilsky, Niemann, Schmitz, & Rose, 2005; Bubeck & Bilsky, 2004). A reduced German version of the Portrait Values Questionnaire (Schmidt, Bamberg, Davidov, Herrmann, & Schwartz, 2007; Schwartz, 2006), which was designed to assess 10 basic values in children and adults, was used in the present study. Since universalism and benevolence as well as traditionalism and conformity values conceptually and empirically overlap and since benevolence and conformity can be treated as more basic for children (Bilsky et al., 2005), the items capturing universalism and traditionalism were removed from the children's set of questionnaires to avoid children's overload. This item reduction left eight basic human values captured with 30 items (of the original 40). Each item describes a person's aspiration to one particular value (i.e., portrait; see Table 1). For each portrait, respondents were asked, "How much like you is this person?" The scale ranged from 1 (*not like me at all*) to 6 (*very much like me*).

Each value score was computed by averaging its indicative items (see Table 2 for descriptive statistics). Internal consistency based on McDonald's omega (McDonald, 1999) was on average ω = .71 for children's scores (ranging from ω = .61 for self-direction to ω = .80 for benevolence) and ω = .72 for parents' scores (ranging from ω = .63 for self-direction to ω = .81 for achievement). In addition, the scale scores were centered on the individual mean rating across the 30 items given by each participant (Schwartz, 1992). Consistent with previous studies (Döring et al., 2015; Schwartz & Bardi, 2001), both parents and children attributed

Table 1
Eight Basic Human Values: Definitions and Item Examples

Basic values	Item examples
Benevolence reflects the priority of caring for the welfare of related people and in-group members.	It is very important to him/her to help the people around him/her. He/she wants to care for other people. (4)
Conformity expresses restraints of actions, inclinations, and impulses to upset others and compliance with social expectations or norms.	It is important to him/her to be polite to other people all the time. He/she tries never to disturb or irritate others. (4)
Security represents the pursuit of personal safety and societal stability.	He/she tries hard to avoid getting sick. Staying healthy is very important to him/her. (5)
Power reflects the importance of social status and prestige, dominance over others, and control of material resources.	It is important to him/her to be in charge and tell others what to do. He/she wants people to do what he/she says. (3)
Achievement refers to pursuing personal success through demonstrating performance and competence according to social standards.	Being very successful is important to him/her. He/she likes to impress other people. (4)
Hedonism represents the priority of pleasure, satisfaction, and sensuous gratification for oneself.	He/she seeks every chance he/she can to have fun. It is important to him/her to do things that give him/her pleasure. (3)
Stimulation can be defined as pursuit of excitement, novelty, and challenge in life.	He/she likes to take risks. He/she is always looking for adventures. (3)
Self-direction reflects the importance of autonomy of thought and action (i.e., choosing, creating, and exploring).	It is important to him/her to make his own decisions about what he/she does. He/she likes to be free to plan and to choose his/her activities for himself/herself. (4)

Note. The number of items for each value is indicated in parentheses.

Table 2
Eight Basic Human Values: Descriptive Statistics

	Twin a		Twin b		Mother		Father	
Variables	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Raw scale scores								
Benevolence	4.75	0.91	4.79	0.91	4.61	0.63	4.49	0.61
Conformity	4.04	1.04	4.01	1.06	3.85	0.81	3.86	0.81
Security	4.26	0.93	4.27	0.93	4.33	0.74	4.33	0.69
Power	2.38	1.18	2.37	1.16	2.43	0.90	3.03	0.97
Achievement	3.30	1.09	3.30	1.12	3.05	0.97	3.54	0.93
Hedonism	4.78	0.93	4.83	0.92	3.58	1.00	3.63	0.96
Stimulation	4.37	1.04	4.40	1.08	3.79	0.92	4.01	0.92
Self-direction	4.09	0.93	4.08	0.98	4.37	0.80	4.46	0.65
Centered scale scores								
Benevolence	0.75	0.66	0.78	0.70	0.86	0.63	0.59	0.60
Conformity	0.04	0.78	0.00	0.79	0.10	0.74	−0.06	0.73
Security	0.26	0.62	0.26	0.64	0.57	0.65	0.41	0.61
Power	−1.61	1.03	−1.63	1.04	−1.32	0.70	−0.89	0.78
Achievement	−0.70	0.78	−0.70	0.80	−0.70	0.68	−0.37	0.69
Hedonism	0.79	0.60	0.83	0.62	−0.17	0.74	−0.28	0.73
Stimulation	0.38	0.70	0.39	0.81	0.04	0.67	0.09	0.74
Self-direction	0.10	0.59	0.07	0.67	0.62	0.63	0.57	0.59

Note. The descriptive statistics were separately calculated for Twin a (n = 403) and Twin b (n = 402) subsamples as well as for mothers (n = 392) and fathers (n = 287).

more importance to benevolence and lowest importance to power. However, children rated hedonism and stimulation as more important, parents evaluated self-direction and power values as more important (see also age effects).

Preliminary Analyses

Multidimensional Scaling

Since multidimensional scaling (MDS) has been used in most previous studies on the value structure, MDS analyses (with the PROXSCAL module of SPSS; Levesque, 2007) were run in the present study to determine the number (n) of dimensions necessary to describe similarities (i.e., correlations) between scale scores as distances in an n-dimensional space: The higher the correlation between two values, the lower their distances in the space. The analyses were performed separately for different subsamples (i.e., Twin a, Twin b, mothers, and fathers). Consistent with previous studies, the scree plot consistently yielded two dimensions for all subsamples and the goodness of fit for the two-dimensional solution was satisfactory, ranging between $STRESS_1 = 0.096$ (Twin a) and $STRESS_1 = 0.158$ (mothers). The two-dimensional structure was quite similar for the children and their parents, and in accordance with Schwartz's proposed circular value structure with the exception of the localization of hedonism values (cf. Figure 2a and b).

Principal Component Analyses

Principal component analyses of centered scale scores with varimax rotation yielded similar results for the Twin a, Twin b, mother, and father subsamples (see Table 3). Eigenvalues dropped off markedly after two large values (for the complete sample: 2.31, 1.80, 1.12, 0.84 . . .; Cattell, 1966). The minimum average partial test (O'Connor, 2000) also indicated a two-component solution. The two resulting dimensions accounted for 52% of the variance and can be interpreted as openness to change (self-direction and stimulation) versus conservation (conformity and security) and self-transcendence (benevolence) versus self-enhancement (power and achievement). Individual factor scores on these dimensions were used in subsequent analyses. Factor scores were calculated using the Anderson–Rubin method (Anderson & Rubin, 1956). This procedure guarantees orthogonality of the two dimensions.

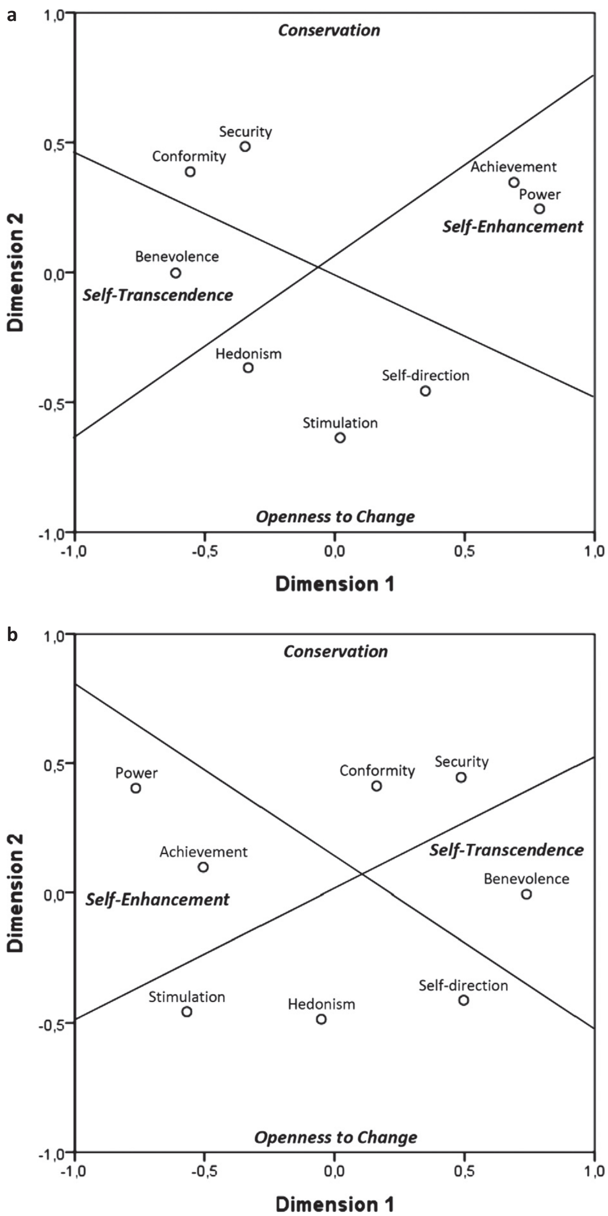

Figure 2. Two-dimensional circular value structure for (a) children (N = 805) and (b) parents (N = 679) based on multidimensional scaling: centroid configuration. Solid lines separate regions of higher order values; Dimension 1 can be interpreted in terms of self-enhancement versus self-transcendence (mirrored inversion for the parents' data) and Dimension 2 as conservation versus openness to change.

Sex and Age Differences in Value Priorities

Previous studies have reported sex and age differences in value priorities (Schwartz & Rubel, 2005; Schwartz & Rubel-Lifschitz, 2009). Table 4 shows sex and age effects for children and parents separately as well as for the complete sample. Consistent with previous studies, females rated benevolence values higher than males, whereas males attributed more importance to power and achievement. Sex differences were rather small and did not vary markedly between parents and their children. Even though age differences were rather marginal within children and parents, moderate to substantial differences between parents and their offspring were found for specific value priorities. Although, parents valued self-direction, power, and security as more important, children rated hedonism and stimulation higher. As sex and age differences can affect the similarity between two specific family members, biasing the estimates of genetic and environmental contributions, individual scores were corrected for those effects using a regression procedure (McGue & Bouchard, 1984). Standardized residuals from these regressions were used for genetically informative twin family analyses.

Main Analyses

Similarity between biological family members was illustrated via correlations based on both uncorrected value scores and scores corrected for sex and age differences. Subsequently, structural equation modeling (SEM) on the basis of the statistical software package Amos (Arbuckle, 2009) was used to analyze family resemblance (i.e., variance–covariance matrices) in value priorities employing the full information maximum likelihood algorithm (FIML; Little & Rubin, 2002). The FIML procedure is useful for handling missing values (in particular, fathers' value scores in the present study). The missing completely at random test (Little, 1988) indicated that missing values could be assumed to be randomly distributed (χ^2 = 379.82, df = 410, p = .86).

Results

Family Correlations

Family correlations represent the similarity among family members regarding the values of interest and are shown for both uncorrected value scores and scores corrected for sex and age differences (see Table 5). The correlations between genetically identical MZ twins were generally larger compared to the correlations among other first-degree relatives (i.e., DZ twins, mother–offspring, and father–offspring) who share on average 50% of genes that can vary among humans. This pattern of similarity indicates a genetic contribution to individual differences in value priorities. In addition,

Table 3
Principal Component Analyses Results: Factor Loadings and Eigenvalues

	Twin a (n = 403)		Twin b (n = 402)		Mothers (n = 392)		Fathers (n = 287)	
Variables	ST–SE	OC–CO	ST–SE	OC–CO	CO–OC	ST–SE	ST–SE	CO–OC
Benevolence	**0.69**	−0.20	**0.72**	−0.25	0.15	**0.64**	**0.52**	0.16
Conformity	0.38	**−0.69**	0.34	**−0.71**	**0.71**	0.37	0.39	**0.72**
Security	0.21	**−0.64**	0.23	**−0.73**	**0.73**	0.28	0.04	**0.77**
Power	**−0.84**	0.14	**−0.86**	0.06	0.07	**−0.80**	**−0.81**	−0.08
Achievement	**−0.77**	−0.01	**0.81**	0.00	0.03	**−0.79**	**−0.78**	−0.07
Hedonism	**0.52**	0.25	**0.45**	0.21	**−0.47**	0.24	**0.44**	−0.28
Stimulation	0.31	**0.58**	0.31	**0.75**	**−0.76**	−0.08	0.35	**−0.76**
Self-direction	0.08	**0.65**	0.12	**0.60**	**−0.46**	0.22	−0.07	−0.36
Eigenvalues	2.45	1.65	2.51	1.93	2.37	1.70	2.13	1.82
Expl. variance (%)	30.67	20.61	31.37	24.17	29.64	21.29	26.59	22.73

Note. Factor loadings > 0.40 are marked in bold. ST–SE = self-transcendence versus self-enhancement; OC–CO = openness to change versus conservation; CO–OC = conservation versus openness to change.

Table 4
Sex and Age Differences in Value Priorities

	Sex effects			Age effects		
Variables	Children (n = 805)	Parents (n = 679)	All (N = 1,484)	Children (n = 805)	Parents (n = 679)	All[a] (N = 1,484)
Value domains						
Benevolence	−.26**	−.25**	−.25**	−.02	.01	−.04
Conformity	−.10*	−.10*	−.10**	−.10*	−.08	.01
Security	−.04	−.12*	−.09*	−.09	.02	.19**
Power	.13**	.28**	.16**	.01	.14**	.26**
Achievement	.15**	.23**	.18**	.03	.04	.09*
Hedonism	.04	−.08	.03	.05	−.23**	−.60**
Stimulation	.04	.04	.06	.02	.01	−.21**
Self-direction	−.06	−.04	−.07*	.09*	.11*	.38**
Core dimensions						
ST–SE	−.19**	−.31**	−.21**	−.05	−.12*	−.25**
OC–CO	.05	.02	.06	.09	−.06	−.39**

Note. Sex codes: 0 = female 1 = male. ST–SE = self-transcendence versus self-enhancement; OC–CO = openness to change versus conservation.
[a]Age effects for the complete sample were estimated on the basis of differences between children (0) and parents (1).
*p < .01. **p < .001.

the correlations between different relatives were lower than r = .50, indicating a large contribution of individual environmental influences that are not shared by family members and, thus, act to decrease the similarity among them. Even though the mother–girl correlation for benevolence and the father–boy link for self-direction tended to be larger compared to other parent–child dyads, the level of correlations did not vary markedly across different parent–child dyads. Spouse correlations between mothers and fathers were significant for value priorities indicating assortative mating except for benevolence, power, achievement, and self-direction.

Nuclear Twin Family Modeling

SEM of twins' and their parents' data (see Figure 3 and Table 6) allows for estimates of additive (a^2) and nonadditive (d^2) genetic contributions to

Table 5
Family Correlations

Variables	Twin correlations MZT$_{SS}$ (n = 138)	DZT$_{SS}$ (n = 132)	DZT$_{OS}$ (n = 128)	Mother–Child Girls[a] (n = 198)	Boys[a] (n = 190)	Father–Child Girls[a] (n = 120)	Boys[a] (n = 129)	Mother–Father (n = 239)
Benevolence	.50 (.45)**	.17 (.12)*	.04 (.09)	.19 (.20)**	.13 (.14)*	.10 (.10)	−.02 (−.01)	.02 (.03)
Conformity	.40 (.39)**	.22 (.21)*	.16 (.17)*	.10 (.11)	.08 (.09)	.13 (.12)	.05 (.06)	.17 (.18)**
Security	.19 (.19)*	.14 (.15)	.12 (.12)	.10 (.11)	.14 (.15)*	.16 (.17)	.15 (.16)	.24 (.24)**
Power	.41 (.40)**	.18 (.17)*	.25 (.30)**	.14 (.15)*	.18 (.18)**	.13 (.13)	.19 (.20)*	.12 (.13)
Achievement	.49 (.47)**	.04 (.03)	.20 (.22)*	.11 (.11)	.18 (.18)**	.10 (.08)	.12 (.11)	.12 (.11)
Hedonism	.25 (.26)**	.20 (.20)*	.14 (.15)	.05 (.05)	.06 (.06)	.05 (.06)	.11 (.11)	.25 (.21)**
Stimulation	.26 (.26)**	.21 (.21)*	.16 (.17)*	.10 (.09)	.12 (.11)	.16 (.16)	.10 (.11)	.25 (.28)**
Self-direction	.38 (.37)**	.19 (.19)*	.24 (.26)**	.13 (.14)*	.13 (.13)	.14 (.12)	.23 (.24)**	.10 (.09)
ST-SE	.47 (.45)**	.19 (.16)*	.25 (.29)**	.14 (.12)*	.19 (.22)**	.14 (.11)	.15 (.20)*	.13 (.19)**
OC-CO	.40 (.39)**	.17 (.18)*	.22 (.22)*	.09 (.10)	.16 (.17)*	.15 (.18)*	.07 (.14)	.23 (.22)**

Note. The correlations are based on all biological family members; correlations based on variables corrected for age and sex effects are shown in parentheses. MZT$_{SS}$ = same-sex monozygotic twin pairs; DZT$_{SS}$ = same-sex dizygotic twin pairs; DZT$_{OS}$ = opposite-sex dizygotic twin pairs; ST-SE = self-transcendence versus self-enhancement; OC-CO = openness to change versus conservation.
[a]One twin of a pair was randomly assigned.
*p < .05. **p < .01.

the variance. The model also allows for different environmental contributions to the variance. These components include influences from mothers (m^2), fathers (f^2), and both ($2mf\mu$), as well as environmental influences shared by twins beyond parental influences (c^2) and individual-specific environmental influences not shared by twins (e^2; including error of measurement). However, the model does not only disentangle the genetic ($a^2 + d^2$) from environmental contributions ($c^2 + m^2 + f^2 + 2mf\mu + e^2$) to individual differences, but also allows for an estimation of the contribution of the covariance between parents' genetic makeup and offspring's shared parental environments, known as passive genotype–environment correlation: $a^2m(1 + \mu) + a^2f(1 + \mu)$.

As can be seen in Table 6, the parent–child covariance can be disentangled into a genetic ($\frac{1}{2}a^2$ [$1 + \mu$]) and an environmental ($m + \mu f$ for mother–child covariance and $f + \mu m$ for father–child covariance) component. Since the model takes spousal correlation into account (i.e., assortative mating, μ), it can be facilitated if assortative mating is negligible.

Sibling-specific shared environmental influences (c) may contribute to twins' similarity. However, larger similarity within twin pairs compared to the parent–offspring similarity may also be due to nonadditive genetic influences (d) that can be shared to some degree by siblings but not between parents and their offspring. Nonadditive genetic influences are indicated when DZ twin correlations are less than half the MZ twin correlations, as was the case for benevolence and achievement (see Table 5). Since nonadditive genetic and sibling-specific shared environmental influences cannot be estimated in the presence of each other within the current design, two alternative models were tested: One model allowed for c effects ($d = 0$) and the other model allowed for d effects (assuming genetic dominance effects between gene loci) instead of c effects ($c = 0$). In addition, more parsimonious models in which all insignificant effects were dropped have been tested.

The results of the NTFD modeling are depicted in Tables 7 and 8. The NTFD models provided at least acceptable model fit, as indicated by the root mean square error of approximation (RMSEA) ≤ .060 (Hu & Bentler, 1999; Steiger, 1990). Only in the case of hedonism did additional fit indices weaken (significant χ^2 and comparative fit index < .90; Bentler, 1990; Hu & Bentler, 1999). The best and most parsimonious models, as indicated by the smallest expected cross-validation index ECVI (Browne & Cudeck, 1993), provided the basis to describe genetic and environmental effects.

The models yielded significant genetic effects (a) contributing to the parent–child and siblings' similarity for all value priorities except for *security*. The effects were moderate to substantial, ranging between $a = .35$ for hedonism and $a = .69$ for self-transcendence. Beyond the genetic contributions to the parent–offspring similarity, the environmentally mediated maternal (m) and paternal (f) effects were rather small and mostly statistically negligible.

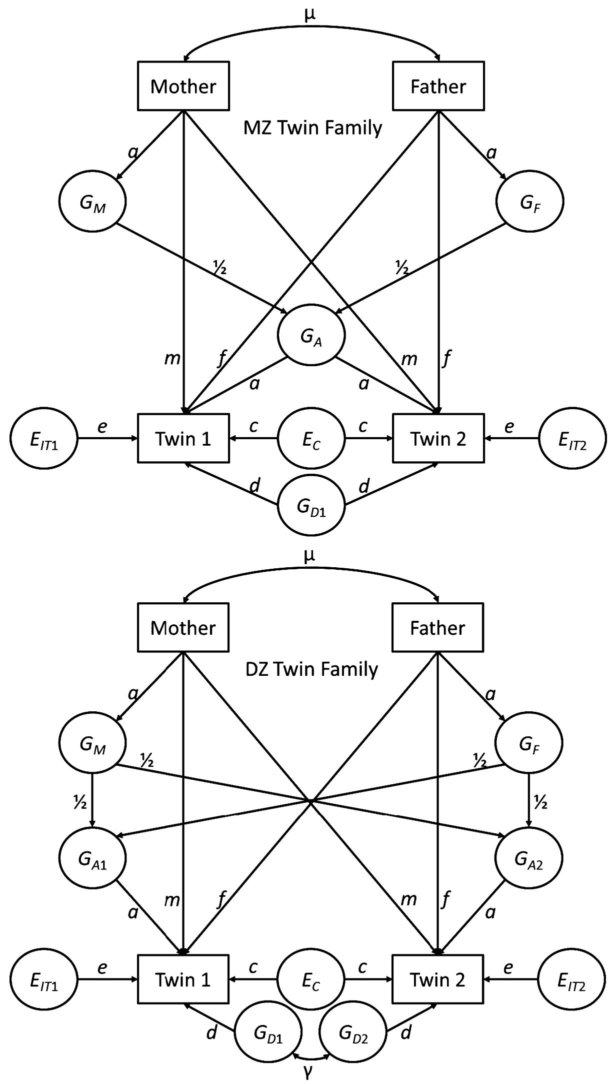

Figure 3. Nuclear twin family model for monozygotic (MZ) and dizygotic (DZ) twins: G = genetic factors; E = environmental factors; a = additive genetic effects; m = environmental transmission from mother to offspring; f = environmental transmission from father to offspring; c = sibling-specific shared environmental effects; e = environmental effects not shared by twins (including measurement error); μ = phenotypic spouse similarity; d = nonadditive genetic effects; γ = genetic correlation due to genetic dominance effects shared by twins; latent factor variances were fixed to one.

Environmental effects shared by twins primarily manifested via sibling-specific shared environments (c), while individual-specific environmental effects including error of measurement (e) represented the major environmental source for all variables, ranging between e = .73 for self-transcendence and e = .92 for security (see Table 7).

Individual differences in value priorities were primarily attributable to genetic variance (h^2) and nonshared environmental influences (e^2), whereas

Table 6
Model of Twins Reared Together and Twins' Parents

Phenotypic statistics	Variance decomposition
Variance	$a^2 + d^2 + m^2 + f^2 + c^2 + 2mf\mu + a^2m(1 + \mu) + a^2f(1 + \mu) + e^2$
Monozygotic twin covariance	$a^2 + d^2 + m^2 + f^2 + c^2 + 2mf\mu + a^2m(1 + \mu) + a^2f(1 + \mu)$
DZ twin covariance	$\frac{1}{2}a^2(1 + \mu) + \gamma d^2 + m^2 + f^2 + c^2 + 2mf\mu + a^2m(1 + \mu) + a^2f(1 + \mu)$
Parent covariance	μ
Mother–twin covariance	$\frac{1}{2}a^2\ (1 + \mu) + m + \mu f$
Father–twin covariance	$\frac{1}{2}a^2\ (1 + \mu) + f + \mu m$

Note. a = additive genetic effects; d = nonadditive genetic effects; c = sibling-specific shared environmental effects; e = environmental effects not shared by twins (including measurement error); μ = phenotypic assortative mating; m = maternal transmission; f = paternal transmission; γ = nonadditive genetic correlation between dizygotic (DZ) twins (0.25 for dominance effects within gene loci and 0 for dominance effects between gene loci).

variance due to environmental parent–child transmission shared by siblings ($m^2 + f^2 + 2mf\mu$) was negligible (see Table 8). After correction for attenuation due to error of measurement (based on internal consistency estimates for the complete sample), genetic influences accounted for about a third and nonshared environmental influences explained about a half of individual differences in value priorities.

Discussion

This study investigated the nature of family resemblance in eight basic values and two core value dimensions on the basis of a NTFD. Our results indicated that parent–child similarity in value priorities is primarily due to their shared genetic makeup instead of environmental parent–child transmission. However, the primary source of individual differences in value priorities represents individual environmental influences not shared by core family members.

Genetic influences accounted for at least half of the variance in benevolence, achievement, and self-direction values. By and large, these results validate previous findings from studies on adult twins that have shown moderate to substantial genetic contributions to individual differences in overall and domain-specific values. For example, achievement, autonomy, and self-directedness value orientations

Table 7
Nuclear Twin Family Model Fitting Results: Fit Statistics and Standardized Path Coefficient Estimates

	Fit statistics					Standardized effects						
Variables	χ^2 (*df*)	*p*	CFI	RMSEA	ECVI	*a*	*d*	μ	*m*	*f*	*c*	*e*
Value domains												
Benevolence												
d = 0	12.55 (13)	.48	1.00	0.000	0.107	.65*		.02	.03	−.10	.00	.77*
c = 0	12.12 (13)	.52	1.00	0.000	0.106	.55*	.35†	.02	.09	−.06		.76*
μ = *f* = *c* = 0	12.89 (15)	.61	1.00	0.000	0.098	.42*	.48*		.10†			.76*
Conformity												
d = 0	19.75 (13)	.10	0.847	0.036	0.125	.53*		.19*	.01	−.02	.33*	.78*
c = 0	21.06 (13)	.07	0.818	0.040	0.129	.66*	.00	.19*	−.04	−.05		.77*
d = *m* = *f* = 0	19.83 (15)	.18	0.891	0.028	0.115	.52*		.19*			.34*	.79*
Security												
d = 0	11.03 (13)	.61	1.00	0.000	0.103	.15		.25*	.10†	.13†	.32*	.92*
c = 0	12.10 (13)	.52	1.00	0.000	0.106	.40*	.00	.25*	.05	.09		.90*
a = *d* = 0	11.05 (15)	.68	1.00	0.000	0.098			.25*	.10*	.13*	.34*	.92*
Power												
d = 0	10.08 (13)	.69	1.00	0.000	0.101	.46*		.14*	.11†	.11†	.36*	.77*
c = 0	12.04 (13)	.52	1.00	0.000	0.106	.62*	.00	.14*	.05	.03		.77*
Achievement												
d = 0	16.75 (13)	.22	0.928	0.026	0.117	.69*		.11	.01	−.05	.00	.74*
c = 0	16.03 (13)	.25	0.939	0.024	0.116	.57*	.37†	.11	.05	−.01		.73*
μ = *m* = *f* = *c* = 0	18.34 (16)	.30	0.950	0.019	0.107	.62*	.30†					.73*
Hedonism												
d = 0	29.52 (13)	.01	0.674	0.057	0.150	.31†		.21*	.02	.00	.38*	.87*
c = 0	31.29 (13)	.00	0.606	0.060	0.154	.53*	.00	.21*	−.03	−.06		.86*
d = *m* = *f* = 0	29.66 (15)	.01	0.744	0.050	0.140	.35*		.21*			.36*	.87*
Stimulation												
d = 0	11.65 (13)	.56	1.00	0.000	0.105	.35†		.26*	.04	.05	.37*	.86*
c = 0	13.51 (13)	.41	0.983	0.010	0.110	.56*	.00	.26*	−.01	.00		.83*
d = *m* = *f* = 0	12.45 (15)	.65	1.00	0.000	0.097	.48*		.27*			.30*	.83*
Self-direction												
d = 0	10.67 (13)	.64	1.00	0.000	0.102	.57*		.08	.02	.10†	.21	.77*
c = 0	10.91 (13)	.62	1.00	0.000	0.103	.63*	.00	.08	.00	.08		.76*
μ = *d* = *m* = *c* = 0	12.28 (16)	.73	1.00	0.000	0.091	.63*				.09†		.76*
Core dimensions												
Self-transcendence versus self-enhancement												
d = 0	7.01 (13)	.90	1.00	0.000	0.093	.58*		.19*	.05	.03	.27	.75*
c = 0	7.70 (13)	.86	1.00	0.000	0.095	.67*	.00	.20*	.02	.01		.74*
d = *m* = *f* = *c* = 0	7.95 (16)	.95	1.00	0.000	0.080	.69*		.20*				.73*
Openness to change versus conservation												
d = 0	11.43 (13)	.58	1.00	0.000	0.104	.58*		.22*	.01	.03	.23	.77*
c = 0	11.74 (13)	.55	1.00	0.000	0.105	.65*	.00	.22*	−.01	.01		.77*
d = *m* = *f* = *c* = 0	11.82 (16)	.76	1.00	0.000	0.090	.64*		.22*				.77*

Note. RMSEA = root mean square error of approximation; *d* = 0: initial model without nonadditive genetic effects; *c* = 0: an alternative initial model allowing for nonadditive genetic effects instead of twin-specific shared environmental influences provided a better model fit for benevolence and achievement; the last row for each variable shows parameters of the model with the best parsimony–fit relation; *a* = additive genetic effects; *d* = nonadditive genetic effects; μ = phenotypic spouse similarity; *m* = environmental transmission from mother to offspring; *f* = environmental transmission from father to offspring; *c* = sibling-specific shared environmental effects; *e* = environmental effects not shared by twins (including measurement error).
$^{\dagger}p < .10$ (significant by trend). $^{*}p < .05$.

have been shown to be substantially heritable (e.g., Keller, Bouchard, Arvey, Segal, & Dawis, 1992; Schermer, Vernon, Maio, & Jang, 2011). Similarly, previous studies have reported at least moderate genetic influences on individual differences in status values, such as power and property, as well as in

Table 8
Nuclear Twin Family Model Fitting Results: Variance Components

	Standardized variance components				
Variables	h^2	$a^2m\ (1 + \mu) + a^2f\ (1 + \mu)$	$m^2 + f^2 + 2mf\mu$	c^2	e^2
Value domains					
Benevolence	.40 (.55)	.02 (.03)	.01 (.01)	.00 (.00)	.57 (.41)
Conformity	.27 (.37)	.00 (.00)	.00 (.00)	.11 (.15)	.62 (.48)
Security	.00 (.00)	.00 (.00)	.04 (.06)	.11 (.18)	.85 (.77)
Power	.21 (.29)	.05 (.07)	.03 (.04)	.13 (.20)	.58 (.41)
Achievement	.47 (.62)	.00 (.00)	.00 (.00)	.00 (.00)	.53 (.38)
Hedonism	.12 (.16)	.00 (.00)	.00 (.00)	.13 (.17)	.75 (.67)
Stimulation	.23 (.33)	.00 (.00)	.00 (.00)	.09 (.13)	.68 (.54)
Self-direction	.39 (.62)	.04 (.06)	.01 (.01)	.00 (.00)	.56 (.31)
Average	.26 (.37)	.01 (.02)	.01 (.01)	.07 (.10)	.65 (.50)
Core dimensions					
ST–SE	.47	.00	.00	.00	.53
OC–CO	.41	.00	.00	.00	.59
Average	.44	.00	.00	.00	.56

Note. Corrected estimates for unreliability ($1 - \omega$) are shown in parentheses. ST–SE = self-transcendence versus self-enhancement; OC–CO = openness to change versus conservation; estimates are based on the models with the best parsimony-fit relation (see Table 7); $h^2 = a^2 + d^2$ = heritability estimates (i.e., variance due to additive and nonadditive genetic effects); $a^2m\ (1 + \mu) + a^2f\ (1 + \mu)$ = variance due to passive genotype–environment correlation; $m^2 + f^2 + 2mf\mu$ = variance due to environmental transmission from parents to offspring; c^2 = variance due to sibling-specific shared environmental effects; e^2 = variance due to environmental effects not shared by twins (including measurement error).

prosocial value priorities, such as benevolence, universalism, altruism, and harmony in family and community (Keller et al., 1992; Renner et al., 2012; Schermer et al., 2008; Schermer et al., 2011).

The genetic influence on individual differences in core value priorities may reflect individual differences in core motives underlying human nature. For example, core human motives resulting from the conflict between horizontal strivings for cooperation (i.e., getting along) and vertical strivings for individual superiority (i.e., getting ahead) may underlie the continuum between self-transcendence (i.e., benevolence) and self-enhancement (i.e., power and achievement; Adler, 1927; Rokeach, 1973). The conflict between the natural self-actualization tendency (i.e., stimulation and self-direction) and essential deficiency motives (see Maslow, 1970), such as needs for safety and belongingness (i.e., security and conformity), may underlie the openness to change dimension versus the conservation dimension. Core human motives are anchored in the human nature and may vary due to genetic differences as basic innate units of motivation. They may reflect the genetic core of human values and more specific attitudes that emerge around age 7 and develop depending on external social and cultural influences as important guiding elements of the agentic self in the social community (McAdams, 2015).

If core motives are the innate motivators of basic values that represent complex and abstract evaluations that help to guide us in social life and are expressed through more specific opinions toward people or particular objects in specific situations or particular contexts, then individual differences in more specific attitudes and beliefs may also be partially heritable. For example, individual differences in openness to change (vs. conservation) may be expressed through individual differences in political liberalism (vs. conservatism) in adulthood. In fact, previous studies on adult twins have reported genetic differences in conservatism (e.g., Bouchard, 2004; Eaves et al., 1997; Hatemi, Dawes, Frost-Keller, Settle, & Verhulst, 2011). Similarly, individual differences in ethnocentrism, nationalism, and negative attitudes toward strangers or minorities as sociopolitical expression of self-enhancement (vs. self-transcendence) have been found to be partially heritable (Kandler, Lewis, Feldhaus, & Riemann, 2015; Lewis, Kandler, & Riemann, 2014; Orey & Park, 2012).

The results of our study cast doubt on the conventional wisdom that similarity between family members regarding value priorities results from environmental sources. Although we found significant environmentally mediated parental effects for some value priorities (e.g., benevolence, security, power, and self-direction), the effects were rather small, providing less evidence for value socialization within families contributing to parent–child and siblings' similarity in value priorities beyond genetic contributions. The twin family analyses yielded significant contributions of twins' shared environments beyond parental influences that act to increase twins' similarity. Those effects may reflect intragenerational shared social contexts, such as peer influences, which may be more important as a source of siblings' similarity in value priorities. This may not be surprising because the primary school age marks the beginning of a trend toward independence from parents and an increasing identification with peers (Ryan, 2001).

However, these findings do not mean that parental influences on children's value priorities are negligible. To the contrary, parents may select and choose niches that match their genetically predisposed value priorities. These environmental settings, in turn, may affect their own value orientations (i.e., active genotype–environment correlation) as well as the value priorities of their children (i.e., passive genotype–environment correlation; Scarr, 1992). For example, parents less open to change may choose more traditional living conditions and may typically interact with more conservative people. The current study found some evidence for the passive type of genotype–environment interplay, in particular in the case of power, self-direction, and benevolence.

Other types of genotype–environment interplay are also plausible. Children may differently evoke parental reactions that match their genetically predisposed value orientations (i.e., evocative genotype–environment correlation; Scarr & McCartney, 1983). Those effects act to increase the difference between MZ and DZ twin similarity as a function of their genetic relatedness. Consequently, estimates of genetic effects on the variance in value priorities can also reflect effects due to evocative genotype–environment interplay to some degree.

Moreover, parents' value orientations that are objectively shared by their offspring may differently influence their offspring's value orientations. Siblings may experience, perceive, or interpret the same parental influence differently (Plomin, Asbury, & Dunn, 2001; Plomin & Daniels, 1987). Those environmental influences would be effectively not shared by individuals raised in the same family. They would be unique to individuals and act to make siblings different to each other.

Unique environmental influences on family members' value priorities may also reflect effects from other nonshared social influences, such as different friends. Peers represent important extrafamilial influences that may be shared or not by twins, because they may have different friends and typically different girl- or boyfriends. In fact, the largest source of individual differences in value priorities subsumed environments that are not shared by family members. Those environmental influences act to decrease similarity in value priorities among them and may reflect nonshared peer influences but also individual events. The latter is consistent with previous studies that have shown that individuals adapt their value priorities to individual life experiences (Bardi et al., 2009; Maio et al., 2009).

Socialization influences may also act beyond individual differences in value priorities between families and family resemblance within families. They may affect value hierarchies (Schwartz & Bardi, 2001). Parents may intend to transmit children that specific values are more important than others, in particular those values that are important for the functionality of a society, such as benevolence. Hence, both parents and children should show high average scores in these values. In contrast, power values are likely to increase the probability of conflicts between social groups. Hence, these values should exhibit low societal importance, and thus, both parents and children should show low average scores in these values. Consistent with previous studies (e.g., Döring et al., 2015), our study also provided evidence for this hypothesis (see Table 2).

This study extends previous research on the sources of the development of individual differences in value priorities by using an NTFD. Yet, several limitations have to be mentioned that should be addressed by future research.

First, even though our sample was representative with respect to sex and zygosity distributions, the sample size was relatively small to explore sex differences regarding different genetic and socialization sources of value priorities (e.g., transmission from father to son vs. transmission from mother to daughter). Future studies with larger data sets and balanced distributions of sexes might focus on those sex differences.

Second, our study relied on eight basic values. Even though our findings on the circular structure and the two core value dimensions were comparable to other studies, the original model includes 10 basic value orientations. Moreover, recent research supports a more nuanced discrimination of 19 basic values (Schwartz et al., 2012). Future studies should take this more nuanced structure into account by analyzing the structure of values and the sources of the development of individual differences in value priorities.

Finally, socialization influences can be considered the result of the interaction between parents and their offspring rather than as a unidirectional process. Consistent with this notion, Benish-Weisman, Levy, and Knafo (2013) found that parents differentiate between their own personal values and their socialization values which they want their adolescent children to adopt. In this vein, parents' socialization values were affected by their children's values. Those interaction effects might be worthwhile to examine in longitudinal nuclear twin family studies.

In summary, the current study provided strong evidence for a genetic component in human value priorities that account for parent–offspring resemblance and individual differences between families. The primary source of individual differences, however, appears to unfold their effects individually and acts to decrease family members' resemblance in human value priorities. This is consistent with the notion that individuals adapt their value priorities to be compatible with the opportunities and constraints of the environment they subjectively perceive and are faced with (Schwartz, 2011).

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